EXPLORING THE SUCCESS OF R&D BIOTECH INNOVATORS IN HIGHER EDUCATION INSTITUTIONS: A CASE STUDY OF UPLB AGRICULTURAL INNOVATION

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Marivilla Lydia Bulan Aggarao

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Author: Marivilla Lydia Bulan Aggarao

Dissertation Committee:

Dissertation Advisor _____

(Prof. Dr. Alex Bennet – Bangkok University)

Dissertation Co-Advisor _____

(Dr. Ronald Vatanan-Thesenvitz – Bangkok University)

Chairman _____

(Prof. (Emeritus) Dr. Boonreang Kajornsin)

Ph.D. KIM Program Director _____

(Assoc. Prof. Dr. Vincent Ribière – Bangkok University)

Committee Member _____

(Asst. Prof. Dr. Dongcheol Heo–Bangkok University)

External Committee Representative _____

(Asst. Prof. Dr. Thanawan Sangsuwan)

(Assoc. Prof. Dr. Vincent Ribière)
Ph.D. KIM Program Director - Managing Director IKI-SEA

February 2021

DECLARATION

In accordance with the Bangkok University Honor Code, I certify that my submitted work here is my own work, and that I have appropriately acknowledged all external sources that were used in this work.

February 2021

Marivilla Lydia Bulan Aggarao

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Co-Advisors of dissertation: Dr. Ronald Vatananan-Thesenvitz, Ph.D.

ABSTRACT

Purpose

The study aimed to investigate why and how R&D BIOTECH innovators in higher education institutions achieve success. Specifically, it sought to (1) describe drivers of innovation and the unique characteristics related to the R&D BIOTECH agricultural sector that influence innovation paths to success; (2) identify competencies and attributes that enable successful R&D BIOTECH innovation; (3) describe the innovator success in R&D BIOTECH as supported and encouraged in HEIs.

Design/methodology/approach

The study used a qualitative method employing a single case study research design. The study utilized the following as the collective way of gathering data from eight (8) identified scientists-innovators in biotechnology: Face-to-face, one-on-one, and open-ended interviews. It conducted the descriptive analysis using coding and content analysis which involved tagging the text to other qualitative data using a system of categories.

Findings

Findings showed that external drivers in the areas of Environmental Aspects and External Relations—having unique characteristics related to the R&D BIOTECH agricultural sector—that influence innovation. While natural calamities and societal problems are beyond the innovators' control, pre-cognition can mitigate them.

Further, findings showed a unique competency pattern and specific attributes that enable successful R&D BIOTECH innovation in HEIs. This collection of innovation skills helps them excel, and what makes their contribution unique from the corporate world. In a competitive and aggressive modern society, industries respond through innovation to sustain the company's economic growth, maintain marketability and achieve a lucrative return on investment. In contrast, Biotechnology responds through their technologies according to the community's needs, especially in alleviating the aftershock of natural calamities to people's livelihood. It also revealed that the knowledge sharing process contributes to a successful innovation product that the end-users can utilize, the farmers, and society, bringing social justice.

Research limitations/implications

There is a greater need for more focus on technologies supporting food security and safety in the volatile environment of the Philippines. There is a dire need—and a call—to create more reliable and cost-effective, and up-to-date technologies to address the challenges of food safety and food security for sustainable development. The influencers that surfaced in this study affect innovation. There would be value in exploring those connections more fully in future research.

Practical implications

Biotechnology is a knowledge-rich community that addresses societal problems besetting the community's lives and wellness, and having the opportunity to get the proper knowledge at the right time, capturing and disseminating lead to successful product innovation. Likewise, moved by their observations and unique characteristics and innovation competencies could ignite knowledge either to be successful in their endeavor to produce incremental or radical innovation. All of these are attributed to the successful path to innovation.

Social implications

Agriculture has a significant impact on the environment, and its biodiversity constitutes the groundwork for food security. Therefore, it is imperative that all concerned bodies such as the university, industry, and government work together, collaborate in research and development, and share knowledge, providing the opportunity to become innovatively creative to meet future agricultural challenges to achieve social justice. For instance, universities can convene and host a working group/forum of all concerned stakeholders (university, industry, on food security.

Originality/Value

The distinctive competency pattern and specific attributes that enable successful R&D BIOTECH are a novel contribution to institutions like the Agricultural Higher Education Institutions challenged to produce incremental or radical innovation products. Further, these successful characteristics may stir the mindsets of the giant and influential corporate world to be more sensitive to their corporate social responsibilities and take the brave step toward renewing their approaches and views on innovation.

Keywords: Circular Economy, Core Competencies, Creativity, Higher Education Institution, Innovation Competencies, Innovators-Scientists, Knowledge, Product Innovation, Knowledge Sharing

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Ultimately, to my Creator, who is the true source of everything and my being. To Him be the highest glory.

Marivilla Lydia Bulan Aggarao

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DEDICATION

This humble piece of work is wholeheartedly

dedicated to my loving parents

Mama Mila (+) and Papa Ted (+)

and

Dr Alex and Dr. David

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LIST OF ABBREVIATIONS

The following abbreviations have been used to facilitate understanding and interpretation of the data and results of the research: Abbreviations are used to represent both latent variables and observed variables:

CDS stands for Car Dealers of one US automotive company in Thailand

CEP stands for Customer Experience Performance

CI stands for Continuous Learning

DI stands for Dialog and Inquiry

DLOQ stands for Dimensions of Learning Organization Questionnaire

ES stands for Embedded System

EP stands for Empowerment

KP stands for Knowledge Performance

LO stands for Learning Organization

LOC stands for Learning Organization Culture

OCI stands for Organizational Coaching Interventions

OL stands for Organizational Learning

SC stands for System Connection

SL stands for Strategic Leadership for Learning

TL stands for Team Learning and Collaboration

CHAPTER 1

INTRODUCTION

1.1 Introduction

Research findings confirm that most novel products fail at an increasing rate despite the continuing improvements in the design and development of new products (Bartels & Machiel, 2011; Wilke & Sorvillo, 2003), with an average of 35% - 45% of recent product failures while 80% failure rate in most products. With these alarming rates resulting from the failure, there is a need for organizations, including higher education institutions, to explore possible opportunities to achieve potential success and eschew losses (Hoffmann & Katja, 2010).

With the advent of the technological era and the immediate impact of globalization and the commotion arising from Industrial Revolution 5.0 (IR 5.0), and the alarming concern of the international pandemic, Hoffmann and Katja (2010) discloses that the life cycle of products has shortened.

Higher education institutions and other organizations must produce novel products to satisfy client needs and keep up with the current contexts to remain relevant. The constant development of new products, which most scholars call product innovation, is viewed as a gigantic indicator and leap in an organization's victory and enduring growth (Shimp, 2000) and the clients they serve. While higher education institutions are confronted with the challenge of IR 5.0 and beyond, equally important is that they can fulfill their mandate and mission within the national context. This study, therefore, attempts to explore how a premier national university approaches product innovation.

A good or service or process, or product that is introduced as something new and has significantly improved characteristics or intended uses is called product innovation. Likewise, Hassan (2017) defined Product Innovation (PI) as something that can translate knowledge and ideas into benefits. It may include goods, services, opinions, or processes the customers view as something new. It considers being innovative when it stands out from the rest and makes things easier in the customers' lives. Seemingly, innovation could be incremental, radical, or transformational (Mudrak et al., 2004). From the lens and perspective of this paper and Biotechnology in higher education institutions, agricultural innovations are either improved or new to the organization. They have become fonts for resolving economic and social issues and significantly impacting society, the offshoot of knowledge and creativity.

In addition, with the admission of economic industrialization accompanying its irresistible benefits and challenges, an agriculture-based economy like the Philippines was left behind to enhance its agricultural richness. Why is it so? Almost everyone is enticed to work in air-conditioned offices or rooms, everyone wants to work in the city, and everyone would like to enjoy the advantages of industrialization. For this reason alone, there is less interest in tilling the soil and or investing in agriculture because of decreasing number of agricultural lands due to the gradual industrialization of the country, as stated by Samar Rep. Edgar Sarmiento (de Carbon, 2019).

Cognizant of the crucial role of agriculture, there must be greater attention given to this sector. All country sectors must take action to restore the moral fiber and good image our agriculture has started. For instance, the government must find ways

to develop agricultural policies and infrastructure aligned with the industry's expectations.

Universities offering agricultural programs must be conscious enough to instill in their graduates the remarkable contributions of their technologies in the market. The agricultural industry must be attractive and provide lucrative income that will enchant more young people to pursue agriculture careers. Encourage more creative researchers and innovators who will produce advanced eco-friendly technologies and make the lives of the users better to sustain every Filipino's natural and organic lifestyle.

In the Philippines, institutions and some universities have not been armed adequately in addressing problems related to food production. According to Spiertz and Kropff (2011), agricultural sciences started with a humble circumstantial beginning in philosophy, chemistry, and medicine. For instance, George Mendell (a monk with roots in farming) and Von Liebig (a chemist). They have highly made a significant contribution to the development of experimental research on agricultural sciences, which served as the foundation in Europe. In the Philippine setting, our very own national hero, Dr. Jose P. Rizal (a well-known physician), first embraced and introduced agriculture to Filipinos. In the Philippines, being gifted with cosmic and fecund lands until then, farming was the fundamental source of living for almost Filipinos.

This paper deemed it imperative to focus on technologies in agriculture produced by the innovators in BIOTECH. This action will give an impression in bringing back the heart of every Filipino to recognize and provide more importance to

this sector because of the critical societal need in this area in which the innovators felt from their hearts. How do institutions achieve innovation paths to success?

The researcher specifically identified those individuals or groups working in higher education institutions engaged in innovation practices in this premise. What are the attributes of this innovation? What conditions of the organization systems help move knowledge and creativity to creation? What competencies contribute to innovation in a higher education institution? Is there an agricultural innovation model that may be a reference for the Institute of Biotechnology in higher education institutions?

All educational institutions develop and use knowledge to be globally competitive and innovative, while creativity is the primary seed that sprouts into innovation. The alteration of ideas is understood as creative into concrete new processes or products (Van de Ven, 1986). The creation of new ventures (Drucker, 1998) is a fundamental challenge in innovation management. The successful outcome of all - new services, new processes or practices, and new products- begins with a single individual or a team pondering a noble idea and evolving that idea afar in its initial state (Amabile, 1996; Baer, 2012). In addition, there is a recognition of the link between knowledge, creativity, and innovation in the literature. It deserves an integrative and comprehensive analysis (Saraooghi et al., 2015), thus the need to discern it and look into their interweaving relationships. Unfortunately, several innovation studies have canned innovation as an artifact that is separated from knowledge and skills and not embedded in know-how. This realization inevitably hints at a basic understanding, if not confusion, of what constitutes innovation. As mentioned by (Trott, 2012), one of the most pressing management problems today is

the ability to acquire and utilize the knowledge and apply this to the development of new products. The same plight of HEIs, when learned, contributes to successful product innovation.

As Williams et al. (2008, p. 4) concur, “Knowledge, skills, and innovation have become the source for resolving economic issues and foundation of comparative advantage across all sectors in the economy.” They conclude by saying that they matter very much for business success, particularly in the ‘developed’ world” (p. 12), which is likewise true for higher education institutions.

Moreover, according to the views of Cooper and Kleinschmidt (2007), Henard and Szymanski (2001), and Van der Panne et al. (2003), firms have discovered, amassed, and synthesized the factors relevant to the success of innovation. In short, a voluminous extent of studies on factors that contributed to the success of innovative products has been examined and described for decades. Naturally, the keys to success factors such as organizational environment, management, and leadership were the focus of interest (Rese & Baier, 2011). Still, other factors have not been taken seriously, especially in the context of the education industry. Hence, the study reconnoiters the process of innovation through product innovation within the theoretical background of innovation trajectories or paths (Fuglsang & Sundbo, 2005; Sundbo, 1997; Sundbo & Gallouj, 2000) and the ontology of thematic critical inquiry (Boyatzis, 1998; Roulston, 2001), how knowledge is built, shared and utilized in the development of technology in the agricultural context. Thus, adding to the body of knowledge in Knowledge and Innovation Management, The project’s trajectories or pathways explain the movement and direction of the progress of a technology that originates from specific clusters of actors. In the case of the present study, actors

would mean the forefathers - who happened to be the sole originators of endemic ideas (concerning technology development) and handed them down to the resident scientists-innovators. Bounded by the indigenous knowledge at the individual level, when shared with a team, learning in a community of practice creates a powerful force in achieving successful innovation in BIOTECH R&D. More so, the study looks into the intertwining relationship of knowledge, creativity, and innovation to achieve successful product innovation. Additionally, the trajectories considered in this endeavor are: factors of innovation and innovation competencies as innovation paths to success leading to an innovation path model in higher education institutions. The focus of this case study is within the trajectory from the pertinent unit of analysis from which the individual actors or innovators represent in the realm of BIOTECH and use the thematic analysis in the development of successful product innovation.

Schumpeter (1934; 1939; 1942) was among the first economists to emphasize the importance of new products as an impetus to booming economic growth. To add, not just to the economic development of companies but the economic growth of the end-users. During the 50s, there were commendations on the studies of innovation cycles, one of which was the accumulation of novel knowledge and its application in developing products and processes (Trott, 2012). However, these studies revealed that firms behaved differently (Simon, 1957; Carter & Williams, 1957), including HEIs. In the 60s, studies confirmed findings significant and showed variances in organizational physiognomies (Cyert & March, 1963; Myers & Marquis, 1969: Woodward, 1980). Other than the economic perspective, various factors were considered, such as business management strategy, organizational behavior, and other significant individuals responsible for the new product, including corporate culture.

As we began the 20th century, there was overwhelming debate and argument concerning innovation and what it constitutes. Schumpeter argued that modern firms equipped with R&D laboratories had become the innovative central actors (Cohen & Levinthal, 1990; Prahalad & Hamel, 1990; Pavitt, 1991; Patel & Pavitt, 2000). In contrast, other organizational sectors could innovate more than contemporary firms without sophisticated R&D laboratories. However, this study recognizes research as the basic foundation of innovation.

Debatable arguments become fusty when there is an effort to differentiate keywords, namely: new, creativity or discovery, and often become semantics (Trott, 2012), especially in the education sector. Trott (2012) further explained that what is new to one organization or unit may be considered stale to another. He is simply trying to tell us that we judge things as a success through various lenses, such as commercial advantage or scientific triumph. However, he said, these could be excellent and reasonable goals. Like in the case of the scientists-innovators, their product innovations are understood to satisfy the lives of end-users and not for commercial profit. Hence, innovation is context-dependent. It means that what is regarded as a failure nowadays may be seen as a success in the future. Thus, there is a need to hearten innovation in a way that may help to increase more effective technologies in the academic sector, not just for profit but for the end-users to deliver them from the captivity of hardship and difficulty of life brought about by environmental issues.

What is meant by innovation in the education sector? Christopher Freeman (1982) once wrote, "…not to innovate is to die". Nevertheless, big industries served as market and technology leaders who have demonstrated an ability to cultivate

fruitful novel technologies and innovate and deliver impressive growth and or return to their shareholders. So what could have been the state of product innovation in the academe? Does it yield a return of investments or assets to the end-users, or does their product innovation matter?

Today, however, the resources required in terms of knowledge, creativity, skills, monetary, and market experience mean that significant innovations are directly linked identical to organizations or institutions. Many other industries, including universities, are inclined to create products. The construction, expansion, growth and development, and even commercial attainment of new ideas come from the viable input of various specialists or experts. Henceforth, at present, innovations are related to assemblies of people or agencies.

In any organization, competition has always been a target in the road map to stay in the market. The pressures it brought have forced higher educational institutions to think like businesses do (Brown & Duguid, 2000). That focus has impelled school leaders and managers to ponder programs on how to stay in the 21st century and cope with the ascending changes and challenges. It drove increased attention on venturing into the world of innovation. For example, school leaders seek opportunities to improve their organizations' impact on the mission (Collins, 2005; Mair & Marti, 2006), respond to the advent of technology and the adversities that beset society, and, foremost, sustain economic growth. The answer to similar challenges in other organizations, including universities, is innovation (Christensen et al., 2008; Schumpeter, 1949). As Zahra and Covin (1994) claim that innovation is extensively well-thought-out as the lifeblood of company's survival, growth, and development.

Innovation is crucial for all firms to survive and grow. To refurbish the worth and significance of their asset endowment and sustain market value, they should begin to innovate (Schumpeter, 1934; Warner, 2013). Analogous to the higher education institution is the call for innovation. Gordon (1995) clarifies that innovation is a vital source for an organization, including the university sector, to become successful and sustain economic growth in the future.

The voluminous research literature on innovation has given more attention to the cultural, structural forms and prevailing methods organizations use to sustain innovation. However, limited specific literature on promoting innovation focuses on the connection between knowledge and creativity in other organizations, such as higher education institutions. In addition, innovation has turned out to be the chief concentration and consideration for industry, firms, businesses, and governments, including higher education institutions. It is given recognition as a significant key influence in the long term and growth of the company (Geroski, 1995; Roper & Love, 2002) and to cope with the demands of the changing time. Innovation has become widely documented as a key to competitive success (Francis & Bessant, 2005). It means innovation is an essential source of competitive advantage.

In the 2013 Education Innovation Summit, Bernard Bull, in his 52 Notes and Quotes has noted what Jim Shelton exactly mentioned:

One of the reasons why educational innovations fail is the misuse of knowledge. Either we do not know, or we do not use what we know. Therefore, we need to change the education products because they are often much kludgier than products in other industries (notes from Jim Shelton, Assistant Deputy Secretary at the U.S. Department of Education).

There is a need to transform knowledge to achieve innovation; innovation is a form of putting knowledge into action. Bennet and Bennet (2007a) explain it further as knowledge [is] put into motion; action without knowledge is dangerous. In this context, knowledge is the capacity (potential or actual) to take effective action in given circumstances (Bennet & Bennet, 2005).

Gurteen (1998) says that knowledge is crucial to contemporary professionals who have to produce innovative products and services continuously. Innovation creates value for others. When what one has created has brought value to people, there is innovation. Simultaneously, Creativity is more considerable by creating original, valuable ideas or practical problem solutions. In light of this, Amabile (1983), Sternberg (1988a), and Weisberg (1988) viewed Creativity as both the process of problem-solving or idea generation and the solution or basic theory. Given the focus on higher education institutions, the question becomes: What is the role of educators in helping society solve perennial problems? This fluid query supports what Sand (2003) states, "Educators are key to the transformation of these ideas so that they will contribute to the solution of problems rather than to the increase of existing problems" (p. 1). *Creativity* is an idea that is novel and valuable (Berry, 2012). As stated in the Americans for the Arts (2006), "Creativity is an increasingly essential outcome of education. Moreover, the global, networked society requires citizens to possess various creativity skills for successfully navigating contemporary economic, political, and social realities" (p. 10).

History tells us that creativity is a necessary outcome of education (Grodoski, 2015). It leads us to the question: How are knowledge and creativity engaged to promote innovation in a higher education institution? Understanding the relationship

between creativity and innovation is necessary to explore this question. As Gurteen (1998) introduces,

"Both creativity and innovation concern the process of creating and applying new knowledge. A more useful approach is to view creativity as the process of generating ideas while seeing innovation as the sifting, refining, and, more critically – the implementation of those ideas. Creativity is about generating ideas, and innovation involves putting them into action. Creativity – coming up with new ideas - is not enough" (p. 4).

Innovation as the bisociation of new and existing ideas and putting them into action is what we need (Bennet & Bennet, 2005). Innovation requires both the application of current and the expansion of relevant new knowledge. While creativity which is imminent of new ideas, is the food of innovation, innovation is a much more challenging and complex proposition than creativity (Gurteen, 1998).

Within this frame of understanding, this study identified attributes of the system that help higher education institutions engage knowledge and creativity to promote product innovation. Features entail various factors of innovation and innovation competencies to deliver the quality product innovation to its intended users as a humble contribution to knowledge and innovation management.

According to Phan (2013), regardless of any innovation, different conditions influence innovation differently. This study also revealed significant factors that contributed to successful creation. Moreover, Miles et al. (2009) stressed that models of innovation systems and innovation frameworks had provided policymakers to develop a robust understanding of what impacts innovation across all sectors of the economy.

In his article "Creating the Right Conditions for Innovation," Doss (2017) says, "*We should understand innovation as an emergent factor of systems." While he forwards that it is evident that* conditions cause outcomes, he goes on to say:

However, let us ask ourselves *what* we know about conditions and processes in our organization and *how* we understand and nurture optimal conditions and procedures. We might find ourselves facing a big blank. What is it that we know (and how do we know it) about our "systems," as opposed to "stuff we do" (p. 1)?

Consistent with this finding, this research specifically looked into the conditions of the organizational systems in higher education institutions that engage knowledge and creativity to promote innovation. Bull (2013) cited in the 2013 Education Innovation Summit introduced above, Michael Crow's three natures of educational institutions: (1) Innovation is less necessary by the scholastically or socially elite institutions ; (2) The industrial age institutions that keep trying the same things through and through with the hope to get mixed and improved results. They resist innovation. Thus, exemplars need to help them identify other possibilities and alternatives; (3) The innovator-those who are "breaking from the pack."

In the Philippine educational setting, innovation is the focal mantra of most universities, colleges, and schools, for it simultaneously brings the limelight and status quo to the organizational system. Innovation is touted on various occasions, such as accreditation, Quality Assurance (QA), corporate meetings, performance-based output, and administrative and academic council meetings. However, there is a lack of transparency in its meaning, usefulness, and impact. Under Republic Act 7722, an Act Creating the Commission on Higher Education (CHED), signifies that the university in a knowledge society or knowledge economy is characterized as: …

not just a generator of knowledge, an educator of young minds and a transmitter of culture but also as a significant agent of economic growth, through which the nation builds its human capital to and be at par in the global economy. It is, therefore, vital to encourage Philippine Higher Education Institutions to become platforms for innovation and drivers of competitiveness and economic growth (CMO, No. 52, Series of 2016). It is, therefore, vital to encourage Philippine Higher Education Institutions to become platforms for innovation and drivers of competitiveness and economic growth (CMO, No. 52, Series of 2016).

Finally, according to Alonzo (2012), the voluminous research literature on innovation has given more attention to the cultural, structural forms and prevailing methods organizations use to sustain innovation. So far, there is no specific literature on promoting innovation that focuses on the link between knowledge and creativity in other organizations such as higher education institutions. It gave the researcher interest and supported the above worthwhile endeavor of CHED, to explore how knowledge and creativity can be engaged to promote innovation in higher education institutions by identifying conditions of the system that help move knowledge and creativity toward creation. Ultimately, the intent was to categorize factors and innovation competencies, leading to a model that distinguishes the education sector from industries in the context of its innovativeness. Does the education sector solely innovate to sustain the economic growth of the university and achieve global competitiveness in particular, or do they innovate according to its mandate in response to the needs of the society in general? How is it different from the industries in looking into the essence of innovation?

1.2 Statement of the Problem

Creativity and innovation are the key drivers of economic growth. However, it is the innovation that sustains the long-term shape of the economy. DiPietro (2012) stated that different countries are very creative while other countries are not, innovating at different rates. So when do we say that an organization or unit is creative and innovative?

The study bridged this gap in higher education institutions, looking into their unique characteristics in engaging knowledge and creativity to promote innovation, specifically, attributes of the system such as factors and innovation competencies that contribute to the promotion of successful product innovation.

We often hear top management or officials talk about innovation during top-level management meetings. It is a topic of discussion in training and workshops, seminars and conferences, and during summits. Innovation is also a catchphrase among zenith universities and colleges. Despite this focus, there is no crystal understanding of the differences between creativity and innovation, with the words often being used interchangeably. The researcher had the opportunity to present the Systematic Literature Review (SLR) findings at an international conference in teacher education, and, surprisingly, most of the audience or participants were astonished. It was their first time to hear and realize that creativity is unlikely different from innovation. Ti supports the statement of Amabile (1996) that creativity though essential, is not an adequate condition for innovation, and perhaps there might be other conditions or factors that this research unveiled.

Therefore, we begin this research by studying the differences between creativity and innovation and developing a model or matrix to clarify their concrete

and unique identities and characteristics. This understanding gives justice to their meaning and usefulness and assists in identifying conditions of the system that engage knowledge and creativity to promote innovation. This understanding also provides a foundation for discovering innovation core competencies and supports developing an agricultural innovation path model for higher education institutions. Finally, the results of this research also offer insights into trends and developments in innovative outcomes and recognize probable areas that, when improved, can magnify innovation activities in the future of an organization.

Further, it helps an organization compare its agricultural innovativeness to others in the same field since, according to DiPietro (2012), every organization determines innovativeness differently. However, in the case of higher education institutions (HEIs), there has never been an established innovation competency, especially in terms of the interweaving relationship between knowledge, creativity, and innovation. Hopefully, the created model will be adopted and utilized in the future.

1.3 Research Questions

This research sought to answer the primary question: Why and how do R & D BIOTECH innovators in higher education institutions achieve success? Specifically, the following secondary questions are explored to answer the primary question: (1) What are the unique characteristics of the R&D BIOTECH agricultural sector that influence innovation? (2) What innovator competencies and attributes enable successful R&D BIOTECH innovation in HEIs? (3) How is innovator success in R&D BIOTECH supported and encouraged in HEIs?

1.4 Significance of the Study

Every endeavor has its importance to its respective targets. This study is significant because it augments the limited quantity of knowledge regarding the impact of agricultural innovation in higher education institutions. It explored the drivers of innovation and the innovation competencies that lead to successful product innovation, which could also improve based on the research findings. There has been an increasing call for HEIs to be innovative in all their undertakings – products, programs, processes, systems, procedures, and ideas to be globally competitive and create value among the beneficiaries of the innovative products. Thus, another significant aspect of the study is that it explored the conditions of the organizational system that help move knowledge and creativity to innovation and develop an agricultural innovation path model for higher education institutions. The study will provide policymakers in universities, colleges, and even related organizations a framework to better understand why and how R & R&D BIOTECH innovators in higher education institutions succeed.

Furthermore, the emerging model of the study may be applied as a core analytical framework to find out how R&D BIOTECH can be achieved and explain what can influence innovation success.

In particular, it offers implications for the following:

1. Theory - As regards theory, it capacitates understanding of innovation in the context of higher education institutions.
2. Practice - Concerning practice, it helps organizations develop a solid innovation framework to meet and satisfy the needs of their clients in the community by becoming more sustainable in terms of innovative capabilities.

3. Model - The model emerged from this research, built on the unique characteristics of R&D BIOTECH's agricultural innovation, the role of knowledge sharing and innovation competencies, and the innovation framework that led to the innovation path model for higher education institutions. The model, sideways with the clarity of definitions upon which built the intertwining relationship of information, knowledge, and creativity to achieve innovation, offers a novel and humble contribution to the field of knowledge and innovation management, especially to practitioners in the academe who wish to be globally innovative and competitive.
4. Higher education institutions – The results of this research serve as a doorway for Philippine HEIs to think globally and be at par among its ASEAN members, realizing its mandate to become platforms for innovation and drivers of competitiveness and economic growth for the society and the country in general.
5. Education purpose - Since the buzzword in the 21st century is innovation, it will guide managers, school leaders, and institutions in using the words creativity and innovation, adding value to their use and application.
6. Researchers - Encourage more creative researchers and innovators who will produce advanced eco-friendly technologies and make the lives of the users better to sustain every Filipino's natural and organic lifestyle.
7. Agricultural sector – The farming industry is aggravated, as evident in the model that the societal problems are the impetus for innovation. Hence, Universities offering agricultural programs must be conscious enough to instill in their graduates the remarkable contributions of their technologies in the

market. The agricultural industry must be attractive and provide lucrative income that will enchant more young people to pursue a career in agriculture.

We understand innovation from the perspective of this paper and the lens of Biotechnology in higher education institutions in the field of agriculture, producing technologies either improved or new to the organization and have become fonts for resolving economic and social issues to leave a significant impact on the society, the offshoot of knowledge and creativity.

Cognizant of agriculture's crucial role, there must be greater attention accorded to it. All country sectors must take action to restore the moral fiber and good image agriculture has started. For instance, the government must find ways to develop agricultural policies and infrastructure aligned with the industry's expectations. Universities offering agricultural programs must be conscious enough to instill in their graduates the remarkable contributions of their technologies in the market. The agriculture industry must be attractive and offer lucrative income so that more young people will be able to pursue a career in agriculture, encouraging more creative researchers and innovators who can produce advanced technologies that are eco-friendly to make the lives of the users better in order to sustain a natural and organic lifestyle for every Filipino.

1.5 Participants of the Study

Many research studies have attempted to discover the critical factors that can indicate the success or failure of a novel product. Balachandra (1997) noted that studies show a vast number of factors influencing the success of a new product. Such as success factors in new product innovation, issues instigating failure, and others have considered both arrays of elements (Balachandra, 1997). For instance, some

studies gather data from definite projects. In contrast, others probe executives to rate the impact and significance of factors for the success of projects directly linked to innovation. On the other side of the rope, the researcher collected data from the scientists-innovators themselves to get the primary source of information.

Wilson (1989) argues that "innovations are highly dependent on chief executive officer's (CEO) or presidents' or leaders' capacity and influence to make change possible (p. 227) and the intertwining relationship of knowledge and creativity to promote innovation. Likewise, Drake et al. (2006) have stressed that firms' commitment to investing in innovation may produce valuable outcomes if leaders are made aware of the direct relationship of external and internal factors to firms' innovation capability. In contrast, the study utilized university-based scientist-innovators.

The selection criteria were very limpid – scientists-innovators who went through the rigors of product innovation. Ten (10) identified respondents received the invitation. However, two had a prior commitment abroad for training; thus, eight (8) were final respondents. Nevertheless, they also shared their demographic profile. They even assured the researcher that they supported whatever the study would result based on data gathered from the respondents since they operate within a well-established set of principles, guidelines, and practices embedded in the organizational culture.

According to Alonzo (2012), "creativity and innovation have the unique ability when permitted to flourish, to invigorate the citizens of organizations by providing an abundance of refreshing vantage points from which to enliven one's passions" (p. 12). Nevertheless, even with this finding, more research is needed to

explore the apparent conditions of the system that help promote innovation in the organization where scientists'-innovators' competencies are connected.

The National Institute of Molecular Biology and Biotechnology (BIOTECH), formerly known as the National Institutes of Biotechnology and Applied Microbiology, University of the Philippines, Los Banos, Laguna, was the study site.

1.6 Definition of Terms

Terms are characterized in the context of this research.

Commission on Higher Education Institution – referred to as **CHED,** as outlined by the Congressional Commission on Education (EDCOM) in 1992, looks into the tertiary and graduate education needs and was part of an extensive plan for developments in the country's education system.

Competencies – operationally, it refers to the skills or elements to achieve innovation, which eventually distinguishes from knowledge and creativity in higher education institutions. Competencies encompass a person's indispensable working habit and entirety in discharging his duties and tasks responsibly to satisfy one's terms of reference adequately.

Core competencies – operationally, core competencies are considered the indispensable working habit and entirety of the innovators in the discharge of their duties and tasks responsibly to satisfy one's terms of reference adequately for the people they serve.

Creativity – operationally refers to *the ability to produce novel technology of the acquired information and knowledge.*

Higher Education Institution - refers to **HEI,** vocational universities, community colleges, liberal arts colleges, institutes of technology, and other collegiate-level

institutions, such as vocational schools, trade schools, and career colleges that award academic degrees or professional certifications. Hence, CMO, No. 52, Series of 2016, has encouraged Philippine Higher Education Institutions to become platforms for innovation, competitiveness, and economic growth drivers.

Innovation – operationally, it is applied creation that provides:

- Relevant influence.
- The impact of the change.
- The significance of its effects on the end-users.

Innovation Competencies (IC) – operationally, innovation competencies are the creative knowledge, skills, and attitude to contribute something novel and of value to society, making life more satisfying and grandeur.

Knowledge – operationally, it refers to the backbone of creativity and a gateway for potential and promising innovation output.

Developed Innovation Path Model (DIPM) – operationally, this refers to the developed model, which describes innovation product development with the intertwining relationships of knowledge, creativity, and innovation until technology transfers for social justice.

Knowledge Absorption - operationally, this refers to integrating the valuable part of experiential knowledge into existing knowledge and applying that knowledge in fulfilling the responsibility of creating innovation products.

Knowledge Sharing - operationally, this refers to capturing and optimizing knowledge, specifically that knowledge handed down by the forefathers.

Product Innovation (PI) – operationally, this refers to the product or technology produced by the scientists-innovators for the intended end-users.

State Universities and Colleges (SUCs) – refers to any public institution of higher learning created by an Act passed by the Congress of the Philippines. The national government fully subsidized these institutions and may be considered a corporate body.

Technology - operationally, this refers to the generic term for products or product innovation on agricultural products or other things that the university offers for commercialization.

CHAPTER 2

REVIEW OF LITERATURE

The literature review provides a foundation to explore the answers to the various research questions established by the researcher and find relevant resources to support the findings and observations. This chapter presents a systematic categorization of various readings on dissertations, research papers, and journals according to the following: Higher Education Institutions (HEIs), Information, Knowledge, Creativity, Innovation, Competencies, Theories and Models of Innovation, and concepts that have direct influence to innovation. These high-level areas begin with developing a shared understanding of that concept, focusing on its use in agricultural innovation in HEIs. Unfolding each area is related to the previous area such that a clear differentiation of terms emerges, develops relationships among the terms, and what these terms represent in HEIs is explored. The constructed conceptual framework was out of the reviews and reading materials to guide the study in developing the innovation path model for HEIs. Since this review focuses on the relationship and use of these concepts in BIOTECH higher educational institutions, we begin with building an understanding of higher education institutions vis-à-vis innovation.

2.1 Higher Educational Institutions

This section will understand higher education institutions based on how other countries perceive them. Its definition is unlocked as we use it throughout the study and the challenges it takes vis-à-vis innovation.

2.1.1 Defining Higher Educational Institutions

According to Teichler (2007), at the end of the 20th century, higher education was depicted as the intellectually most demanding stage of pre-career education. Different countries consider defining universities depending on the national context. Ooro (2013) mentioned that although Bologna provided a foundational model of what constitutes a university, it still exhibited specific attributes depending on the context within which it existed and the programs and innovations it adopted. Teichler (2007) continues to say that *universities* within Europe are the "Multidisciplinary institutions dispensing both teaching and research, eligible to award advanced academic degrees and are considered as the key institutions of higher education" (p.15).

For purposes of this research, a *Higher Education Institution* ***(HEI)*** refers to a level of education providing universities, vocational universities, community colleges, liberal arts colleges, institutes of technology, and other collegiate-level institutions, such as vocational schools, trade schools, and career colleges that award academic degrees or professional certifications.

In addition to the features of universities, Teichler (2007) discussed Philippine Higher Education Institutions by Republic Act (RA) 8922, otherwise known as Higher Modernization Act of 1997, the declared policy of the State to establish, maintain, and support a complete, adequate and integrated system of education relevant to the needs of the people and society. It is composed of private and public institutions, otherwise known as the State Universities Colleges (SUCs), and governed by the Board of Regents as mandated by the government, the locus of the study.

A prominent example that higher education is already evolving and at par with other organizations in the sector of society is how they transform themselves in light of a world continuously facing the challenges of globalization and internationalization

and a market-driven society (Ooro, 2013). Similarly, to keep pace with a highly technological- knowledge society, HEIs continuously advance their curricular programs, policies, procedures, processes, products, teaching strategies, structures, and human resources to capacitate every institution member to become innovative.

The Commission on Higher Education (CHED) is the key leader of the Philippine higher education system, effectively working in partnership with other major higher education stakeholders to build *the country's human capital and innovation capacity* toward developing the Filipino nation as a responsible member of the international community. Under Republic Act (RA) 7722, An Act Creating the Commission on Higher Education (CHED), Philippines, and the university in a knowledge economy or knowledge society is characterized as:

> … not just a generator of knowledge, an educator of young minds and a transmitter of culture but also as a significant agent of economic growth, through which the nation builds its human capital to and be at par in the global economy. It is, therefore, vital to encourage Philippine Higher Education Institutions to *become platforms for innovation and drivers of competitiveness and economic growth* (CMO, No. 52, Series of 2016).

With the various models utilized by numerous universities, including the Philippines, there are similarities in the functions of teaching, learning, and research. However, there are specificities vis-a-vis the model the country adopts in particular. There is a comprehensive utilization of knowledge, creativity, and innovation. Nonetheless, there are no traces of the intertwining impact of knowledge, creativity, and innovation in HEIs and how knowledge and creativity are engaged to promote innovation. An explicit model is needed to address this literature gap.

Clark (2004) pointed out throughout the century that, higher education institutions affianced in a significant reorientation that breaks away from traditional practices to stay at the throng of success. An indication that signifies this milestone is the emphasis on innovation, which boosts an institution's capacity to engage in high-level research and competitive training that can best describe as a world-class institution, a capacity that Clark (2004) says exists in both developed and developing countries societies including the Philippines. Thus, the study is interested in understanding the dynamics of innovation, particularly on innovative products in HEIs and how these technologies bring social justice to society and the country.

2.1.2 The Challenge for Higher Educational Institutions

According to Conchada and Tiongco (2015), higher education institutions (HEIs) play a pivotal role in concocting a country to be globally competitive through the skilled human capital resources it produces and putting the country on the world map through its unique and commercialized innovation products. The mission is arduous as the institution has to persistently check itself against the set national and international standards and keep itself updated on the labor market's demands. However, in the study of Paqueo et al. (2011), the quality of numerous higher education institutions in the Philippines has diminished over time, manifested in the quality of their graduates and the lack of resources to engage in innovative activities.

In addressing the ostensible issue, some radical reforms are established, such as rationalizing the structure of public higher education and improving the higher education budget to safeguard resource mobilization and cost-effectiveness (Paqueo et al., 2011). However, HEIs will achieve these reforms if they are firm and innovative and set standards above the minimum requisite. Gordon (1995) clarifies that

innovation is the primary factor to sustain economic growth and future success in the university sector. Is there an established innovation path model for Philippine state universities that could raise the minimum requirement bar of excellence?

Etzkowitz and Zhou (2017) say that the university has been traditionally viewed as a support structure for innovation, providing trained persons, research results, and knowledge to industry. University is both a research and development laboratory and a mechanism through which the nation builds its human capital to enable it to actively participate in the global economy (Angeles, 2017). Moreover, Etzkowitz and Zhou (2017) say that recently the university has increasingly become involved in the formation of firms, often based on new technologies originating in academic research.

Researchers and practitioners recognize that knowledge is an essential factor in creating a competitive edge (Carlile, 2002; Numprasertchai & Igel, 2004) that can bring impetus to development in the organization, most especially to its economic growth, which in turn is the lifeblood of all firms. It conveys that knowledge has become an essential factor for achieving economic development (Djonlagic & Kurtić, 2016) and innovative products. In connection to this, Rowley (2000) affirmed that higher education institutions are in the knowledge business since they are engaged in substantial knowledge creation. As creators of knowledge, universities believe in delivering a substantial impact on the organization's development through their technologies [innovation products] (Williams et al., 2008).

Hence, this research seeks to answer the primary question: Why and how do R & D BIOTECH innovators in higher education institutions achieve success? Furthermore, it pursues to specifically answer the following secondary questions: (1)

What are the unique characteristics of the R&D BIOTECH agricultural sector that influence innovation? (2) What innovator competencies and attributes enable successful R&D BIOTECH innovation in HEIs? (3) How is innovator success in R&D BIOTECH supported and encouraged in HEIs?

2.2 Exploring Knowledge and Information

In this section, we first focus on the definition of knowledge, then explore knowledge in the context of knowledge management (KM), knowledge sharing (KS), and the knowledge economy (KE). Then we will look specifically at the role of knowledge in higher education institutions.

2.2.1 Defining Knowledge

While the term knowledge appears again and again in our everyday conversation, it carries a variety of meanings. The Longman online dictionary defines *knowledge* as the information, skills, and understanding gained through learning or experience. Knowledge refers to the insights, understandings, and practical know-how that we all possess in dealing with the daily conditions of life (Wiig, 1997). Gurteen (1998) viewed it as *know-how* and *know-why.* Knowledge is the totality of knowledge and skills used by individuals to solve problems. However, knowledge also unravels issues and concerns beyond this thought that beset humanity. As Smith (2000a, p. 18) says, "Knowledge is increasingly important as a problem-solving input." How does it solve societal problems besetting the farmers? Generally, we perceive that knowledge is just the *know-how*, while other times, we connect it to a deeper meaning: wisdom (Frost, 2010; Bennet et al., 2010).

As Williams et al. (2008, p. 4) concur, "Knowledge, skills, and innovation have become the source for resolving economic issues and foundation of comparative

advantage across all sectors in the economy." They conclude by saying that they matter very much for business success, particularly in the 'developed' world" (p. 12), and this is likewise true for higher education institutions.

On the one hand, knowledge is the headboard for creativity. Based on the interview with the Intellectual Property Office of the Philippines (IPOPhl), there is no creativity if there is no knowledge. On the other hand, one must know something before creating something new. Out of factual information or knowledge, one can identify the problem or what is lacking from the existing product, systems, and processes, and then new ideas come out, and new products, systems, or processes come out.

2.2.2 Differentiating Knowledge from Information

On numerous practical junctures, we refer knowledge to information. It means one has to have a handful of knowledge and informed decisions to serve the purpose of the current undertaking. Furthermore, Gurteen (1998, p. 6) stresses that "To make knowledge productive – you need information." That knowledge alone is not enough; one needs information and knowledge. Thus, we conclude that knowledge requires information, yet it is information connected to experience and related to action.

Further, Feghali and El-Den (2008) bring in the element of sharing, saying, "It is true that without experience, there is no accumulation of knowledge. Nevertheless, in its truest essence, knowledge can only have meaning if articulated and shared'' (p. 32). Relating knowledge and information, Dziuba (2000) aptly describes:

> Knowledge is the information that is understood, enriched by judgment, and used in action. Knowledge is an accumulation and adequately structured information. It results from a thought process in understanding how to use it.

In this sense, knowledge represents the human ability to interpret information by giving it meaning (p. 25).

Furthermore, according to Bennet and Bennet (2008), information results from association articulated by a set of patterns or any non-random pattern. Data (a form of information) is simple patterns, and data and information are both patterns and will only have meaning when an organism starts to recognize and interpret the patterns to form new products. Tannenbaum and Nash (2002) agree,

> "The firm's ability to apply knowledge and information towards discovering new products and technologies and other related endeavors of the organization whose aim is to optimize the generated knowledge and information results to new product development" (p. 101).

2.2.3 Knowledge Management (KM)

It has come to the attention of scholars that knowledge is an imperative source for value creation in an organization; hence, there is a need to manage it judiciously (Massa & Testa, 2009) to serve its purpose. Thus, the creation of knowledge management. KM has the principles that include the processes, applications, and technologies that help the knowledge worker achieve creativity and bring value to the firm (Carlucci et al., 2004; Gurteen, 1998) and carry the best in every member of the organization. In addition, it consists of acquiring knowledge, assimilation, protection, innovation, and dissemination (Lee & Yang, 2000), which cascades abundantly and smoothly to its prospective consumers. Becerra-Fernandez and Sabherwal (2001) defined KM as:

> "Exploiting what is necessary to get the utmost knowledge resources in an organization becomes the central discipline that stimulates the creation, sharing, and leveraging of the corporation's knowledge" (p. 4).

Further, they add that KM is a mechanism for utilizing all the available human resources, and both tangible and intangible resources make the organization prosper and achieve its short and long-term goals. Wide-ranging literature and case studies support the belief that knowledge management (KM) plays a primary function in managing any business endeavor successfully (Agustin-Perez et al., 2007), which is also applicable to higher education institutions. Hence, the increasing curiosity about managing knowledge has captured the attention of management scholars, including academic scholars.

Knowledge management skillfully creates conditions for increasing creativity and igniting the innovativeness of all employees, including knowledge and human workers. In addition, well-managed knowledge brings an organization's specific and desirable benefits in terms of increased decision effectiveness, loyalty, confidence, quality culture and knowledge" (Chelmecka, 2018, p. 210).

Knowledge management (KM), as defined by Sallis and Jones (2002), is the process of constructively using the information and knowledge inherent in schools to enhance performance, management, and operation. Schools are now considering the idea that economic success will increasingly depend on the knowledge component within the organization to foster, develop, and benefit from the human resources and increases problem-solving capability and the ability to formulate plans for improvements (Sallis & Jones, 2002) and raise the bar.

Organizational performance will be improved and advanced when there is proper location and sharing of knowledge, which is one of the underlying principles of KM (Davenport et al., 1998). As Turban and Aronson (2002) say, knowledge resides within the organization in an unstructured manner through their organizational memory. So that with the help of KM, organizations can identify, select, organize, disseminate, and transfer important information and expertise as needed. Having this practice, Wiig (2004) contends that this will enable the organization to get the most out of the organizational knowledge-related effectiveness and prosperity. Hence, providing a justifiable modest benefit (Hatch & Dyer, 2004) and having the edge over competitors.

Linking knowledge (through KM) to creativity and innovation, Yang and Rui (2009) specifically add, "Knowledge management is a feasible strategy for successful development of new yields" (p. 28) such as products, processes, systems, policies, and structures. Further, KM also extends its function to the staff by strengthening their professional competency, improving the organization's structures and procedures, and, more importantly, translating information into a more valued and lasting asset. Bhusry and Ranjan (2011) directly link their definition of KM as "Managing of organizational information and knowledge by applying skills, experience, innovation and intelligence" (p. 1) towards it.

Given the literature review, for this research, knowledge management is asserted as a bridge for HEIs that will pave the way on the road to innovation. In other words, KM in HEI supervises structural information and knowledge through creativity and skills, vast experiences and aptitude, and metacognitive and decision-making skills to achieve innovation.

Hence, this study aims to explore how knowledge and creativity be engaged to promote innovation in higher education institutions.

2.2.4 Knowledge Sharing

Given the various definitions and classifications of knowledge as well as techniques on how to transform and exploit as reported in the literature (Feghali & El-Den, 2008; Awad & Ghaziri, 2004; Jarvenpa & Eerikki, 2004; Geyer, 2001; Scharmer, 2000; Vasconcelos et al., 2000; Nonaka & Takeuchi, 1995), how does Biotechnology perceive, interpret and utilize knowledge? As Davenport and Prusak (2000) say:

> "Knowledge is an unsolidified mixture of strong structure such as bounded experience, values, contextual information, expert insight, and grounded intuition that provides an environment and serve as a framework for evaluating and incorporating new experiences and information" (p. 5).

Moreover, an excellent argument originates from Bennet and Bennet (2007a) that knowledge is squandered when not acted upon; action with no knowledge is precarious. It means that knowledge is the capacity (potential or actual) to take effective action (Bennet & Bennet, 2004), and thought leaders have tied knowledge to action (Bennet & Bennet, 2005; Wiig, 2004). Feghali and El-Den (2008) bring in the element of sharing, saying, "It is true that without experience, there is no accumulation of knowledge but in its truest essence, knowledge can only have meaning if it is articulated and shared'' (p. 32).

However, according to Gurteen (1998), a person putting knowledge into action must be *competent*. It means three essential elements are necessary - *knowledge* and *skill* and the right motivation and *attitude.* What could be the

innovators' competencies that drove them to put their knowledge into action in achieving the goal of product development? For the new product development to be effective, there must be a continuous sharing and utilization of knowledge to expand its breadth of usefulness in the organization (Nonaka & Takeuchi, 1995). Goldenberg et al. (2001) add that they are of chief significance in the life span of an organization.

In recent times, Biotechnology has introduced product innovations aimed at meeting the needs of industry, community, and national policy but failed to discuss knowledge sharing flow that influences innovation. Knowledge *sharing* is "team members sharing task-relevant ideas, information and suggestions with each other" (Srivastava et al., 2006, p. 4) transferred by the forefather. It means that the acquisition of knowledge is through competent individuals for one purpose in one context (Minciullo & Pedrini, 2015) and Thorisson and Talbot (2018) to produce product innovation. The availability of shared knowledge is necessary for adapting, extending, and creating new knowledge and innovation (Hislop, 2007).

The move towards sustainable agriculture requires a more detailed understanding of farmers' knowledge(s) and knowledge practices. Increasingly, it is vital to understand what farmers understand and how their knowledge practices incorporate others – especially given the emerging call for environmentally-oriented policy measures to move beyond an individual farmer focus (Thomas et al., 2020).

On the other hand, tying knowledge to action allows varying quality (or effectiveness) depending on how well a specific action achieves its anticipated outcome. Since the future is not certain to some extent, knowledge cannot be considered either true or false. There is a probability that its effectiveness is between zero and one; hence, it is always open to some degree of uncertainty (Bennet &

Bennet, 2007a). The knowledge advanced by organizations is frequently vastly tacit. Thus, it is not easy to articulate and codify (Winter, 1987). The truth is that technology transfer is often difficult to transfer without the key individuals. It explains why the dispersion of new technology often depends on the mobility of engineers and scientists (Teece, 1997) and includes scientists-innovators.

There are five components to the transfer of knowledge: the context of the sharing, the source of knowledge, the recipient, the channel of sharing, and the content of what is shared (Desouza & Paquette, 2011). A willingness to share is the source transfers, and the recipient receives—the greater degree of tacitness, the more complex the sharing of knowledge (Pablos, 2006). Desouza and Paquette (2011) point out that sharing "tacit" knowledge is beneficial for the source and recipient to have a common language and understanding related to the content and trust social connections. *Knowledge sharing* is "team members sharing task-relevant ideas, information, and suggestions" (Srivastava et al., 2006, p. 4). The availability of shared knowledge is necessary for adapting, extending, and creating new knowledge and innovation (Hislop, 2007).

Moreover, many scholars emphasize the role of ICTs as a valuable means for facilitating knowledge sharing and communication by reducing time and distance and consequently increasing the quality and reach of reliable knowledge (Fichman et al., 2011). However, the critical issue is to choose and implement appropriate ICTs that provide a close fit between workers and their requirements. Sufficient technology skills, maintenance of ICT systems, and compatibility between ICTs and processes are factors of intense knowledge sharing. Lack of these issues can lead to knowledge

sharing failure even when having appropriate ICTs in place (Bradley et al., 2013; Aron et al., 2011; Guah & Currie, 2004).

Rewards are also essential to motivate actors to participate in knowledge sharing. Knowledge-sharing participants need to see the benefit for themselves in the knowledge-sharing process. Otherwise, they might abandon the knowledge-sharing process when they face the first problem in sharing/receiving knowledge (Peng Lin & Wuu, 2012). So, what sort of rewards could have been the motivation of the participants in the study?

The move towards sustainable agriculture requires a more detailed understanding of farmers' knowledge(s) and knowledge practices. Increasingly, it is important to understand what farmers understand and how their knowledge practices incorporate others – especially given the emerging call for environmentally-oriented policy measures to move beyond an individual farmer focus (Thomas et al., 2020).

This research looks into the weaving pattern of how knowledge is shared and how the participants engage creativity to promote innovation products in Biotechnology of higher education institutions so that products, processes, systems, or the so-called technologies can be shared with stakeholders and commercialized; thus, avoiding frozen potential.

More importantly, whether incremental, radical, or transformationa these technologies [innovations] must be transferred to the industry for utilization. There are two significant categories of innovation: incremental and radical innovation, explicated in 2.6.2. Incremental innovation is improving or revising what has already existed. On the contrary, radical innovation completely changes the technology into a whole new technology.

What is technology transfer? According to the World Bank Technology, technology transfer is the formal and informal transfer of skills, technical knowledge, or technology from public research organizations to industry. It is crucial because knowledge skills technology transfer promotes systematic process innovation that boosts productivity and economic development (World Bank, 2018).

Moreover, according to the United Nations Department of Economic and Social Affairs (2013), technology transfer involves more than hardware supply; it can involve the complex processes of sharing knowledge and adapting a specific technology to meet local conditions. Domestic pro and managerial capacities, institutions, and investments in technological learning influence the effectiveness of which technology can be absorbed and adapted. Publications on the importance of research on knowledge absorption are robust (Chen et al., 2009; Peeters et al., 2014; Senivongse et al., 2019). Both human resources and institutional development are crucial to facilitating technology utilization. Institutional development includes technology and business assessment capacities, incubation, and technology testing and demonstration. Countries' mitigation and adaptive capacities can be enhanced when climate policies are integrated into national sustainable development strategies (United Nations Department of Economic and Social Affairs UN-DESA, 2013).

Republic Act (RA) 10055. This Act shall be known as the “Philippine Technology Transfer Act of 2009”. An Act provides a framework and support system for the ownership, management, use, and commercialization of intellectual property generated from research and development funded by the government and other purposes. This Act aims to promote and facilitate the transfer, dissemination, and effective use, management, and commercialization of intellectual property,

technology, and knowledge resulting from R&D funded by the government to benefit the national economy and taxpayers (Intellectual Property Office of the Philippines, 2018).

Another way to promote commercialization and secure technologies is through Intellectual Property (IP) Code. IP Code refers to Republic Act No. 8293, otherwise known as the "Intellectual Property Code of the Philippines. It recognizes and protects Intellectual Property (IP). IP is the term used to describe intangible assets resulting from the creative work of an individual or organization. IP also refers to creations of the mind, such as inventions, literary and artistic works, symbols, names, images, and designs used in commerce. An example of commercialization is the spin-off. Spin-offs are not necessarily new firms of experienced businesspeople; entrepreneurs take resources from existing companies (Koster, 2005). A spin-off is a new company formed from an existing one. It means that inventors may create a company out of the parent company.

In an article released on their website (Arana, 2019), the Department of Science and Technology-Fairness Opinion Board (DOST-FOB) has approved products picked up by the private sector for commercialization and is currently having to a great extent an impact on the community. What could be some examples of commercialized technologies produced by the participants?

In a short message delivered in one of his speeches, UPLB Chancellor Fernando C. Sanchez, Jr. said that commercialization is a significant step toward ensuring that the University's research outputs are promoted to the general public, allowing UPLB to contribute further to national development. Similarly, Glenn N. Baticados, director of the TTBDO and faculty member at the College of Economics

and Management, vowed that the Center would build good relationships with its stakeholders to bring UPLB's technologies to the market. In an interview, he further said, "With closer ties and collaboration between the academe, the government, and industry, we hope to foster an inclusive innovation ecosystem wherein the University is in touch with the actual needs of the public and industry"

2.2.4.1 Trust. Trust matters in the dispersal of knowledge. Literature shows that there are a variety of factors that influence knowledge sharing in teams. Some factors include personality traits, communication styles, trust, interpersonal attitudes, leadership, diversity of expertise, and team size. Research has found that leadership and trust positively impact team knowledge sharing (Lee et al., 2010). Research even indicates a strong positive relationship between trust and knowledge sharing for all teams (Staples & Webster, 2008). However, when teams collaborate and share information openly, vulnerabilities often surface. Higgins et al. (2010) claim that the best teams understand why they are together, what they need to accomplish, and what each individual expects to do with trust. Messmer (2003) forwards that the increase in project teams requires members to communicate effectively and work well together to yield more excellent value to product innovation. Weiss (2002) forwards that one of the emerging trends in management strategy is re-organizing the company into teams, notably to boost productivity. Furthermore, Bunderson and Sutcliffe (2002) say that by broadening the range of experience and expertise available to a team, functional diversity can promote team effectiveness resulting in a sound and productive output. Johnson et al. (2008) say a work team has three specific properties:

1. The actions of individuals must be interdependent and coordinated.
2. Each member must have a particular, specified role.

3. There must be common task goals and objectives.

On the other hand, when a teammate discovers evidence that leads them to believe they are not trusted, they conceal information, reject influence, and try to take control (Gillespie & Mann, 2005). Pramlal (2004) claims that teams need to be cohesive and practical to succeed in any undertakings, and trust pushes the team to stay cohesive. Further, functional diversity coupled with a trust in another's expertise can promote team effectiveness resulting in a sound and productive output (Bunderson & Sutcliffe, 2002), which means that when they do so, they discuss things among themselves to resolve the issue. In other words, tolerance for making mistakes also plays a significant role in knowledge sharing (Tabrizi & Morgan, 2014). When an organization creates an environment with tolerance for mistakes, professionals will be motivated to report errors and learn from them to improve quality services (Currie & Suhomlinova, 2006). There is leniency in compelling errors because that is where a large amount of learning occurs.

The team is also open to accepting criticism and humble enough to listen to suggestions. According to Bennet and Bennet (2005), "*The simple and profound conscious choice of humility provides an opportunity to ensure freedom of thought ...* it is clear that utilizing the tool of humility moves the individual beyond embedded mindsets, providing an opening for learning from others. It also benefits others. Openness to the thoughts of others allows them to be freer in their thinking, thus increasing their contribution to the diversity of thought and increasing the potential for bisociation" (p. 164).

The interpersonal level of humility means being other-focused rather than self-focused, which includes "empathy, knowing the needs and wants of others and taking

those into consideration in your decisions and actions" (Bennet et al., 2018, p. 2). Each of the eight participants observed characteristics that reflect humility at both the individual and interpersonal levels. These characteristics included: willingness to listen, seeking and honoring truth, rewards not necessary for right actions, receptive to new ways of thinking, focus on others in service, seeking input and perspectives of others, not afraid to admit being wrong, openly addressing weaknesses, responsive to those in authority, grateful for their success and their ability to make a difference for the country, and recognition of a higher power. All of these characteristics surfaced as qualities related to humility in the MQI Research Study (Bennet et al., 2018).

How is trust manifested in the team to achieve a successful innovation product?

2.2.4.2 Community of Practice (CoP). Learning begins with individuals spreading through teams and communities of practice. Communities of practice are people who share a concern or a passion for something they do and learn how to do it better as they regularly interact (Wenger et al., 2002.). Within the team, members discuss and share their expertise among the group. Team design scenarios by sharing ideas and knowledge for future discussions to build up, grow, and sustain the group. According to Durham University Business School (1997), scenario building is a common theme in foresight. Foresight is an attribute or a competence and, specifically, a process that attempts to broaden the boundaries of perception (Laan van der & Erwee (2012) and widen the scope of orientation. On the one hand, Major et al. (2001) argue that foresight has mainly developed due to the extensive literature on business strategy. On the other hand, could foresight also be a strategy used in Biotechnology?

Scenarios move foresight beyond guidance into proactive consideration of desired futures, considering preferable (what you want to happen), probable (what will most likely happen), plausible (what could happen), all based on current knowledge, and possible (what might happen), based on future knowledge (Bennet et al., 2020). Scenarios can be considered pictures (mental representations) of future situations designed to help organizations make better decisions in the present.

The concept of a CoP has been adopted most readily by people in business because of the recognition that knowledge is a critical asset and strategically managed. Communities of practice provide an approach that focuses on people and the social structures that enable them to learn with and from each other (Wenger et al., 2002).

How is CoP adopted in the context of HEIs?

2.2.4.3 Knowledge Absorption. To grow, develop, and be innovative, companies and organizations—including Biotechnology in higher education institutions—need knowledge, an intangible resource (Barney & Clark, 2007) attached to an individual or company that needs to be shared and absorbed. At the same time, other experts incorporate knowledge into the concept of intellectual capital (Stewart, 2010) and even economic gain. So, where does Biotechnology of HEIs refer, and how is knowledge absorbed?

The construct of absorptive capacity emerged in 1989 as a mechanism focused at the organizational level, which enabled the absorption of external knowledge; thus, as an organizational internalization process, it is based on the ability to identify, assimilate and exploit new knowledge, specifically in the area of Research and Development (Cohen & Levinthal, 1989; 1990). Cohen and Levinthal (1990) define

knowledge absorption as the ability to recognize new values of external information/knowledge, assimilate, apply, and be able to predict future technological advancements for commercial purposes.

Knowledge is an essential factor for anyone as a source of innovation, the growth of entrepreneurial values (Drucker, 1985), competitive advantage (Teece, 2007), and an essential source of value creation (Poston & Speier, 2005). This type of knowledge differs from tacit knowledge and explicit knowledge (Nonaka & Takeuchi, 1995), requiring different parameters in terms of knowledge sharing and knowledge absorption. These ideas are also part of knowledge mobilization (KMb), which creates a value stream through the creation, assimilation, leveraging, sharing, and application of resolute knowledge to a bounded community (Bennet & Bennet, 2007a). KMb promotes a living flow of shared understanding among all stakeholders and the means and opportunities to move community-based knowledge to enhance subsequent research-based knowledge development.

In other words, KMb is the ability to bring together knowledge, people, and action to create value, embedding knowledge generation (creation) and knowledge use within the core structure of communities and organizations (Clark & Kelly, 2005). Knowledge characteristics can be measured, transferred, and cumulative (Muizer & Kerste, 2002).

Zahra and George (2002) claim four dimensions of the capacity to absorb knowledge: acquisition, assimilation, transformation, and exploitation. They define *acquisitions* as the ability to recognize the value and acquire critical external knowledge for the company. Knowledge absorption is essential for an individual or a company to achieve success since it can facilitate decision-making capabilities, build

learning (through a learning routine), and stimulate cultural change and innovation (Edwards, 2000). Still, overall performance can improve just when people do things differently.

Susen and Turner (2011) and García-Goñi et al. (2007) argue that innovation depends mainly on the professionals who can create and apply new ideas and knowledge in their daily work. Such emphasis on skills and innovation reflects several efforts to bridge and narrow the current skills and productivity gap (Audretsch et al., 2012; Nakamura et al., 2010).

How is the professional [scientist-innovators] able to create and apply new ideas and share knowledge in their daily task?

2.2.4.4 Knowledge Economy. Knowledge-Economy (KE) is the main engine that advances the Knowledge Society, and the contemporary era has witnessed its turning point to bit change in several forms (Kearney, 2009). This statement relates to the existing state of our education as explicated by Amabile (1998) that we are in the midst of an increasingly rapid transformation in education across dimensions of purpose, content, pedagogy, and methodologies. Technology, social change, increased demand, and the decades-long trend of ever-increasing costs have left us with multiple challenges and the need to be highly innovative in an educational culture that tends to be cautious of change (Amabile, 1998). Almost all institutions, including HEIs, are on guard with inevitable change.

In order to outdo the susceptibility of change, businesses, firms, and various agencies, including HEIs and developed and developing countries, are pushing in aiming for a highly skilled and highly valued economy that is sustainable based on employment, innovation, and education. The development of a knowledge economy is

also a solution to every country's economic and social problems. In order to compare countries' knowledge economy development, the World Bank 2012 developed a framework and identified key knowledge economy pillars. These include:

Education & Training

An educated and skilled population is needed to create, share and use knowledge.

ICT and Infrastructure

A dynamic information infrastructure-ranging from radio to the internet-is required to facilitate the effective communication, dissemination and processing of information.

Economic Incentive & Institutional Regime

A regulatory and economic environment that enables the free flow of knowledge, supports investment in Information and Communications Technology (ICT), and encourages entrepreneurship is central to the knowledge economy.

Research and Innovation Systems

A network of research centers, universities, think tanks, private enterprises and community groups is necessary to tap into the growing stock of global knowledge, assimilate and adapt it to local needs,

and create new knowledge.

Smith (2000b) says that a knowledge-based economy in which all corporate sectors are knowledge-intensive, are responsive to new ideas and technological change, are innovative, and employ highly skilled personnel that are continuously engaged in ongoing learning to adapt to a progressive and aggressive world. A

knowledge-based economy is not simply one that emphasizes the advent of new technologies or even the conglomeration of knowledge. OECD (1996) declares that "Knowledge-based fully recognizes the role of knowledge and technology in economic growth" (p. 9).

Knowledge has grown into a vital and deliberate resource, essential for success and competitiveness and the high-powered value of technology. For this reason, HEIs will experience increased gravity, predisposed by the knowledge economy, globalization, and internationalization, where knowledge, creativity, and innovation are the indispensable foundations for competitiveness and the propensity for change (Cranfield & Taylor, 2008).

In order to survive change and sustain the firms' advantage over competitors, an organization constantly reviews its portfolio. One top consideration is their employees' portfolios, ensuring knowledge workers possess the necessary knowledge, skills, values, attitude, and personalities to dispense their performance and attain social and economic development.

According to Djonlagic and Kurtic (2016), given this call, the knowledge economy has increased the demand for a well-educated and highly skilled educated workforce, especially a workforce with a university degree and intrinsically motivated to innovate. The connection with universities is clear. As Kaya and Sağsan (2016) convene, "Higher education institutions dubbed as knowledge hubs in order to train knowledge workers, a workforce necessary to overcome change and the formation of knowledge hubs will be the foundations of the Knowledge Cities" (p. 291). Therefore, knowledge workers play an increasingly important role, and the centrality of

knowledge underpins competitiveness in knowledge-based economies (Amabile, 1988).

A knowledge economy, then, becomes a driver of innovation. As Chełmecka (2018) explains, “Under a knowledge-based economy, knowledge, intelligence, imagination, mental ability, self-initiative, and creativity are all the capital that drives innovation and development” (p. (216). KE also drives competitiveness. In what appears to be a circular loop, Kaya and Sağsan (2016) say that in response to the competitive economic environment, there has been a significant worldwide increase in knowledge-based economies over the last thirty years, including those institutions that confer degree programs to their graduates. For instance, Higher Education Institutions (HEIs) execute an imperative role in the knowledge-based economy. As knowledge organizations, they can spread knowledge skills, produce a high profile and top graduates, enrich innovation and creativity and contribute efficiently and successfully to the production of knowledge and scholarly outputs (Kok & Abdullah, 2005; Abdullah et al., 2005) in return produce individuals to take effective action out of the knowledge gained and on the job training (OJT).

Hence, there is a need to educate the knowledge workforce and the institution they are connected to because they become knowledge hubs referred to as ‘knowledgization’. Therefore, education, significantly higher education institutions, is vital for knowledge economy development since they are responsible for creating, disseminating, transferring, and spilling knowledge to the industry (Djonlagic & Kurtic, 2016) for creative and productive development purposes.

Without in-depth critical analysis, discussions of modern economies, education and universities, biotechnology, intellectual property, and ICT

development. In the face of global marketplaces and the fluidity of intellectual capital, the idea of the role of primary, secondary, and tertiary education necessitates refashioning in developing nations (Weber, 2011). Correspondingly, Kaya and Sağsan (2016) assert that "Universities can be an avenue to champion the required human capital through the idea of "knowledgization" (p. 292). As Amabile (1998) summarizes:

> "The 'knowledge economy' has shown a high demand for workers who are independent and decisive and are have the ability to be creative and innovative that fuels novel initiatives" (p. 126).

Universities are the main instruments of society for the constant pursuit of knowledge. According to some authors (Sedziuvienne & Vveinhardt, 2009; Shams et al. (2009), there are two incredible viewpoints of knowledge in HEIs, namely: (1) academic knowledge – where learning and teaching activities occur; and (2) organizational knowledge – contains the overall business knowledge of an institution.

Increasingly, industries require and pay knowledge workers because of their expertise. Broadly, companies do not train these workers, but they are paid to share what they know and train others in the company. Therefore, these industries will require Knowledge Workers (KWs) in the knowledge city concept. Drucker (1977) concurs on the importance of knowledge workers by stating, "Treat all knowledge workers and their knowledge as the organization's most valuable assets, and they will never leave the company" (p. 22).

Then, the focus of knowledge work is the human effort, individual and collective. As Dhamdhere (2015) describes,

> "All knowledge generating organizations including higher education academics are engaged in conducting educational and research activities and generating innovative thoughts in the area of concentration to develop knowledge workers who will contribute to advance the organization through their innovations" (p. 100).

Similarly, Martinez-Fernandez and Sharpe (2008) pronounce, "There is an increased recognition to universities as knowledge hubs because they exhibit a strong influence on the intellectual vivacity of the city where they belong" (p. 48). Finally, TIAC (2002) concludes, "Knowledge hub is the society of knowledge within a certain intergalactic, in which HEIs are among those groups" (p. 1).

The knowledge society in public and private sectors, such as research institutes or universities, is comprised of knowledge-driven organizations (Turpin & Martinez-Fernandez, 2003). Where there is a tremendous amount of knowledge formed and conveyed, Acs (2002) calls it the 'system of activities' where there is the spirit of knowledge sharing and transmission of information. Dhamdhere (2015) details:

> "The information produced comes from various scholarly forms such as books, journal articles, thesis or dissertations, technical reports, fact finding reports, case studies, patents, development of test methods and standards, which eventually could be an examples of innovation in the context of HEIs (pp. 162-163).

The knowledge-based economy places a phenomenal position on the dispersal and utilization of information and knowledge and its creation to generate potential outputs that are marketable and can sustain the socio-economic position of individuals

and firms (David & Foray, 1995). It implies, and it becomes clear that universities exude a primary function in the knowledge economy in the 21st century and survive in the techno mania service-based society (Kok & Abdullah, 2005; Pinto, 2013; 2014). Likewise, as learning organizations, higher education institutions (HEIs) produce top-quality graduates and hire and pay for knowledge contributions, capacitating creativity, and innovation. But, in the present context of HEIs, are workers or employees paid for their innovations, or do they produce technologies in response to the problems besetting society?

In this context, KE is making all sectors of the organization knowledge-comprehensive, receptive to bright and new ideas, responsive and adaptive to technological change, and innovative in the pursuit of excelling its mandate and contributing to the people's lives better.

2.2.4.5 The Role of Knowledge in Higher Education Institution. The economy and the society, including the academia in the 21st century, are named 'knowledge-based.' It is in this premise that researchers and practitioners recognize that knowledge is an essential factor in the creation of a competitive edge (Carlile, 2002; Numprasertchai & Igel, 2004) that could bring impetus to development in the organization, most especially to its economic growth, which is the lifeblood of all firms. "Recent development theories tell us that knowledge has become an important factor for achieving economic development" (Djonlagic & Kurtic, 2016, p. 91) and innovation products.

Andriesen (2004) said that in today's economy, knowledge is the engine that drives the development of modern-day companies, including higher education institutions. The book of Nonaka and Takeuchi (1995), "The Knowledge-Creating

Company," shares the same thoughts that only those companies that can create knowledge can be successful in today's world and beyond (Volkov & Garanina, 2007).

In addition, in the 21st century, so-called information society and age of knowledge and in the context of globalization, internationalization, and the modern economy – the importance of knowledge resources increases. Knowledge and information tend to be abundant in higher education institutions, individual or group knowledge. What is lacking is the capacity to use them in meaningful ways and a full appreciation of their value. All educational institutions develop and use knowledge (Bhusry & Ranjan, 2011) to be globally competitive, creative, and innovative. There is a repository of the produced information and knowledge disseminated among the society to utilize for economic growth and development (Dhamdhere, 2015) and the welfare of the society. However, why do educational innovations not succeed?

According to Bernard Bull, in his Quotes and 52 Notes from the 2013 Education and Innovation Summit, Jim Shelton asked: "Why do educational innovations fail? He then went on to say:

> "One of the reasons why educational innovations fail is the misuse of knowledge. Either we don't know or we don't use what we know. We need to change the education products because they are very often much kludgier than products in other industries." (Notes from Jim Shelton, Assistant Deputy Secretary at the U.S. Department of Education).

Dhamdhere (2015) has a comparable comment:

> "Generated and produced information in the academic institute is cyclic in nature because there is no proper and established recording. Thus, they remain as ancient literature and utilization is not maximized (p. 162).

Therefore, "Knowledge and skills have to be practical and functional in producing goods and services" (Smith, 2000a, p. 15; OECD, 1999, p. 11) to attain economic growth. "Innovation as a growth driver is increasingly acknowledged" (Martinez-Fernandez & Toner, 2000, p. 2). Those economies in which the production, distribution, and use of knowledge are the main drivers of growth, wealth creation, and employment across all industrial sectors, including the academic sector, are described as "knowledge-based" or "learning economies" (OECD, 2001a, p. 9).

As Dhamdhere (2015) states, in the hastily moving global economy and society, including the society of academicians, knowledge is a vibrant force to push economic growth forward. Moreover, Peter Drucker, a renowned father of KM, explicitly describes knowledge as the primary reserve for a nation's military and economic strength. Shukla (2012) likewise mentions, "Knowledge is the ideas or understandings that an entity creates to use to take effective action to attain the entity's goals" (p. 3).

All educational institutions develop and use knowledge to be globally competitive and innovative, while creativity is the primary seed that sprouts into innovation. The alteration of ideas creates concrete new processes or products (Van de Ven, 1986), and creating new ventures (Drucker, 1998) is a fundamental challenge in the management of innovation. The successful creation of new services, processes or practices, and products begin with a single individual or team pondering a noble idea and evolving its preliminary state afar (Baer, 2012). The link between

knowledge, creativity, and innovation is recognized in the literature and deserves an integrative and comprehensive analysis (Saraooghi et al., 2015); thus, the need to discern it and look into their interweaving relationships.

The UNESCO World Declaration on Higher Education for the 21st century concedes that "knowledge creation, transmission, and application are the lifeblood of the knowledge-based economy," and higher education institutions are among the primary entities tasked "to generate, transmit, disseminate and apply knowledge." They are a chief component of the nation's research and innovation system.

The Commission on Higher Education (CHED) stimulates, directs, and supports higher education institutions in carrying out their functions as a research and development laboratory in the country to enable colleges and universities to produce high-quality research that will advance learning and national development as well as international comparability of the Philippine higher education system. Accordingly, CHED created the National Higher Education Research Agenda (NHERA) and related allies partners to produce innovative products out of research-based and scientific-based outputs.

NHERA-1 (1998-2008)

The NHERA provides the policies, directions, priorities, and thrusts of Philippine higher education research in the medium to long term. Essentially, it encourages networking among HEIs, with each network focusing on themes. Furthermore, it promotes partnerships/collaboration of HEIs with other research institutions, local and foreign, and industry and private laboratories to conduct research and apply research outputs.

In line with the said mandates, the following goals for higher education research were set for NHERA-I:

• Push the frontiers of knowledge across all the identified higher education disciplines in the country;

• Enhance instruction through original contributions in specialized disciplines thereby encouraging students to become themselves creative, innovative and productive individuals; and

• Develop unifying theories or models which can be translated into mature technologies for the purpose of improving the quality of life of the Filipinos within the sphere of influence of academic institutions in the country.

It in this light that the study develops an innovation path model for HEIs [An HEI Journey on the Path toward Agriculture Innovation].

2.2.4.6. University as a Core Community/Country Resource as A Knowledge Hub and A Knowledge Portal. Knowledge—is a vital component for the economic development of modern economies—for the longest time, has been replaced by the concept of capital and labor as the key players in the economy (Eckl, 2012). However, the communities that flourish in the globalized and knowledge-based economy of the 21st century are those with significant knowledge assets (Goldstein & Glaser, 2012).

Undeniably, globalization pushed companies, both government and private sectors, into competition worldwide, forcing them to adopt market-oriented policies. Competition stimulates firms to persistently innovate, improve quality and reduce the cost of existing products (Necoechea-Mondragón et al., 2013). Likewise, companies can no longer acquire or afford all of the technological and human resources they

need, which constrains their ability to develop flexible relationships with other firms and (most importantly) institutions such as universities (Audretsch et al., 2012). Despite this, an upshot of globalization has been the increasing trend in research over the last 25 years toward involving technology and knowledge transfers from academic institutions to private industry (Siegel et al., 2003).

Since the beginning of the 19th century, universities have had the double role of performing both higher education and research activities. In the last decades of the 20th century, universities also started to be viewed as providers of valuable knowledge for exploitation in practical terms (Necoechea-Mondragón et al., 2013). The relation prevailing between knowledge production in universities, industrial innovation, and economicgrowth are of snowballing interest and has promoted significant changes in the traditional structure of many higher education institutions. These firmly established relations in the framework are—according to Necoechea-Mondragón et al. (2013)—commonly termed the third mission. Subsequently, the transfer of knowledge or technology outside universities and the role of universities in this transfer are currently considered critical elements of the university mission and accomplished in a formally organized way (Rolfo & Finardi, 2012).

The conversion of university research into a knowledge hub that facilitates knowledge sharing is vital for the future of many nations, especially in nations in the developing world (Warren et al., 2008). Universities play a unique role in society, providing an assembly of experts in experimentation and innovation. To retain national competitiveness in the global economy, leaders worldwide have had to push for the primacy of universities (Breznitz & Feldman, 2012).

Currently, the universities in some countries contribute to healthy and sustainable regional economies in numerous ways, such as the site of this study, UPLB BIOTECH. There is a so-called 'milieu,' or co-location effect because universities produce substantial positive economic development effects by attracting and encouraging scientists, engineers, and entrepreneurs to locate in specific geographical regions. These regions have a concentration of highly educated and creative people teaching and conducting research employed by the university (Goldstein & Glaser, 2012) and developing innovation products that are equally useful to society and beyond.

Furthermore, in this decade, research universities are perceived as sources of commercial technology essential to the future of regional economic development, as opposed to institutions dedicated to pure scientific discovery alone (Necoechea-Mondragón et al., 2013). As a result, there have been attempts to replicate the successes of this new approach in universities. Examples are Silicon Valley, the Route 128 corridor around Boston (with MIT at its core), the Research Triangle Park in North Carolina (that has three major universities), and Cambridge in the UK. These examples have frequently influenced policymakers who seek to somehow translate the historical developments in these regions to other locales. However, despite many such efforts (Lambooy, 2004), this effort has been relatively little successful (Warren et al., 2008).

However, universities are not appreciated in developing countries as crucial players in cutting-edge innovation or as leaders of industrial commercialization under globalized conditions. While widely acknowledged as influential institutions, they primarily function as training sites for knowledge workers and as R&D sites for

redevelopment in technology (Necoechea-Mondragón et al., 2013). Even so, rather than acting as innovators, their potential of generating widely-used technological patents or commercialized products has been limited. Moreover, there is often a mismatch between the ambitious goals of the state and the reality of the industry, institutional structure, and marketplace in these countries (Klabbers, 2012).

Another critical factor that has ironically undermined the universities' role is the significant growth of some of the most successful companies. Companies such as Lenovo, Huawei in China, and Telmex, CEMEX, GRUMA, Modelo, and Bimbo in Mexico, have become global companies in their rights, with substantial R&D capacity such that they are no longer dependent on universities as a source of technology and innovation (Necoechea-Mondragón et al., 2013). As a result, universities receive criticisms for being more adept at developing new technologies than moving them into private sector applications. In a similar vein, policymakers have often maintained that the long lag between discovering new knowledge at the university and its use by firms could seriously impact global competitiveness (Siegel et al., 2003).

In technology transfer, it is not only the creation of knowledge that counts, but the flow of this knowledge to the company and the aptitude to absorb and transfer this knowledge (Jarohnovich & Kalnins, 2015). Some researchers have investigated why the inventions from many universities have not been able to produce any meaningful stream of income. There are several reasons. First, they have found that high technology is one of the most challenging things to market. Second, it takes considerable time to successfully license or market good university inventions/patents that often do not make business sense (i.e., cash flow). Moreover, third, the university inventor may have no pre-invention/pre-transfer ties to a potential industrial

user/licensee; in such cases, marketing of the technology is considerably more challenging because it starts from scratch after the disclosure to the University Office of Technology Transfer [OTT] (Swamidass & Vulasa, 2009).

Mission and environment seem as two key drivers of success for the commercialization of technology from universities. The clear establishment of and broad commitment to a defined mission statement is critical to aligning each component of a university technology transfer strategy. The mission of an OTT needs to be defined, or at least supported, at the top levels of the institution's administration (Warren et al., 2008). The alignment of OTTs activities with the broader goals of the institution works to justify the investment of resources required to achieve the expected returns.

2.3 Exploring Creativity

In this section, we focus on the definition of creativity, then investigate the relationship between knowledge and creativity before exploring the role of creativity in higher education institutions.

2.3.1 Defining Creativity

History tells us that creativity is a necessary outcome of education (Grodoski, 2015). So then, how do higher education institutions perceive and judge creativity in their organization? Gomez (2007) noted that diverse scholars had delineated creativity differently. In this light, the researcher presents various definitions of creativity from different perspectives culled from the literature.

We start from the point of view given by Anderson et al. (2001). Viewing the 'New Taxonomy of the Educational Objectives,' *creativity* has been defined "as the

ability to put elements together to form a novel coherent whole or make an original product." Amabile (1996) adds that creativity is to produce something new.

For instance, the same product may be creative in a business firm but not in an academic organization, and that change of the product must be in some way or the other must-have novelty in it. Moreover, products produced may be purposeful in some settings, such as products evaluated for patent protection, but they may not be helpful in all settings (Plucker & Dow, 2010), such such in an educational scenario. For instance, universities offer comprehensive, innovative programs anchored in their respective curricular offerings, serving different purposes and usefulness.

Furthermore, from rigorous scrutiny of research conducted by many intellectual disciplines, including psychology, education, art, and science (Runco, 2004), creativity has been defined explicitly and implicitly for decades (Plucker et al., 2010). Reid and Petocz (2004) forward that it is diverse ways in various disciplines:

> "In education it is called "innovation"; in business "entrepreneurship"; in mathematics it is sometimes equated with "problem-solving", and in music it is "performance or composition" (p. 40).

On the part of psychologists, they have divided creativity into two approaches. First is product-oriented creativity, where novel and appropriate work is produced (Sternberg & Lubart, 2014) Second is the process-oriented creativity, where new ideas, solutions to problems, and the generation self-actualization of individuals (James et al., 2004). Based on the product-oriented creativity approach, Csikszentmihalyi (1996) defines creativity "as an act, idea, or product that changes or transforms an existing domain (p.28).

On one occasion, Pozzi and Ott (2009), "2009 was declared as 'European Year of Creativity and Innovation' by the European Council because Europe needs innovation, and learning systems where creativity is a driving point for innovation, the main influence for the development of personal, occupational, entrepreneurial and social competences of their human capital" (p. 1) so with the Philippines, particularly the higher education institutions. Similarly, according to Amabile (1998), innovation is built on creative ideas as the essential elements of innovation. On the one hand, *creativity* is an idea that is both novel and useful (Berry, 2012).

There is a considerable agreement on defining creativity in its novelty and usefulness, whether products or ideas (Runco, 2004; Simonton, 1999). At the onset, Sternberg (1988a) and Weisberg (1988) refers to creativity as the process of generating idea. So then, what do we do with these generated ideas? What is the role of Biotechnology? Sand (2003) says that educators cum innovators play a primary role in transforming these ideas. As he says, "These individuals are key to transforming these ideas so that they will contribute to the solution of problems rather than to the increase of existing problems" (p. 1).

Further, Plucker et al. (2010) noted that novelty and usefulness had been included in almost all descriptions [of creativity]. It signifies that there must be uniqueness and, at the same time, use of those ideas produced to be engaged in creative endeavor and satisfy a group at some point in time. Who are these groups that may be satisfied Stein may be referring to in the context of Biotechnology in HEIs?

However, Plucker et al. (2004) found that most implicit definitions conformed to the traditional unique-and-useful conceptualization. From this background, Plucker et al. (2004) suggested a new meaning when considering the social context where

there is a manifestation of creativity. “Creativity is the novel and useful product produced either individually or group through their interaction with their environment, process, and aptitude, within a social context” (p. 90).

Such a definition, widely adopted in the literature, broadens yet contextualizes the traditional definition in several ways (Plucker et al., 2010) to suit the social context. First, it emphasizes that judgments of the existence of creativity do not happen in a vacuum and that the context in which the behaviors occur strongly influences creativity evaluations. Moreover, Chełmecka (2018) pointed out that creativity impacts the rise of new, socially believed solutions reinforced by favorable social relationships. Similarly, creativity in education is within a social context.

According to Reid and Petocz (2004), we measure innovative products within the domain set of standards such as guidelines, methods, and notions of creativity. On the one hand, IPOPhl defines *creativity* as the technical solution to a technical problem, creative ability, or action of doing something new, which is close to the definition of HEIs. Specifically, creativity is a trait to produce invention and innovation. However, on the other hand, we are all born with the ability to be creative.

Amabile (1996) offered a similar definition but added something to the definition of creativity. Creativity is the primary phase of innovation. Gurteen (1998) shares the same view. “All innovation commences with creative ideas. Creativity is the initial point for innovation (p. 4) and is a component of innovation. In this view, creativity by individuals and teams is a preliminary stage for innovation, and creativity is a necessary but not sufficient condition for innovation. Perhaps, there must be other conditions in this study explored.

Given the various definitions and the multifarious nature of creativity, academicians find it challenging to agree on a concrete definition (Manzi, 2015) in which the current research gives new meaning in the context of successful innovation of Biotechnology in HEIs. In this research, creativity is the ability to produce novel technology of the acquired information and knowledge.

According to Chełmecka (2018), the expression of this ability is through "openness, originality, and flexibility." This newness of the product or service produced by an individual or group, or institutional product or process, has to be optimized or used by the market for the idea, product, or process to become innovative. The above-perceived statement equally relates to what Mermiri (2009) firmly adheres to products and services are carefully selected based on how they alter people's lives, affect their rational thoughts, and make decisions. In modern times, Dewey (1933), [known to be the father of critical thinking], pointed out that critical thinking includes reflecting on problems or problem-solving, analyzing the status quo, and actively participating in the combination and extracting steps of analysis and conclusion tied to creativity.

Kim et al. (2018) collated definitions of problem-solving abilities from various authors as shown below.

Table 2.1

Definition of Problem-solving

Publication	Definition
Spivack et al. (1976)	The ability to discover and create technologies and methods that can maximize new and diverse problems in everyday interpersonal relationships
D'zurilla & Nezu (1990)	A cognitive, emotional, and behavioral process that attempts to find the best effective response when an individual has a specific problem in their daily lives
Stevenson & Jarillo (1990)	Basic entrepreneurial skill
Warner & Hefetz. (2002).	The ability to create the best solutions to problems while working
Shane (2003)	The ability to define opportunities with new information, such as puzzles

Note. By Kim et al. (2018)

Jabri (1991) describes two independent thinking styles of problem-solving: structured problem-solving styles and intuitive problem-solving ability. While Isaksen (1987) says that intuitive problem-solving styles simultaneously tend to process information from different paradigms, Jabri's (1991) position that intuitive problem-solving ability focuses on problem-solving, not tied to existing rules with multiple ideas but with critical thinking.

The concept of critical thinking is embedded in a core body of research over the last 30 to 50 years and derived from roots in ancient Greek. The word" critical" derives etymologically from two Greek roots: "kriticos" (meaning discerning

judgment) and "kriterion" (meaning standards). Etymologically, the word implies the development of "discerning judgment based on standards" (Elder, 2007).

In addition, critical thinking is about thinking and acting not only for one's good but also for the social good, free from stereotypes, acting by moral principles, and being fair and open-minded (Norris 2014; Mason 2007; Phelan 2001). Zhong (2002) says that critical thinking guides people's beliefs and actions through observing, reflecting, reasoning, and communicating psychological processes, while Zhou (2018) and Wen et al. (2009) claim that critical thinking is conscious and reflective thinking.

2.3.2 Relationship of Creativity and Knowledge

The modern economy has to cope with the demands of globalization and internationalization to remain in the 21st-century. It is essential to reinforce creativity by merging the practices of working together, partaking knowledge, information, and ideas among members of the organization. As Runco (2007) points out: “The relationship between creativity and knowledge and the direction of improving the management of knowledge-based organizations has been demonstrated” (p. 322). How is it established in HEIs?

A creative person constantly searches for knowledge through reading, watching and analyzing films, mingling, and talking with people. In addition, he possesses Socratic questioning, hearing and listening, accepting criticisms and feedback, learning from mistakes, and having the audacity to experience novel things; seize the stars, soar high, catch the sunset, enjoy the rain, and love adventure—going to exotic places, hiking, biking, walking, cooking, and taking care of the nature. This person has many memories to write and develop new knowledge.

Creativity and knowledge have a strong bond that promotes innovation. As described by Caniëls et al. (2014), their relationships are intertwined creation of creative partnerships that have the potential for competence, communication, inspiration, cognitive and educational potential, passion, integrity, and commitment toward one's profession. Furthermore, these partnerships give birth to new opportunities, stimulating creativity and collaboration with the industries, becoming a platform for knowledge exchange and creativity and innovation, thus, bringing benefits to the organization.

Indeed, there is a growing importance of creativity and knowledge and its management in organizations functioning in the knowledge and information society. Chełmecka (2018) describes this relationship clearly:

> "Creativity and knowledge should go hand in hand. Knowledge is valuable when combined with creativity, creating new, inexpensive solutions". Knowledge and information therefore is a practical component for creativity and creativity enables an individual to craft reality" (p. 10).

As can be seen, knowledge and creativity offer tremendous potential for innovation in any endeavor. Creative potential affects social growth and economic development. Creativity influences the emergence of new and reinforced socially accepted solutions by favorable social relationships.

2.3.3 Creativity in Higher Education Institutions

In Article 9 of their statement of Missions and Functions in Higher Education, the World Conference on Higher Education proclaimed creativity as 'an innovative educational approach' (Reid & Petocz, 2004). Creativity lays the foundation of quality and responsive education for the common good. In addition, the growth of a

knowledge economy was directly linked to universities as centers of knowledge creation, with creativity at the core of progress. As stated in the Americans for the Arts (2006),

> "Creativity is an increasingly essential outcome of education. The global, networked society necessitates citizens to possess a variety of creativity skills for successfully navigating contemporary economic, political, and social realities" (p. 10).

Creativity in Higher Education, a project initiated by the European University Association (EUA, 2007) and co-funded by the Socrates Programme of the European Commission, was an exploratory activity intended to enhance understanding of the concept (Winckler, 2007). In this project, the author identified laudable practices and provided higher education institutions and their major external stakeholders with operative references on how to raise creativity.

Creativity has proven to influence research, education, economy, and society (Csikszentmihalyi, 1996), including different country sectors, including agriculture. There is an extensive body of literature on creativity in education, but many of these studies are focused on primary and secondary education, not on higher education (Smith & Vass, 2017) which is the interest of the study. Numerous meta-analyses recap this fiction (e.g., Davies et al., 2013; Mullet et al., 2016).

Higher education institutions face many more challenges today than ever before in history. As World Bank stated as early as 1994, the higher education sector worldwide is pressed with dwindling resources and is still experiencing the same dilemma to date. Hence, the need to be creative and innovative. After all, innovation

is not feasible without creativity (Carayannis & Campbell, 2014). Nevertheless, how true is this statement in HEIs?

Jackson et al. (2006) attest to this observation by saying that higher education has not yet fully recognized the relevance of creativity. Undeniably, "defining creativity in the context of education is one of the challenges researchers are facing" (Bereczki, 2016, p. 1). Even in the larger sense, Bronson and Merryman (2010) point out that even in American society, creativity, in a way, has never really been understood. Jones (2009) explored how creativity could be satisfactorily and objectively assessed if each discipline values and frames it differently. While it is undoubtedly imperative to address the meaning of creativity in education (Smith & Vass, 2017), more importantly, how is creativity construed in different languages and various contexts, especially in terms of innovation products? In this light, the present study considers this gap along with exploring the engagement of creativity in HEIs and its role in the achievement of innovation.

There is greater accountability placed on institutions to be creative in their performance and build a unique niche of their own in terms of innovation and its contribution to the larger society and their educational programs. Their success lies in the capability of their educational leaders and innovation key players to respond to the challenges of society and the country. As Mansouri (2015) describes:

> "As centers of knowledge creation, higher education institutions (HEIs) and, in particular, universities, have to provide academic and social environments that favor the creativity of the budding human (p. 1), in most cases, the innovators themselves.

For this reason, higher education institutions continue to be creative in their products, processes, or ideas to stay in the globally competitive market. Thus, it is a fact that creative education has become a significant urgency in many countries throughout the world, but the style may differ significantly, and the Philippine educational system is no exception.

In addition, Amabile´s (1996) concept of creativity is not only applicable to a problem but may also be related to an opportunity to grow and develop. On the other hand, Manzi's (2015) impression lies in a process-based definition that integrates the product due to the process in HEIs. As can be seen, these differences offer the potential for confusion in a global world where innovation becomes key to an organization's continued success.

Various pandemic problems such as environmental issues, poverty, violence, drugs, ethnic strife, natural calamities, and diseases that can mentally, emotionally, and physically destroy humanity are factors besetting the 21st-century generation. Creativity offers the opportunity to move through these problems. How do the HEIs respond to this reality of the Philippines jammed with environmental issues such as the tremendous impact of climate change that dramatically affects our agriculture sector?

As Sand (2003, p. 1) says, "Creative ability is important to all generations, particularly the next generation and our scientists-innovators of all ages. Individuals need learning experiences to help them bring creative solutions to these problems". Further, higher education institutions are vital to transforming these human resources to contribute to the solution of problems rather than the increase existing problems (Sand, 2003). Tudor (2008) confirms the prominence of human creativity. "With the

upsurge capricious and hastily changing world enveloped with various intricate problems, creativity is a catalyst for innovation, adaptability, and survival" (p.1). Understanding the conditions of the HEIs system that engage knowledge and creativity to ensure the development of the individual's potential to make valuable contributions to society (innovation) is critical to achieving these goals.

2.3.4 Passion and Creativity

Passion is a force behind an action, and it is "something" that drives us, a steering factor (Kunat, 2018). Passion is considered those desires, behaviors, and thoughts that suggest urge with considerable force (Bennet & Scott, 2019). Moreover, passion is associated with motivation (Moeller, 2014) and human emotions (Fisher & Amabile, 2009; Fredricks et al., 2010; St-Louis, Vallerand, 2015).

On the other hand, creativity generates new, original, and valuable products - ideas, concepts, and solutions (Grohman & Szmidt, 2013). Creativity produces unique, novelty, and valuable products, services, processes, or procedures (Hennessey & Amabile, 2010; Peterson & Seligman, 2004; Plucker et al., 2004). It is a group of interconnected and codependent human features: human abilities, a creative approach, openness, and freedom (Karwowski, 2010). Creativity is associated with a person's character, sensitivity to problems, openness, motivation, and cognitive competencies for action-creative abilities (Karwowski, 2009). Finally, creativity is associated with its creative potential (Runco, 2004, 2016; Barbot et al., 2015; Silvia et al., 2016).

Scientists stress that positive emotions make the creative process easier (Kaufman, 2003; St-Louis, Vallerand, 2015). In addition, positive emotions open up human beings and make them more creative (Fredrickson, 2001). Passion is the

source of pro-creative emotions in human creativity (Kunat, 2018) for social transformation.

According to Frijda (2005), passion refers to urges of desires, behaviors, and thoughts with a considerable significant force to act upon them. Batten (1998) says one of the most “notable characteristics of servant leadership is the passion for serving. “Such approaches to servant-leadership unswervingly inspire passionate action, a sense of urgency and commitment” (Lad & Luechauer, 1998, p. 60) and service, which is one of the features of servant leadership because the word “servant” is related to “service” (Asamoah, 2018, p. 107). Bennet and Bennet (2005) used this as an operational definition of passion in their 2005 study of thought leaders, which engaged in Knowledge Management Thought Leaders (KMTL study).

Mihalyi Csikszentmihalyi, derived from the results of his research from 1990- to 1995, developed the ten dimensions of complexity that he called the natural characteristics of creative persons. Very particular was the ninth dimension that states, “Most creative persons are very passionate about their work, yet they can be extremely objective about it as well” (Csikszentmihalyi, 1996, p. 72), thus, linking passion directly to the element of creativity. “Without the passion, we soon lose interest in a difficult task. However, without being objective, our work is not very good and lacks credibility (Csikszentmihalyi, 1996, p. 72). Hence, there is a movement from passion to objectivity, from action to reflection. As Bennet and Bennet (2005, p. 237) stated, “positive passion indicates the value (something precious) and passion, whether positive or negative, is determinant of what is of higher interest and great."

In addition, passion 'is like the fire underneath the soup pot,' 'it heats everything, blends the flavors, and makes those spices mix with the basic ingredients to produce something that tastes wonderful' (Goleman et al., 1992, p. 31), and that brings up creativity in every individual. Passion creates creativity, laughter, and joy. Evans (2017) says there is a structure to humor that includes surprise, which is at the heart of comedy and creativity. "It is about producing something in a new way, a different way, a surprising way ... if you want to be creative in your life or work, it is important to be available to surprise. The best way to surprise people is to spend time immersed in humor to turn on surprise" (p. 1). Evans goes so far as to recommend setting up a daily "laughter break" to move beyond the "freeways of habit." In the play of laughter, the emotions, and turn peptides, flow through the body. Pert (2008) believes that "there is a free flow of information carried by the biochemicals of emotion, the neuropeptides, and their receptors" (p. 276), fully participating in the creative process.

How passionate and creative are innovators in their call to serve humanity?

2.3.5 Role of Spirituality or Religion in Altruism

The word “altruism” is often used interchangeably with a host of other terms, including “aiding,” “helping,” “volunteering,” and “prosocial behavior” (Midlarsky & Kahana, 2007). In altruism, a relatively rare behavior, the intention to help is other-oriented rather than egotistic. Similarly, religion is known for its tremendous influence on its followers, and, most prominently, these behaviors are often depicted as generous or selfless (Bennett & Einolf, 2017; Galen et., 2015).

Yalom and Leszcz (2005), altruism is commonly thought of as unselfish concern and actions for the welfare of others, which fosters personal psychological

growth and increases an individual's ability to connect with others. Theurer and Wister (2010) and Kahana et al. (2013) say that assisting others in the form of volunteer activities and informal support of neighbors are the necessary forms of helping behavior understood on a sense of altruism for action and agency (Piliavin et al., 2002). In addition, Dunlin and Hill (2003); Warburton and McLaughlin (2005); Brown et al. (2005); Poortinga (2006); Parke and Chappell (2008); and Serrat et al. (2018) found that older adults more often than not are helping others because it has a positive effect on their well-being and life satisfaction.

In some respects, understanding the concepts of altruism and religion in practicing specific beliefs is intertwined. Altruism—motivated by the desire to do good deeds or help others without the expectation of reward, reciprocation, or recognition—is significant for all religions (Neusner & Chilton, 2005). Altruism, in the form of love (increasing joy in others) and compassion (relieving suffering in others), and one's happiness, is the natural consequence of altruism (Harvey, 2000). Etter (2019), in her research, suggests that an increase in religiosity correlates to an increase in altruistic intentions and altruistic behaviors. Hence, altruism is an important and even central goal in religions. The expectation is that religion should help each sincerely religious individual—or those with similar spiritual direction those not practicing a specific religion—achieve Altruism.

The term "spiritual" means about the soul, or "standing in relationship to another based on matters of the soul" (Oxford, 2002, p. 2963). The "soul," in turn, represents "the animating principle of human life in terms of thought and action, specifically focused on its moral aspects, the emotional part of human nature, and higher development of the mental faculties" (Bennet et al., 2018, p. 255). As

Csikszentmihalyi (2003, p. 19) says, “An enduring vision in both work and life derives its power from the soul—the energy a person or organization devotes to purposes beyond itself.” As defined, this is the essence of altruism. Thus, spirituality and religion play a significant role in the characteristic of altruism.

Altruism denotes advocacy. According to Anush Begloian, a communication and advocacy expert comes from the Latin "*advocare"* and means to call out for support (Begloian, 2017) without expecting anything in return, selfless service to humankind. The origins of advocacy date back to ancient Rome and Greece, when well-established orators would perform as advocates or wrote orations specifically for pleading someone's cause. Ritu R. Sharma from the Academy for Educational Development, like Begloian (2017), describes advocacy as a tool for putting a problem on the agenda, providing a solution to that problem, and building support for acting on both the problem and the solution. Same thought as that of Flynn and Black (2011) that altruism is unselfish concern and actions for the welfare of others, which fosters personal psychological growth and increases an individual's ability to connect with others.

Advocacy and commitment are couples. Commitment results from tying personal goals and goal setting (Locke et al., 1988). Reviewing one of the articles of Locke et al. (1988), the authors contradicted their previous definition of commitment, concentrated on the self. According to these authors, commitment refers to one’s attachment to or determination to reach a goal, regardless of the goal’s origin. Thus, it can apply to any goal, whether self-set, participative or assigned. Allen and Meyer (1990) and Meyer et al. (2002) have extensively researched two types of commitment: affective commitment and continuance commitment. *Affective commitment* is defined

as "an affective or emotional attachment to the organization such that the strongly committed individual identifies with, is involved in, and enjoys membership in, the organization" (Allen & Meyer, 1990, p. 2). On the other hand, continuance commitment is "a tendency to engage in consistent lines of activity" (Becker & Wilson, 2000; Powell & Meyer, 2004; Somers, 2009; Weibo et al., 2010).

How do the innovators manifest advocacy and commitment in their technologies produced?

2.4 Exploring Innovation

2.4.1 Defining Innovation

In this section, we first focus on the definition of innovation, then differentiate innovation and creativity before exploring the relationship between innovation, creativity, and knowledge. We then delve into generic innovation theories and models, followed by a discussion of innovation in higher education institutions.

There are growing mushroom definitions of innovation. However, to begin defining innovation, Amabile's (1988) almost definitions of innovation are reasonably close to creativity since both emphasize the creation of ideas rather than the application. On the contrary, Siegel and Renko (2012) described innovation as something original or more effective when applied. Other researchers define *innovation* as a process rather than an outcome. Are these post-truths the same in higher education institutions?

In addition, according to Mansouri (2015), “innovation is repeatedly heard and used in the media and everyday conversations. Some may think that it is not relevant to their work or their organization and behave with a “fishmonger” mentality. In the Philippine educational setting, innovation is the focal mantra of most universities,

colleges, and schools around for it brings limelight and status quo to the organizational system. The word “innovation” is heard in accreditation, Quality Assurance (QA), corporate meetings, performance-based output, and administrative and academic council meetings. However, it lacks lucidity in its meaning, usefulness, and impact.

Nevertheless, this study presents some definitions of innovation in different contexts and precisely aligns these understandings in the light of HEIs as it explores the intertwining of knowledge and creativity to promote innovation in higher education institutions. As Gordon (1995) forwards: “Innovation is apparent to be a fundamental key to forthcoming victory in the university sector” (p. 28). There is growing evidence that leaders and innovators play a significant role in fostering innovation in organizations (Stevens, 2014). Moreover, innovation is a vital tool for competitive success (Francis & Bessant, 2005), including the HEIs. “It is, therefore, imperative to encourage Philippine higher education institutions to become platforms for innovation and drivers of competitiveness and economic growth” (CMO, No. 52, Series of 2016).

As long ago in the thirties, Schumpeter (1934) argued that innovation is crucial for all firms to survive and grow. In the fifties, Schumpeter (1950) again argued that to refurbish the worth and significance of their asset endowment and sustain market value, they should begin to innovate, which is analogous to the higher education institution call for innovation. In fact, through relentless innovation and development, firms can sustain their competitive advantage and economic growth (Rastogi, 2002).

In the ’80s, Ettlie et al. (1984) noted the intricacies of research and practice regarding the definition of innovation. In the ’90s, a similar challenge was observed both by Zairi (1994) and Cooper (1998). The lack of conjoint definition of innovation which emasculates understanding of the nature of innovation-led the researchers to grasp innovation in all types of the organization, including HEIs. In addition, Baregheh et al. (2009) maintain that innovation is known to exhibit a fundamental part in fashioning value and satisfying viable advantages in most organizations like the higher education institutions (p. 6). In this proposition, Bessant et al. (2005) agree, emphasizing that “innovation represents the core renewal process in any organization” (p. 136).

In the 20th century, Rogers (2003) viewed innovation as an idea, practice, or object perceived as new by a unit of adoption and carried out into practice. Note the concept carried out into practice. Similarly, OECD (2007) defines *innovation* as “the carrying out of a new or significantly improved product - good or service (p. 46). Gardner et al. (2007) define innovation as “encompassing the entire process—from idea to implementation—for new products, services, processes, practices, and policies” (p. 1052). In other words, something produced is novel.

In another lens, however, innovation, as defined by Fadaee and Alzharh (2014), “Is the process of converting products or ideas into merchantable merchandise or service” (p.1) and usability. Furthermore, the International Organization for Standardization (ISO) 9241-11 says that usability is when a product can achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use (Agarwal & Venkatesh, 2002; Sauro & Kindlund, 2005; Whitehead, 2006;

Peevers et al., 2007). In other words, usability is a doorway for navigating the technology to find its purpose (Selden & Orenstein, 2011).

Usability of the technology is a factor that is given considerable attention to providing an affordable and durable product. Hence, the interview findings agree with the findings of Selden and Orenstein (2011) that usability is a doorway for navigating the technology to find its purpose.

Meanwhile, Hunter (2013) views innovation as "the implementation or creation of something new that has realized value to others (p. 4). Meaning it has transformed others. This concept of ***realized value to others*** distinguishes it from creativity which the study adopts. Drucker (2004) adds that innovation is a purposeful activity characterized by discipline, a systematic, organized way to convert an idea into an innovation that the innovators recognize.

Following Schumpeter (1950), Fuglsang and Sorensen (2011), and Mansouri (2015), *innovation* is something new - products and services, processes and technologies, ways of organizing people and things, business models or organizational processes, markets, and foremost, ways of marketing. What captures innovation in higher education institutions? Mansouri (2015) explicitly defines and views innovation from different perspective:

> "…in economics, management, science, and other fields of practice and analysis, innovation is customarily considered to be a process that conveys innumerable novel ideas in a way that they have a noticeable impact on science, education, economy or society. In the organizational context, innovation may be linked to positive changes in efficiency, productivity, quality, competitiveness and market share (p. 3).

Moreover, Marchal (2012) has added good descriptions of innovation, such as action plans, cooperation, and risk. An organization must build on concrete and workable plans where members cooperate to realize those ideas and take the risk to implement them to make a change in the lives of those benefiting from the innovation. In doing so, either we fail or succeed. As Zahra and Covin (1994) say, "Lest innovation changes what it negotiates the world and brings those offerings, it risks its survival and growth projections" (p. 2).

Additionally, Innovation is going beyond the old practice and having new pathways for solving acute problems or fulfilling [a] mission" (Rockefeller Foundation, 2013, p. 1). In the interim, Damanpour (1991) states, "Innovation is strongly tied to change (p. 34) because when innovation is successfully adopted, it creates a tremendous change in the adoptee. Therefore, change and innovation are a couple.

Drucker (1985) stated that innovation is associated with unwavering change. A reflective attitude capable of imagining what exists or does not, a process grounded in various phases ranging from an idea to its application. Moreover, there are a couple of views regarding innovation shared by various authors: Schumpeter regarded innovation as 'creative destruction' for growth Abernathy & Clark, (1985); Im et al. (2013) and Hargadon (2003) claim that innovation is the recombination of existing ideas; Tidd et. al (2001), it is the core organizational process for renewing and optimizing the generation and delivery of outputs; and Abernathy and Clark (1985) contend that innovation is concerned with the initial market introduction of a new product or process that either disrupt or entrenches existing competencies. One of the

interests of the study is to find out those innovations competencies that led to successful product innovations.

In a nutshell, see Table 2.2 for a shortened list of critical articles and studies showing definitions of innovation.

Table 2.2

Key Definitions of Innovation

Scholar/s	Definition
Schumpeter (1950)	something that is produced is novel
Amabile (1988)	production of ideas rather than the implementation
Rogers (2003)	an idea, practice, or object that is perceived as new by a unit of adoption and carried out into practice.
Drucker (2002)	a purposeful activity characterizes with discipline, systematic, organized way to convert an idea into an innovation
Gardner, Achary, & Yach (2007)	from idea to implementation—for new products, services, processes, practices, and policies
Fuglsang & Sorensen (2011)	development of a new product, service, business model, or organizational process
Marchal (2012)	ideas generation and evaluation, action plans, cooperation, and risk
Siegel & Renko (2012)	a process or object developed by a firm to create something original or more effective.
Rockefeller Foundation (2013)	finding new pathways for solving acute problems or fulfilling [a] mission
Fadaee & Alzharh (2014)	process of converting invention or idea into a marketable product or service
Mansouri (2015)	the implementation of something new -- a new idea, a more effective device or a new process
IPOPhl (2018)	innovation is the product of ones invention

Comparably, see Table 2.3 for the list of key articles and studies offering definitions of innovation made by Stevens (2014).

Table 2.3

Key Definitions of Innovation (Stevens, 2014)

Scholar	Definition
Thompson (1967)	Generating, accepting and implementing of new ideas, processes and products or services
Daft (2007)	Adoption of an idea or behavior by an organization
Rogers (1995)	Innovation is the adoption of an existing ideas for the first time by a given organization
Damanpour (1996)	Adoption of an idea or behavior new to the adopting organization
Slappendel (1996)	The process through which new ideas, objects, and practices are created, developed, and reinvented
Lynn (1997)	Original, disruptive, and fundamental transformation of an organization's core tasks.
Moore et al. (1997)	Large enough, general enough and durable enough to appreciably affect the organization or character of the organization

The common themes shared by those two (2) tables confirm that innovation produces something completely new or that an idea, system, process, procedure, product, or service is adopted and implemented. Are these themes reflected or common also in HEIs?

On the other hand, according to Zheng (2010), "other views on innovation are equally prevalent" (p. 41). For example, innovation is viewed as a paradigm shift,

suggesting an alteration in a model or pattern that is nearly universally accepted (Thomas, 2003; Gassmann et al., 2006; Griffa, 2008).

In a similar study, Zheng (2010) offers a tabular representation of definitions of innovation from various perspectives, as shown in Table 2.4.

Table 2.4

A Summary of the Definitions of Innovation Appearing in Recent Studies (Adapted from Zheng, 2010)

AUTHOR(S)	PERSPECTIVE	DEFINITION OF INNOVATION
Shepherd & Ahmed (2000)	Solution provider	To discover, or reframe, problems for which solutions are needed
Flint (2006)	Knowledge & Customer	New products or services via improved features or lower prices
Jaskyte & Kisieliene (2006)	Organizational	The adoption of new ideas or behaviors that are new to the adopted organization
Sheehan et al. (2006)	Service enabler	New activities undertaken to deliver help, information, or other intellectual content
Selden & MacMillan (2006)	Customer	Identifying and meeting customers' needs
Reena (2009)	Market	Innovation means opening new market opportunities
Wilson (2007)	Knowledge management	The transformation of knowledge into new products, services, and processes
Griffa (2008)	Paradigm shift	Change in a model or pattern that is nearly universally accepted

There seems to be no existing perspective on innovation offered by the academe upon reflecting on the numerous observations on innovation. The research reveals an educational view of innovation through its findings. There is a considerable debate over innovation (Stevens, 2014). Behn (2008) asked the following questions about the concept: What is it? What is the core concept? What needs replication? What variations of the basic concept will work? Furthermore, this study asked, "What are the factors for innovation," or better yet, "What do innovators think as factors that could account for their success as innovators?"

Seemingly, scholars debated and offered various descriptions of innovation within various contexts. Damanpour and Schneider (2006) have similar sentiments saying that, with the countless studies showered on innovation by various disciplines conferring definitions from different perspectives, we see an overlap of its definition. However, there is no general agreement, and the sheer quantity and variety of definitions lead to a state such that no clear and authoritative definition of innovation has emerged. Nonetheless, Adams et al. (2006) made a remarkable comment, "Since innovation is extremely vague and its definition or measure is deficient, there must be a universal definition adaptable and aligned with the prevailing framework of the discipline covering several features of innovation" (p. 22). In this battle cry, the current research unveils innovation within the structure of HEIs. Innovation is the applied creation that provides relevant influence, the impact of the change, and the significance of its effects on the end-users.

2.4.2 Differentiating Innovation and Creativity

Mansouri (2015), "A chairman of the board may be too inefficient and too dull to understand anything about innovation and creativity. As a result, all his decisions

and actions are arbitrary and run against the core meanings of creativity and innovation and run against the general interests of the organization itself" (p. 2). So then, what must a leader do to achieve innovation? What about leaders in the academe? Vicenzi (2000) attests that successful leaders create environments that promote systematic creativity and innovation and eventually result in successful organizations.

In differentiating innovation and creativity, Fallon (2014) reminds us that creativity and innovation are two powerful disputes that frequently misconstrued in a brainstorming exercise, business meetings and corporate mission declarations including faculty and administrative council assemblies. Do school leaders or managers know the difference between them when utilized?" (p. 1), and how do they affect technology creation and transfer? Mansouri (2015) seriously states that everybody is talking about Creativity and innovation these days though they may not know what these two words, or terms, actually mean in theory or implementation.

Likewise, various literature offered voluminous differences between the two, yet we often hear people saying they are interchangeable.

It is evident in the similarity of some of the definitions introduced above for creativity and innovation. However, creativity and innovation are accorded scholarly attention over the years (Amabile & Pratt, 2016), and business and educational leaders and managers commonly interchange creativity and innovation without understanding what separates the two (Fallon, 2014). Nonetheless, both are important for an organization to last longer and realize its mandate for the general public.

Creativity and innovation are two dominant stipulations in academe, particularly in the higher education institutions, for they define the status quo of every

institution. Although every individual institution aims or targets an innovative identification, still on the verge of miscomprehension since there has never been an established distinct disparity between them. Additionally, for all the attention showered on creativity and innovation, there is no concrete model that differentiates them from each other (Amabile, 1988). Hence, this study proposes an innovation model where these constructs are uniquely justified as we progress into achieving innovation products in the context of HEIs.

In this light, the current research through the developed model distinguished their unique differences. One of the recommendations of Anderson et al. (2014) in their narrative review entitled "Innovation and Creativity in Organizations:" State-of-the-Science Review, Prospective Commentary, and Guiding Framework, recommended that future research is needed to identify the full range of individual differences and contextual factors for both creativity and innovation. This study sought to explore these concepts further in the context of discovering a valuable differentiation between HEIs.

To set the parameters for the research, first, let us more or less differentiate the two based on some previous studies. Creativity and innovation are diverse, multifarious, promising, and phenomenal that entail skillful management and governance to exploit the potential of employees and every member of the organization and benefit from new and improved ways of working. Creativity and innovation are vital to an organization's successful performance. "Without creativity and innovation, the world of today would appear quite different; higher education institutions cannot survive and compete" (Mansouri, 2015, p. 2) and cannot maintain their crown of the Center of Excellence [CoE]. Nevertheless, what is precisely the

difference between these two icons that elevate the success of innovation products? This query paved the way for this study to look into their knitting connections that led to the pinnacle of innovation and successful product innovation.

Conversely, Carr and Johansson (1995) defined *creativity* as the generation of ideas and alternatives, while innovation transforms those ideas and alternatives into a practical application that will lead to change and improvement. Koen et al. (2002) and other researchers (Woodman et al., 1993) defines *creativity* as the production of novel and valuable ideas by individuals working together, while innovation is the successful implementation of creative ideas within an organization. For Anderson et al. (2014), creativity is simply the generation of ideas, while innovation is idea implementation. Creativity is linked with ideas generation, while innovation infers ideas transformation into novel goods, services, products, or processes. In this manner, innovation is the application of creative results. Thus, creativity plays a crucial role in the innovation process, leading to successful product innovation.

Furthermore, according to Gurteen (1998), "Creativity which is coming up with new ideas, is not enough. We need innovation which is putting the new or existing ideas into action" (p. 4). Essentially, putting them into action is not enough. Novel products, processes, ideas, and the like must be utilized by the market and or capacitated the life of the consumers/clients—putting value—to be innovative.

Hunter (2013) defines *creativity* as the ability to conceive something original or unusual, while innovation is the implementation or creation of something new that has realized value to others. This definition of Hunter (2013) between creativity and innovation somehow supports the direction of the study. If implemented and has realized value to the end-users, innovation has taken its place; it is safe to say the

ideas, products, and processes that an individual initially creates [the innovators] or group in this study

As revealed by the literature, there were no traces of identifying their unique characteristics. Though there were several accounts recorded for the description between creativity and innovation still, we lack standard general agreement on their differences. Adding to the observation of Mansouri (2015), "restrictions between both concepts are not that distinct." Though many attempts to offer descriptions, it still lacks an agreement generally accepted between creativity and innovation (West & Farr, 1990). Can we separately differentiate the two in realizing successful product innovation in the context of HEIs?

Table 2.5 is a tabular representation of the difference and unique relationship between creativity and innovation offered by some known researchers.

Table 2.5

Tabular Representation of the Difference and Unique Relationship between Creativity and Innovation

Author/s	Creativity	Innovation	Unique Relationship
Amabile (1988); Stein (1974); Woodman Sawyer, & Griffin (1993)	production of novel and useful ideas by an individual or small group of individuals working together	built on creative ideas as the basic elements	The first is a necessary but not sufficient condition for the second and it can stem only from creative ideas that originate within an organization

(Continued)

Table 2.5 (Continued)

Tabular Representation of the Difference and Unique Relationship between Creativity and Innovation

Author/s	Creativity	Innovation	Unique Relationship
Carr & Johansson (1995)	generation of ideas and alternatives	transformation of ideas and alternatives into a beneficial application that will lead to change and improvement.	Both stem from ideas and alternatives
Gurteen (1998)	process of generating ideas generation of ideas	implementation of those ideas. putting them into action	All innovation begins with creative ideas. Creativity is the starting point for innovation
Van de Ven (1986); Amabile et al. (1996); Drazin, Glynn, & Kazajian (1999); Koen et al. (2002) Alves et al. (2007)	creativity by individuals and teams is a starting point for innovation	successful implementation of creative ideas within an organization	Creativity is an incremental factor for innovation
Hunter (2013)	capability or act of conceiving something original or unusual	implementation or creation of something new that has realized value to others	Both stem from something new
Anderson et al. (2014)	idea generation	idea implementation	Both stem from ideas

Summing up, the generation of new ideas is the starting point of creativity; implementation, acceptance, and creation of value to others is innovation. Therefore, creativity becomes the sole accountability of every member of the organization.

Indeed, it is necessary for all levels and dimensions within a team in an organization to attain successful innovation. Alves et al. (2007) claim in their study "Creativity and Innovation through Multidisciplinary and Multisectoral Cooperation" that generating a high number of creative ideas resulted in the developing of innovative products. How do the innovators acquire idea generation?

2.4.3 Relationship of Innovation, Creativity and Knowledge

This section discusses the relationship between and among knowledge, creativity, and innovation from various perspectives and relates it to the context of the higher education institution. The higher education sector needs to prepare its system for the fast and furious service-based economy. Visionary headship assists the growing abundance of knowledge and information and how to optimize such valuable assets; to be implemented, utilized, and create a market value. Nonaka and Takeuchi (1995) have stressed that knowledge-producer organizations tend to become successful even in the subsequent milieu.

The richness of knowledge and information must be shared and put into action. Gurteen (1998), however, pointed out that one must be competent when putting knowledge into action. One must have the knowledge and skill and the right motivation and attitude to have no wasted energy. Bennet and Bennet (2007a) emphasized that knowledge devoid of action is squandered, and action devoid of knowledge is perilous. Moreover, Bennet and Bennet (2007a) said that outcomes of the action result in varying degrees of quality depending on the expected results though it must aim to be of relevance to the community when coupling knowledge to action. Hence, different higher education institutional systems collaborate with various agencies to share and learn from the knowledge workers.

Chelmecka (2018) resonates that knowledge management skillfully creates conditions for developing the creativity of all employees, including knowledge workers. Knowledge sharing is very apparent among knowledge workers in all forms of opportunities – training, workshop seminars, exposure to national and international fora and conferences, and others. Higher education institutions invest in knowledge management and sharing by concocting the workforce to endure in the existing and pressing competitive universal domes (Albertyn & Frick, 2016). Howell and Annansingh (2013) support this idea by saying, "with continuous knowledge sharing, the expertise of employees is enhanced, and potential innovative practices built within the organization" (p. 33).

In other words, one must produce ideas, things, and interpretations that are distinctive and convenient to be involved in a creative activity produced by the forefathers and carried on by the innovators mentored by the forefathers. West and Farr (1990) conclude that we do not overstate the importance of new ideas. Similarly, according to the Intellectual Property Office of the Philippines (IPOPhl, 2018), all knowledge comes from ideas. If there is no idea, there is no knowledge and creativity. As a result, one can be creative in solving a technical problem. It is a creative ability or action of doing something new. Creativity is a trait to produce invention and innovation. Moreover, innovation, according to Christopher M. Kalanje, Consultant, SMEs Division, WIPO is a process from the outset of an idea until it reaches the market to serve its purpose. Ideas come from creative individuals who have the inspiration and motivation to help society and the country.

At the onset, individuals begin to visualize ideas and capture essential thoughts that may arise during the collaboration stage through the cohesive teamwork

exemplified by the innovators. Gradually, there is a weaving of novel and bright ideas, conceiving solutions that are unique in solving existing problems and creating something new as Albertyn and Frick (2016) say, knowledge management and sharing for novelty creation results in creativity. Creativity and innovation are interconnected concepts, and they are by no means alike (West & Farr, 1990) and by no means notable because they are contributory factors for the establishment of knowledge and conversion into business value" (Gurteen, 1998, p. 4) and more importantly achieving social justice.

Variably, Bennet et al. (2018) state a link between the concept of knowledge and creativity. However, it is not necessarily hierarchical, as shown in Figure 2.9, where knowledge and creativity are both considered capacities, with knowledge considered the action lever for creativity. Means, information, and innovation are "things," patterns we can get our hands around. At the same time, knowledge and creativity are capacities; that is, they denote movement, moving information to the application, one result [knowledge] ending in effectiveness, and one result [creativity] ending in use/benefit (Bennet & Bennet, 2008).

A creative person applies her or his innovative capacities—and habitually (Ockuly & Mulyadi, 2013), to creative university employees. This reality is very much related to the study since creativity is a component of being innovative. Ockuly & Mulyadi (2013) in their paper, has asked, "What creative modes can become habitual? Become part of us? How does it happen? Can our creativity change us?" Creativity is an individual ability to build an invention or come up with an idea (Fadaee & Alzharh, 2014) to level up on innovation. Eventually, the current study

adds to the questions above, “How knowledge and creativity are engaged to promote innovation in a higher education institution?”

There has been a discussion on innovation through time immemorial from the point of view of every organization, including HEIs (Chesbrough, 2003; Roffe, 1999a; Damanpour, 1991, 1996; Schoenecker et al., 1995; Lee, 1995; Drucker, 1994; Martinsons, 1993; Gifford, 1992;-Ripley & Ripley, 1992; Russel, 1990; Meyer, 1988). In order to sustain customer demands and lifestyles, optimize the intricacies of technology, exploit opportunities, get better performance results, and improve the mode of living of the end-users, an organization must be into innovation (Baregheh et al., 2009). As Hemlin et al. (2013) argue, “Innovation has been an arena to societal and economic development and prime solutions to the life-threatening dilemmas besetting humanity” (p. 1). In like manner, HEIs through BIOTECH innovate in response to the societal problems besetting the Filipino community.

On the other hand, to reach the pinnacle of innovation, an organization pursues to provide matchless new value and meet current or potential customers' explicit or implied needs. Schumpeterian approach to innovation refers to bringing valuable new products - goods and services to the marketplace.

The educational management team should be alert enough to discern where the firm is going and how to get there to accomplish it magnificently. There is a clear definition of the organization’s goal – innovation, the very cornerstone of survival and growth. Moreover, Gurteen (1998) reiterates that ‘adding and existing’ are the keywords for innovation, which means that innovation adds something new to an existing product or process. The product or process originated from information and

knowledge and function equitably. When it works better or fulfills a different need and creates impact, there is innovation.

The ability to foster innovation in the dynamic and hypercompetitive 21st-century economy is essential for organizational survival. Organizations, including higher education institutions, must embrace innovation to maintain a competitive edge. Read (1996) declares, “The success of a modern knowledge-based organization depends on a grasp of knowledge keenness in creativity and innovation, and adaptability to discovery and inventiveness.” (p. 223). We can vividly see the direct relationship between creativity and innovation in this reality. It explains further the assumption of Atomium Culture (n.d.) that creativity and innovation are deliberately considered key competencies directly related to social and economic progress, effectiveness, and service of organizations in the knowledge epoch.

In an article by Marchal (2012), he discussed the relationship between creativity and innovation and included knowledge in the loop. While creativity concerns looking into new and broader angles, pushing limits, and being receptive to multiplicity, innovation carries into making an extraordinary brand in the community out of the consequences of creating an individual or group has produced. Henceforth, innovation is a complex and dynamic process comprising various facilities and capacities, competencies, and proficiencies, being creativity at the core and knowledge as the proper foundation or the base of the ladder.

Meaning, that before creativity and innovation are connected, knowledge takes its existence. To conceive something new, we need the knowledge to build creative ideas, processes, products, and services-producing something unique that is beneficial to the community. However, with the ostensible products coming around, are they of

value and impact the customers? Innovation achieved the peak of the hierarchy or ladder if these novel things are consumed and have exploited the lives of every consumer and are market-driven.

Undeniably, the efficacious firms are those persistently innovating anchored on the firm's experiences and their in-depth knowledge of things, technological awareness, and high profile workforce (Andriesen, 2004) and its creativity to come up with novel ideas, products, and processes that have tremendously contributed to the success of an organization. Knowledge and creativity proved to be the most remarkable components for innovation in an enterprise (Chełmecka, 2018), including higher education institutions. Subsequently, creativity, innovation, and entrepreneurship create conditions for accelerating the competitiveness of enterprises (Chełmecka, 2018) so as not to lag behind the overlying connection of knowledge and information.

Judge et al. (1997) has observed in the literature that there is little agreement about what kind of organizational culture stimulates creativity and innovation and what conditions of the system motivate creativity and innovation. Martins and Martins experienced akin notice (2002) hence, posed a question, "what type of organizational culture will support creativity and innovation in an organization?" In another lens, this research asks the question: "What conditions of the organization systems help move knowledge and creativity to innovation in higher education institutions?" This research primarily aims to explore how knowledge and creativity are engaged to promote innovation in higher education institutions.

Chełmecka (2018) adds that this relationship is a two-way learning experience. "Creativity enables you to gain new, higher-quality knowledge. The

interaction of creativity and knowledge should translate into the success of any organization, contributing to its effectiveness and maturity" (Chełmecka, 2018, p. 205), which opens the horizon for innovation.

In summary, based on the reviewed literature, this study proposes this stand out premise - with knowledge comes creation, with creation comes innovation so that whatever is thought of **[*knowledge*]** to produce something to be novel **[*creation*]** when is being utilized by the market and impacts lives is **[*innovation*]**. Linking all these concepts in a broader perspective **[*knowledge*]; [*creation*]; [*innovation*]**, the researcher has come up with this resolution: Information is the key to knowledge, and knowledge opens creative ideas, products, or processes. It is the backbone of creativity and a gateway for potential and promising innovation output. In contrast, creativity is the ability to produce novel technology from the acquired information and knowledge. Innovation is applied creation that provides relevant influence, the impact of the change, and the significance of its effects on the end users for social justice.

2.5 Types of Innovation

With the numerous types of innovation at hand that firms, including higher education, can choose from to deliver their mandates and make an impact on the society, it is but befitting and imperative for an organization, according to Goyal and Pitt (2007) to determine the kind of innovation necessary for new product development and unceasing improvement. Nonetheless, according to them, all of these types of innovation function in juxtaposition on countless occasions. Giving an instance, they said, a new product or changes are not possible with similar changes in the process that goes with it or new managing thinking and advertising strategies.

Therefore, innovation is a manner of thinking and action required for organizations' survival and gains. This study maintains this idea that innovators acting upon innovation is a freewill, a mindset coupled with vigor feat considering that it will refurbish the lives of the end-users. Below is a list of the type of innovation adapted from Trott (2012).

Table 2.6

A Typology of Innovations

Source: Adapted to Trott (2005)

Type of innovation	Example
Product innovation	The development of a new or improved product
Process innovation	The development of a new manufacturing process such as Pilkington's float glass process
Organizational innovation	A new venture division; a new internal communication
Management innovation	TQM (total quality management) systems; BPR (business recessing re-engineering; introduction of SAPR3 Note: SAP is a German software firm and R3 is an enterprise resourcing planning (ERP) product
Production innovation	Quality circle; just-in-time (JIT) manufacturing system; new production planning software, e.g. MRP II; new inspection system
Commercial/marketing innovation	New financing arrangements new sales approach, e.g. direct-marketing
Service innovation	Internet-based financial services

Note. Adapted from Trott (2005)

With the advent of the technological era and the impact of globalization, Hoffmann and Katja (2010) found out that products' life cycle has become very short in their study. Nevertheless, organizations, including higher education institutions, are obliged to create new products at frequent intervals to meet the requirements of their customers. Therefore, the constant development of new products, which most scholars call product innovation, is a big necessity for the success of any organization and its long-term growth (Shimp, 2000) and a tool for social justice.

2.5.1 Product Innovation

Research findings confirm that most novel products fail at an increasing rate despite the continuing improvements in the design and development of new products (Bartels & Machiel, 2011; Wilke & Sorvillo, 2003), with an average of 35%-45% of new product failure while 80% failure rate in most products. With these alarming rates resulting from the failure, there is a need for organizations, including higher education institutions, to explore possible opportunities to achieve potential success and eschew losses (Hoffmann & Katja, 2010).

With the advent of the technological era and the immediate impact of globalization and the pandemonium arising from Industrial Revolution 5.0 (IR 5.0), and the alarming concern of the international pandemic, Hoffmann and Katja (2010) discloses that the life cycle of products has shortened.

Higher education institutions need to produce novel products regularly to satisfy client needs and keep up with the current contexts to remain relevant. The constant development of new products, which most scholars call product innovation, is viewed as a gigantic indicator and leap in an organization’s victory and enduring growth (Shimp, 2000) and the clients they serve. While higher education institutions

are confronted with the challenge of IR 5.0 and beyond, equally important is that they can fulfill their mandate and mission within the national context.

A good or service or process, or product that is introduced as something new and has significantly improved characteristics or intended uses is called product innovation. Likewise, Hassan (2017) defined Product Innovation (PI) as something that can translate knowledge and ideas into benefits. It may include goods, services, ideas, or processes viewed by the customers as something new and claimed as innovative when it stands out from the rest and makes things easier in the customers' lives. Seemingly, innovation could be incremental, radical, or transformational (Mudrak et al., 2004). Moreover, according to the views of Cooper and Kleinschmidt (2007), Henard and Szymanski (2001), and Van der Panne et al. (2003), firms have discovered, amassed, and synthesized the factors relevant to the success of innovation.

This study reconnoiters the process of innovation through product innovation within the conjectural background of innovation trajectories or paths (Fuglsang & Sundbo, 2005; Sundbo, 1997; Sundbo & Gallouj, 2000) and the ontology of thematic critical inquiry (Boyatzis, 1998; Roulston, 2001) how knowledge is built, shared and utilized in the development of technology in the agricultural context.

The study chose to focus on product innovation since it is the most evident and tangible measure of innovation and passed the commercialization requirements and proved to impact the end-users, and contributed to social justice. Product innovation introduces a new good or service that has significantly improved characteristics or intended uses (Goyal & Pitt, 2007), leaving a remarkable influence on the community. Likewise, in his research, Hassan (2017) defined Product Innovation (PI) as goods, services, ideas, or processes perceived by the customer as a new thing in life. A

product or an idea becomes innovative when it stands out from the rest and makes the customers' lives easier. Therefore, product innovation in the study refers to the product or technology produced by the scientists-innovators for the intended end-users. Similarly, ***technology*** refers to the generic term for products or product innovation focused on agricultural products or other things that the university offers for technology transfer.

Nurgraha and Mulyadi (2018), in their study, mentioned that an entrepreneur engaged in the micro-creative industry must be able to create and innovate by always displaying product innovation to maintain existing and attract new customers. Conferring to Nurgraha and Mulyadi (2018), creating Product Innovation (PI) is not only based on co-creation experience but must be balanced with the development of creativity and innovation ability (DCI). The concept of co-creation experience (CCE) focuses on the idea of the customer as a value creator in product innovation (PI) interacting with the organization (Nina, 2013). With Nurgraha and Mulyadi's (2018) discussion, do the school-based scientists-innovators involved in product innovation also display creativity and innovativeness to maintain and attract potential clients?

On the other hand, Ünay and Zehir (2012), in their research in the fashion business, say that Product Innovation is related to the creativity of fashion designers/textiles essential to creating a more robust and world-leading international brand, competitive products, and innovation. However, in the academe, the concepts related to product innovation could remain as Center of Excellence (COE) in their respective field.

Despite the crucial importance of being innovative (Ottenbacher & Harrington, 2014), the knowledge about how to achieve success is limited (Johne &

Storey, 1998). As a result, managers in the industry, directors of units, service, and agriculture sectors often rely on gut feeling, speculation, and limited experience about the keys to innovation success (Ottenbacher & Harrington, 2014; Godarth et al., 2015). Higher education institutions are no exception to this crucial reality in innovation. In recent times, higher education institutions have introduced product innovations to meet the needs of industry, community, and national policy but failed to discuss its development and influence.

2.6 Models of Innovation

Management researchers, policy-makers, educators, and practitioners exhibit a great deal of interest in innovation (Delbecq & Mills, 1985; Amabile, 1988) and educational leaders and managers. Considerable attention to creating and developing innovation models, and higher education institutions are starting to take this trend seriously and invest to grab its advantage. Higher education institutions, as the prime producers of human resources, continuously seek to improve their performances, products, processes, and systems by engaging in innovation. Kalanje (2003) has stressed that technologically-based innovation, called 'innovation,' is a central element for fruitful firm performance in a knowledge-driven, globally competitive setting.

Others dwelt on reviewing capacious articles and papers on innovation and offered a similar version. Given the written discussion about innovation in the business media in the industrial research, according to Delbecq and Mills (1985); Amabile (1988), we lag behind a model that is comprehensive in describing the occurrence and factors that influence innovation and higher education is not exempted on this gap. Amabile (1988) points out that both researchers and practitioners need a

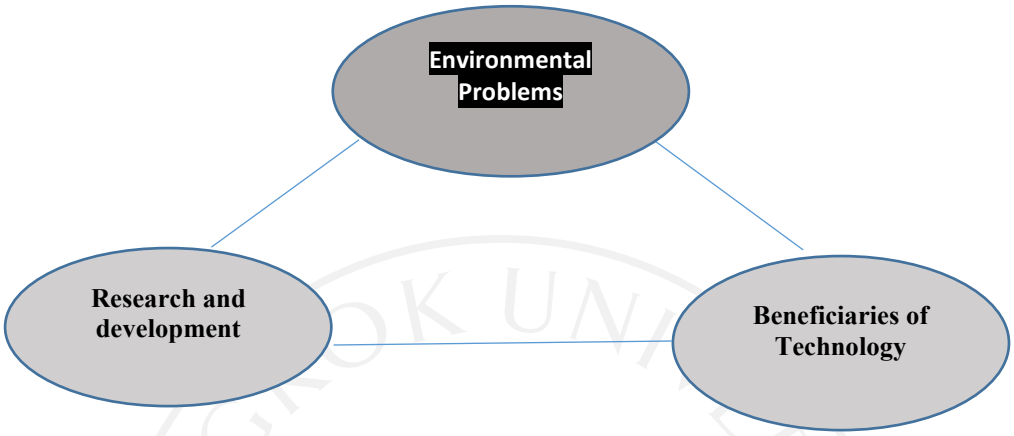
model to encompass existing information and integrate previous for at least three reasons: First, to arouse supplementary research and channel that research toward the significance of the information. Second, to fathom and integrate existing information. Third, to fit current knowledge about innovation in guiding the exercise of cultivating innovation. Having those on the menu, we recognize the principal contribution of knowledge to creativity to innovation.

We note various considerations in framing a model of innovation. For instance, Sengupta (2014) shares these reflections: (1) How does a firm grow?; (2) How does it affect industry growth?; (3) What role does the market play in this framework? These issues are central to the formulation of innovation models in recent times with fast-paced economic productivity. Likewise, in the academe, similar concerns may be raised. How is HEI engaged in innovation? How do leaders build an innovation model in the context of HEI? How does it affect the economic growth of the university? How does it affect the environment, society, and the beneficiaries of innovation? How does it transform the people's lives they serve? How does it affect the market and the different resources?

2.6.1 Simultaneous Coupling

Figure 2.1

Simultaneous Coupling



Based on the structure of the simultaneous coupling model, it is evident that there is no starting point for how innovation occurs, which is similar to the observation of (Trott, 2012); we do not know in advance the marker for innovation. Galbraith (1982) pointed out that factors of innovations include: technology, customer need, manufacturing, or a host of factors, including competition. It concentrates on driving the downstream efforts rather than how innovations occur (Galbraith, 1982). Whereas the linear model can only explain where the initial stimulus for innovation was born, an initial trigger for the idea or need. Moreover, the simultaneous coupling model results from the quick link of the knowledge within all three functions that foster innovation (Galbraith, 1982), similar to the emerging model where natural disasters calamities cause environmental problems to trigger innovation. Given this fact, Cohen and Levinthal (1990) and Trott (1998) say that few firms—including higher education institutions—can scan and search their environments effectively, and only those who do have the ability will thrive and survive and create an impact.

2.6.2 Incremental and Radical Innovation

Product innovativeness, as defined by Olson et al. (1995), is the degree to which the developed product is new to the company and the market. In the real work of Kessler and Bierly (2002); Langerak and Hultink (2006), the gradation of product innovativeness is a broadly used and classically acknowledged exigency factor. According to Griffin (1997), there are different management processes, activities, and outcomes involved in radical and incremental innovations.

Gantumur and Stephan (2011) believed that radical innovation could remodel the industry's structure and reshape the architectural paradigm when carrying out specific tasks. On the contrary, incremental innovation tends to adapt and continue what has been practiced or designed (Kessler & Chakrabarti, 1998). In addition, during the implementation of development tasks, incremental innovations are more likely to receive and reasonably associated with a more straightforward feedback cycle than radical innovation (Gopalakrishnan & Bierly, 2001). Finally, radical innovations involve more transfer of largely tacit knowledge than incremental innovations (Carmona-Lavado et al., 2010); thus, it is tough to transfer.

It is interesting to note the differences between radical and incremental product innovation concerning product innovation development. Radical product innovation departs from the usual and existing routines and practices, requiring new conceptual models in the firm. Contrariwise, incremental product innovation variation in existing customs and practices that rely on existing conceptual models.

Product innovation development involves a team or group of committed and passionate individuals. On one side of the coin (radical product innovation), there is high complexity and uncertainty of fundamental technological changes, frequently

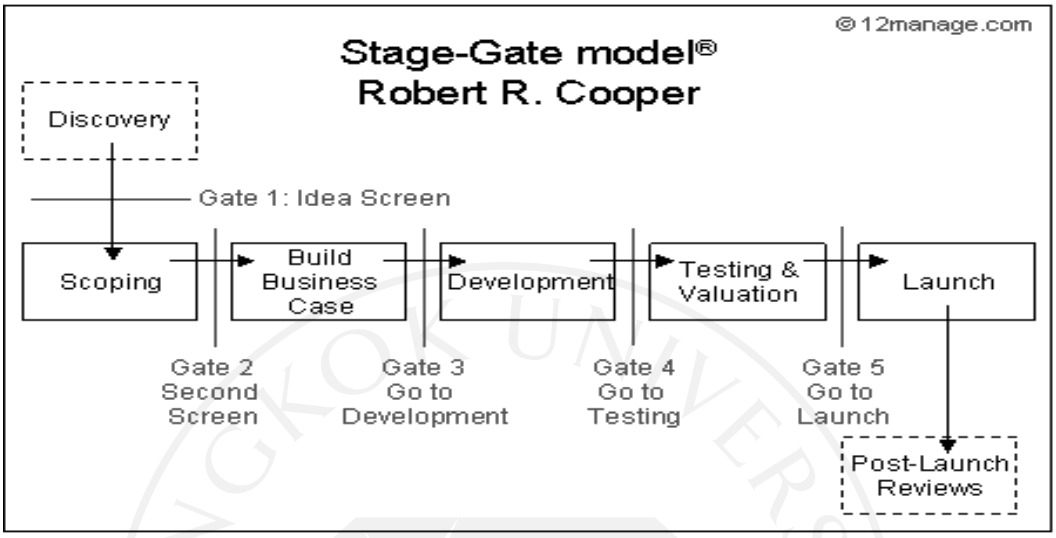
experienced by the project team (Kessler & Chakrabarti, 1998; Garcıa et al., 2008). In contrast, (incremental product innovation), there is a minor product revision or product line extensions for existing markets and customers performed by the project team (Chang & Cho, 2008). Both incremental and radical innovation apply to Biotechnology's product innovation in higher education institutions.

2.6.3 Stage Gate Model

Stage-Gate® is a value-creating business process and risk model designed to quickly and profitably transform an organization's best new ideas into winning new products. When organizations embrace it, it creates a culture of product innovation excellence - product leadership, accountability, high-performance teams, customer and market focus, robust solutions (Edgett, 2014), alignment, discipline, speed, and quality. In addition, there is a belief that product innovation begins with ideas and ends once a product is successfully launched into the market (see Fig 2.2). In contrast, the innovation process in HEIs starts from ideas rooted in the social problems, but it does not end even when the product innovation has successfully reached the market because innovators tend to see the impact of their products still.

Figure 2.2

Stage-Gate Model



Note. Adapted from Robert Cooper, 1990

Later, the stage-gate process was preceded by a discovery stage of the original model, which had only five phases. It contains pre-work designed to discover opportunities and generate new ideas. Is there a similarity between this business model to the emerging model in HEIs?

The Stage-Gate Process

1. Scoping. It is the process of preliminary investigating each project quickly and provides inexpensive information by desk research to enable narrowing the number of projects.
2. Build the Business Case. It is the process of investigating in a much more detailed way by primary marketing and technical research. The business case must include a product definition, a product justification and a project plan.

3. Development. It is the process of designing a detailed and developing of new product along with some simple product tests. Also a production plan and a market launch plan are developed.
4. Testing and Validation. It is the process of testing the product extensively product in both the marketplace, the lab and the plant.

The Gates

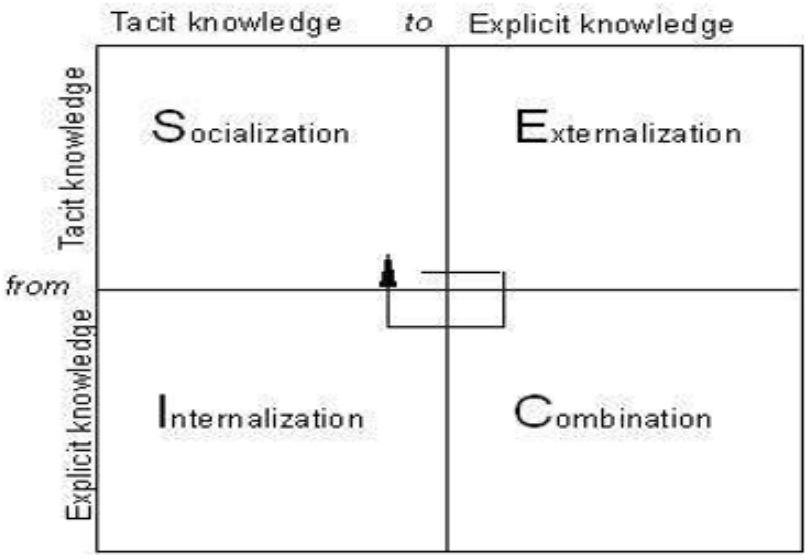
Preceding each stage, a project passes through a gate where a decision is made whether or not to continue investing in the project **(a Go/Kill decision).** These serve as quality-control checkpoints with three goals: ***Ensure quality of execution****, (2)* ***Evaluate business rationale*** *and (3)* ***Approve the project plan and resources****.*

2.6.4 The SECI Model

The SECI model is known as the Knowledge Creation model (Nonaka & Takeuchi, 1995), which describes that knowledge types can be combined and converted, showing how knowledge is shared and created in the organization, as shown in figure 2.3 below. Nonaka's (1994) view of knowledge creation involves transforming knowledge types between tacit and explicit. He argues that to create new knowledge, individuals in organizations take existing knowledge and change it into a new form of knowledge. There are four means of knowledge conversion such as: tacit to tacit (Socialization), tacit to explicit (Externalization), explicit to explicit (Combination), and explicit to tacit (Internalization).

Figure 2.3

The 'engine' of Knowledge Creation



Note. Adapted from Nonaka & Takeuchi, 1995

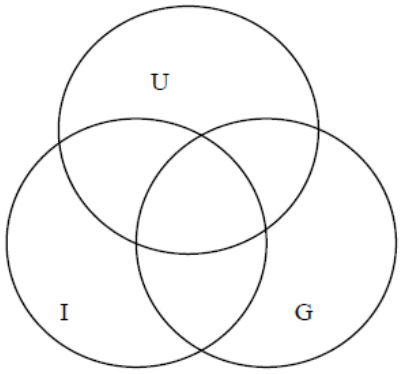
Nonaka (1994) also developed the Ba concept that, along with the SECI model, contributes to understanding knowledge creation. The Ba concept describes a shared physical, virtual, or mental space for individual relationships to converge to create new knowledge. Ba serves as an area where the exchange and creation of new ideas are encouraged and allows individuals to interact with other individuals and the environment. In this model, knowledge is converted and created as users practice, collaborate, interact, and learn. The process is a continuous, dynamic swirl of knowledge rather than a static model.

In like manner, where and how do innovators in Biotechnology exchange and create knowledge? How do they encourage each other to share and utilize knowledge?

2.6.5 Triple Helix Model

Figure 2.4

Triple Helix-Field Interaction Model



Note. Adapted from Etzkowitz, 2003

Another theory found related to the study is the triple helix model. Triple Helix Theory proposed an innovative model of a nonlinear and spiral type. University, industry, and government closely collaborate in sharing resources to improve their efficiency in innovation (Etzkowitz, 2005). Furthermore, according to Etzkowitz (2003), the triple helix model postulates that the interaction between industry-university-government is the key to improving the conditions for innovation in a knowledge-based society.

He described the industry as the locus of interaction. In contrast, the government is the source of contractual relations that guarantee stable interactions and exchange, whereas the university is a source of new knowledge and technology, and that industry and government have always been significant institutions in modern society.

The university is elevated to an equivalent status in a knowledge-based society, contrary to previous institutional configurations in which it occupied a

secondary status. In the case of the current study, the university serves as the technology provider (rooted in the indigenous knowledge passed on by the forefathers to the innovators), and the government provides the financial aspect to achieve successful product innovation. The industry's role is to adapt the product for mass production.

2.7 Related Theories

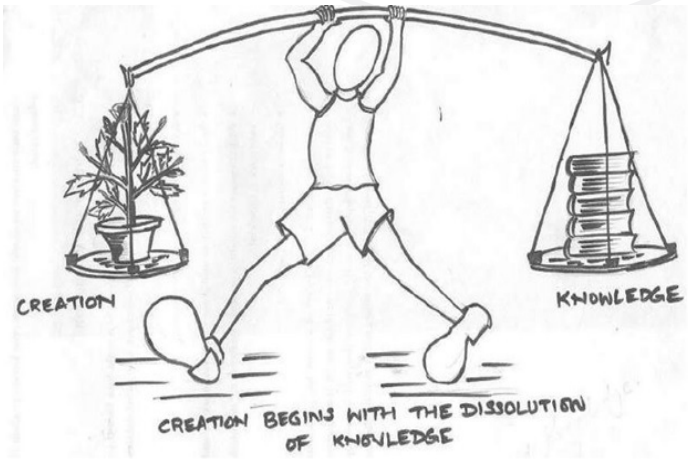
This section discusses some of the theories related to the study undertaken. Theories are a public pronouncement of what a scientist or an independent/group of minds has done something and are subject to further studies/research. They are sets of concepts/propositions that help describe and explain observations that one has made.

2.7.1 Interaction between Creation and Knowledge

The first theory that relates to the study is the theory designed by Amabile (1996) on the interaction between creation and knowledge.

Figure 2.5

Creation Begins with the Dissolution of Knowledge



Note. Adapted from Amabile, 1996

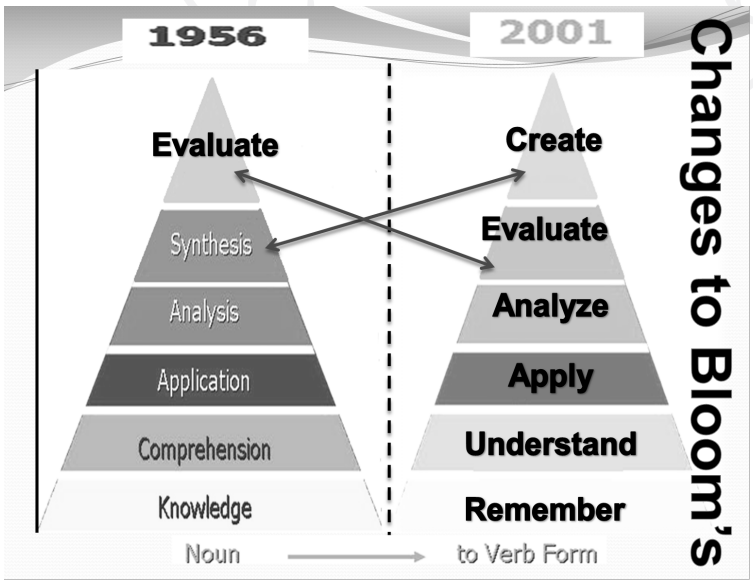
As specified in the above illustration, creation begins with the dissolution of knowledge. It settles the idea that knowledge is the headboard for creativity. There is no creativity if there is no knowledge. One has to know something before creating something new. Out of factual information or knowledge, one can identify the problem or what is lacking from the existing product, systems, and processes, and then new ideas come out, and new products, systems, or processes are invented. Amabile et al. (1996) explain that all innovation begins with creative ideas and that creativity is necessary but not a sufficient condition for innovation. Hence, creativity is a crucial element required for innovation.

The study clearly shows that knowledge is tied with creativity to achieve innovation.

2.7.2 The Revised Bloom's Taxonomy

Figure 2.6

The Revised Bloom's Taxonomy



Note. Used with Permission

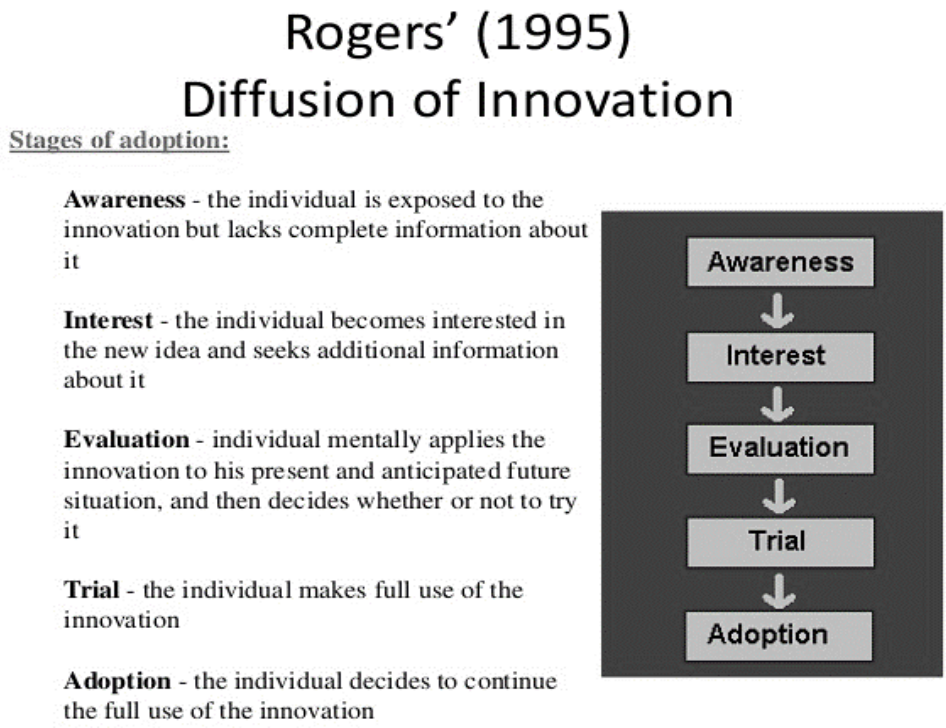
The second theory that anchors the current paper is on the *Revised Bloom's Taxonomy* Anderson et al., 2001), as shown in Figure 2.6, changing the names in Bloom's six categories from a noun to a verb and adding creation at the peak. Knowledge is at the baseline. Seemingly, knowledge is the foundation of the succeeding elements in the revised educational taxonomy until it reaches the creation level. Krathwohl et al. (1964) interpret it as building something new out of the generated experiences, thoughts, ideas, and processes coming from the diverse elements that one went through.

Then what happens to the produced product? First, note that we add *innovation to achieve the relevance of the created product.* Then, once this created structure or idea converts into a defined product, service, or practice, specific measures can be taken to socialize or market it. Croitoru (2012) stressed that innovation, as defined by Schumpeter 1934; 2008, is a socially-transformative product, service, or concept and is a critical driver of value (Croitoru, 2012; Avelino et al., 2017).

2.7.3 Diffusion of Innovation Theory

Figure 2.7

Diffusion of Innovation



Note. Adapted from Rogers, 1995

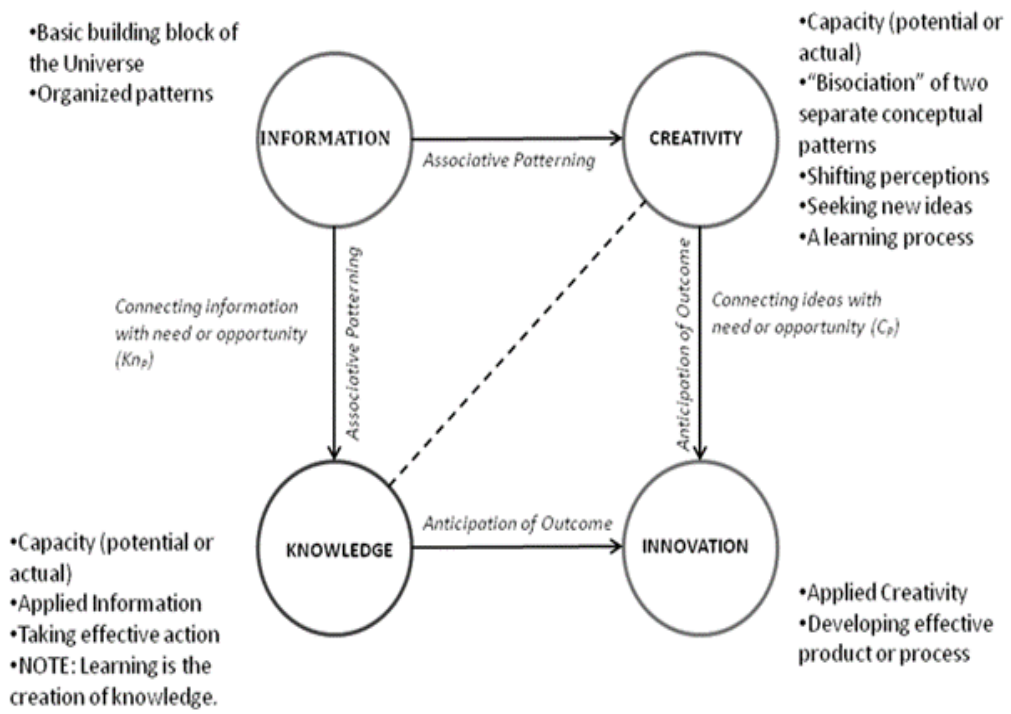
Third is the Diffusion of Innovation Theory, a process by which an innovation is communicated through channels over time among the members of a social system. It has five stages of adoption. Evaluating the five stages begins with awareness. At this level, the individual must weave and establish comprehensive information regarding something [innovation]. Take note that information is the foundation of knowledge, as explicated later in the framework of Bennet and Bennet (2005). In the second level, innovators conduct rigorous research to firm up the information and build scientific knowledge. Such gesture manifests their deep desire or intense interest in product innovation. At the third level, innovators assess the potential impact of the technology and use the end-users' feedback to improve the product. Then technology

test is conducted (trial at the fourth level), and the culmination of the iteration process until the perfection of the technology, launched, or adopted (the last level), meaning that innovators consider technology transfer once the beneficiaries use the technology.

2.7.4 The Relationship of Innovation, Knowledge and Creativity

Figure 2.8

The Relationship of Innovation, Knowledge and Creativity.



Note. Adapted from Bennet & Bennet, 2005. Used with permission.

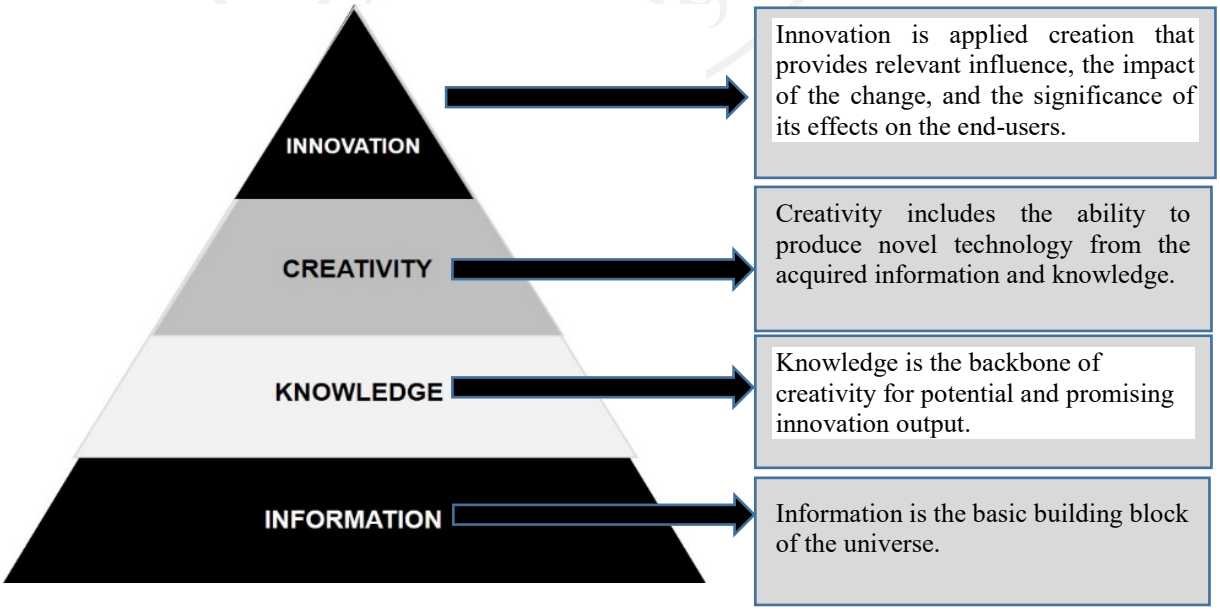
Last but not the least is the framework of Bennet and Bennet (2005) on the Relationship between Innovation, Knowledge, and Creativity, as shown above (Fig. 2.8) in the context of knowledge management. The innovation process goes on to the movement from information, knowledge, creativity, and innovation. To illustrate, Bennet and Bennet (2005); Bennet et al. (2015) defines *information* as the organized

patterns and the basic building block of the universe. On the other hand, the knowledge applies information and effective action from the available information. Meanwhile, creativity is "bisociation" of two distinct conceptual patterns and a learning process. At the same time, innovation applies creativity or the usefulness of something created.

In other words, this should be utilized or exploited to make sense of the created patterns. Maximizing the forms generates meaning or adds value to ***Innovation. Innovation***, therefore, is applied creation that gives relevant influence, the impact of the change, and the significance of its effects. It shows that Innovation is at the peak of the pinnacle, as shown below.

Figure 2.9

Progression of the Innovation Model from Information to Knowledge to Creativity to Innovation



In summary, discovered issues emerge and the need for empirical research. The study of innovation revealed that innovation is a complex and dynamic element of the economic growth and stability of the organization. There is no agreed definition of creativity and innovation in education (Bereczki, 2016). Future research is needed to identify the full range of individual differences and contextual factors for creativity and innovation (Anderson et al., 2014), develop a model and framework, and distinguish their unique differences in the light of higher education institutions (Amabile, 1998).

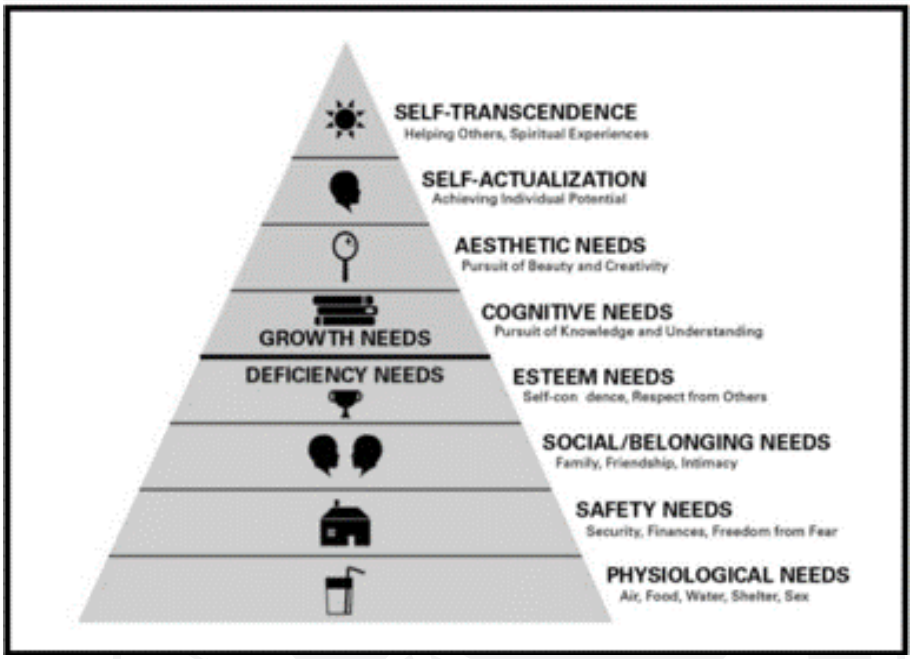
2.7.5 Abraham Maslow's Hierarchy of Needs

Maslow's hierarchy of needs is the study of how humans intrinsically partake in behavioral motivation. Maslow used the terms "physiological," "safety," "belonging and love," "social needs" or "esteem," and "self-actualization" to describe the pattern through which human motivations generally move (Maslow, 1943). Each previous stage must be satisfied for motivation to arise at the next stage. This theory is a foundation for knowing how effort and motivation are correlated when discussing human behavior. Significantly, each of these individual levels contains a certain amount of internal sensation that needs to be satisfied in order for an individual to complete their hierarchy.

According to Webber (2019), Maslow furthered the research of his theory, recognizing that self-transcendence was a higher and different need. The theoretical framework includes eight parts that are divided into deficiency needs and growth needs, as shown in Figure 2.10 below:

Figure 2.10

Expanding Maslow's Hierarchy of Needs.



Note. Zhang and Dong as Adapted from Webber (2019)

Maslow (1964, 1968; 1973) described self-transcendence as a person's ability to obtain a unitive consciousness with other humans. As a result, the transcended person can view the world—and his or her purpose in the world—concerning other human beings on a more global scale and is aware that they can have an impact, not just within their geographical boundaries or culture, but on the whole world (Ohnersorgen & Venter, 2012).

Further, Maslow (1987) held that reaching self-transcendence is when a person seeks to further a cause beyond the self and experience a communion beyond the boundaries of the self. The transcended individuals who reach the top of Maslow's revised hierarchy seek a benefit beyond the merely personal, identifying with

something more significant than the purely individual self, often engaging in selfless service to others (Koltko-Rivera, 2006).

2.7.6 Lawrence Kohlberg's Morality Development

Moreover, according to Ohnersorgen & Venter (2012) and McLeod (2020), humanity needs self-transcended people—leaders, innovators, and everyday citizens alike— advocating not only for their own needs but for the needs of others, not only in their immediate nation and culture but all over the world. Ohnersorgen & Venter (2012) pointed out that Maslow's self-transcendence is the most accurate description of the type of person the world needs now: people taking responsibility not only for themselves but also for others to experience social justice.

According to Richards (2018), one thing that makes humans different from other species on earth is that our instincts and emotions drive us. And not a tiny part of those emotions is directly connected to our sense of morality. So, morality is not given to us on a silver plate; we learn and develop along the way.

Kohlberg (1969) defined *morality* as recognizing the distinction between good and evil or between right and wrong; respect for and obedience to the rules of proper conduct; and the mental disposition or characteristics of behaving in a manner intended to produce good results. Kohlberg's morality development model infers that our moral reasoning gets defined as we grow in age, which builds on our cognitive development (Goolsby & Hunt, 1992). Furthermore, Kohlberg proposed that individuals form ways of thinking through their experiences, including understanding moral concepts such as justice, rights, equality, and human welfare. Kohlberg identified six stages of moral reasoning (as shown in Table 2.7 below) grouped into

three primary levels. Each level represents a fundamental shift in the social-moral perspective of the individual as they mature.

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Table 2.7

Progression of Morality Development

Levels	. Stages	Focus	Concept of Morality
	Pre-conventional		
	• Individuals do not yet have a personal morality code.		
	• Morality is shaped from people around and an individual faces the consequences of breaking the rules set by the society.		
I	1 **Obedience and Punishment Orientation**	Ego-centrism (self-centered)	Morality is defined by how society perceived to be right and wrong.
	2 **Instrumental Orientation**	What's in there for me?" (self)	The right thing to do is defined by individual beliefs.
	Conventional		
	• **Morality** accept general rules and moral standards of society and adults.		
	3 **Good Boy, Nice Girl Orientation**	Gaining approval from others of one's actions (self).	Actions must be pleasing to others even if we are not comfortable with it.

(Continued)

Table 2.7 (Continued)

Progression of Morality Development

Levels	. Stages	Focus	Concept of Morality
II	4 **Law and Order Orientation**	Acceptance of moral code and rules of our society (community-direct involvement).	Actions and rules set up by the community are believed and followed in order to maintain peace and order.
	Post-Conventional		
	• Stand to live by our own moral code and ethical principles [example: liberty and justice]		
	• Independent of one's own moral code or conduct.		
III	5 **Social Contract Orientation**	Share on opinions about the moral code and rules set by society and question certain laws and institutions and their work for the society (society-extended community).	Morality serves the common good. Majority wins.
	6 **Universal Ethical Principle Orientation**	Moral codes are based on social ideas such as respect, individual dignity, and equality among everyone. (universal)	Moral reasoning is defined by using certain universally accepted ethical principles that serve the people and the society in general.

Note. Adapted from Kohlberg, 1969

The pre-conventional level's first level characterizes a person's moral judgments from a concrete, individual perspective. Nevertheless, people shape morality in general, and individuals face the consequences of breaking the rules set by society.

Individuals at the conventional level of reasoning have a basic understanding of conventional morality and reason with an understanding that norms and conventions are necessary to uphold society. Individuals tend to be self-identified with these rules and uphold them consistently, viewing morality as acting following what society defines as right.

Finally, the post-conventional level is characterized by reasoning based on principles, using a "prior to society" perspective. These individuals reason based on the principles which underlie rules and norms. There is an understanding that elements of morality, such as regard for life and human welfare, transcend particular cultures and societies and are to be upheld irrespective of other conventions or normative obligations (Power et al., 1989).

2.8 Innovation in Higher Education Institutions

In any organization, competition has always been a target in the road map to stay in the market, and the pressures it brought have forced higher educational institutions to think like businesses do (Brown & Duguid, 2000). That focus has impelled school leaders and managers to ponder programs on how to stay in the 21st century and cope with the ascending changes and challenges surrounding it. It increased attention on venturing into the world of innovation. For example, school leaders seek opportunities to improve their organizations' impact on the mission (Collins, 2005; Mair & Marti, 2006), respond to the advent of technology and the

adversities that beset society, and, foremost, sustain economic growth. The answer to similar challenges in other organizations, including universities, is innovation (Christensen et al., 2008; Schumpeter, 1949). As Zahra and Covin (1994) claim, "innovation is extensively well-thought-out as the lifeblood of company's survival, growth, and development."

Innovation is crucial for all firms to survive and grow, and in order to refurbish the worth and significance of their asset endowment and sustain market value, they should begin to innovate (Schumpeter 1934; Warner, 2013). Analogous to the higher education institution is the call for innovation.

As we freshly began the 20th century, there was overwhelming debate and argument concerning innovation and what it constitutes. Schumpeter argued that modern firms equipped with R&D laboratories had become the innovative central actors (Patel & Pavitt, 2000; Pavitt, 1991; Cohen & Levinthal, 1990; Prahalad & Hamel, 1990). In contrast, more than the contemporary firms, other organization sectors could innovate without sophisticated R&D laboratories. However, this study recognizes research as the basic foundation of innovation.

Debatable arguments become fusty when there is an effort to differentiate keywords, namely: new, creativity or discovery, and often become semantics (Trott, 2012), especially in the education sector. Trott (2012) further explained that what is new to one organization or unit may be considered stale to another. He is simply trying to tell us that we judge things as a success through various lenses, such as commercial advantage or scientific triumph. He said these could be both good and reasonable goals in themselves.

What is meant by innovation in the education sector? Christopher Freeman (1982) once wrote, "…not to innovate is to die". Unquestionably, there is recognition that big industries that serve as market and technology leaders have demonstrated an ability to cultivate fruitful novel technologies and innovate and deliver impressive growth and or return to their shareholders. What could have been the state of product innovation in the academe? Does it yield a return on investments in their sphere?

Higher education institutions (HEIs) play an essential part in creating a country globally competitive through the skilled human capital resources it produces Conchada and Tiongco (2015) and putting the country on the world map through its unique and commercialized innovation products. The mission is overwhelming as the institution has to relentlessly check itself against the national and international set criteria and keep itself attuned to the labor market's latest demands. Seemingly, in the case of the Philippines, several higher education institutions admittedly are not ready, as manifested in the lack of resources to engage in innovative activities (Paqueo et al., 2011).

The Commission on Higher Education, as the leading government, is constantly finding ways to address the issue. More so, CHED motivates higher education institutions to raise their graduates' quality and encourages them to engage and produce substantial technologies.

Reforms are in place, such as: rationalizing the structure of public higher education and improving the higher education budget to ensure resource mobilization and cost-effectiveness (Paqueo et al., 2011). However, according to (Paqueo et al., 2011), these reforms will not be enough if there is no pressure on the side of HEIs to constantly improve and innovate and set standards above the minimum requirement.

Gordon (1995), with clarity, says that innovation is the primary factor to sustain economic growth and future success in the university sector. Is there an established innovation path model for Philippine state universities that could raise the minimum requirement bar of excellence?

Hence, this research sought to answer the primary question: How do R & D BIOTECH innovators in higher education institutions achieve success? Specifically, it pursued to answer the following secondary questions primary question: (1) What are the unique characteristics related to the R&D BIOTECH agricultural sector that influence innovation? (2) What innovator competencies and attributes enable successful R&D BIOTECH innovation in HEIs? (3) How is innovator success in R&D BIOTECH supported and encouraged in HEIs?

2.8.1 Global and Regional Drivers

Innovation has become globally and regionally driven since innovation is a significant focus of attention for business, industry, government, including higher education institutions throughout the biosphere, and is acknowledged as a vital factor of an organization's success and long-term growth (Roper & Love, 2002) to cope with the demands of the changing time. Moreover, innovation has become widely documented as a key to competitive success (Francis & Bessant, 2005). Therefore, innovation is an essential source of competitive advantage in all sectors of society.

Globally speaking, in the 12th comprehensive plan of Rashtriya Uchchatar Abhiyan (RUSA, 2013) for the expansion of the state higher education system for ensuring access, equity, and quality and address issues regarding quality, research and innovation, they deliberately considered creating an empowering atmosphere of research and innovation (Dhamdhere, 2015).

The RUSA's decision in building a culture of research and innovation in HEI has become magnified by the conclusion of Edquist (2006) that in the Higher Education Research and Innovation (HERI), a dynamic in the innovation field has emerged, and that is "research for innovation" and "research on innovation." The economic sector and research universities are forging partnerships among government and non-government agencies for budding research turning into innovation that will make a difference in the lives of the individuals.

On the regional side, CHED developed the National Higher Education Research Agenda (NHERA) and related allies to provide the long-term policies, directions, priorities, and thrusts of Philippine higher education research. Essentially, it emboldens them to forge partnerships and networking, with each network focusing and enhancing on themes that the intuitional member is good at sharing. HEIs are also empowered to collaboratively work with other research institutions, local and foreign, as well as with industry and private laboratories, to conduct research and apply research outputs (Angeles, 2017) and concretize these into productive technologies.

In line with the said mandates of the goals for higher education research is to develop unifying theories or models to be translated into mature technologies which could benefit and improve the quality of Filipinos' lives within the compass of influence of academic institutions in the country.

The Intellectual Property Office of the Philippines (IPOPhl) encourages University-Industry collaboration to avoid "re-inventing the wheel," thus saving a researcher's time, effort, and resources. In doing research, there must be a close collaboration between and among universities and the actors involved in product innovation and industries. There will be no duplication or redundant output to

establish novelty and patentability. The university must identify the needs of the industry and conduct research to address the existing problem. All products started with research. They are the creation of the human mind. According to IPOPhl, creativity is a trait to produce invention and innovation, the ability or action of doing something new. In other words, innovation is the product of one's invention. Let us briefly discuss the difference between invention and innovation.

2.8.1.1 Invention vs. Innovation. Undeniably, many people confuse innovation with invention. Researchers are correct in their claim that innovation is the first cousin of invention, but they are not interchangeable. Hence, it is imperative to launch precise meanings for them. Based on empirical data, innovation is a comprehensive concept understood in various ways. However, one of the more comprehensive definitions by Myers and Marquis (1969) is: Innovation is not a single action but an entire process of the interrelated sub-process. It is not just the conception of a new idea, the invention of a new device, or the development of a new market. The process is all these things acting in an integrated fashion.

It is essential to clarify the use of the term ‘new’ in the context of innovation. Popa et al. (2010) persuasively articulated: It matters little, as far as human behavior is concerned, whether or not an idea is ‘objectively’ new as measured by the lapse of time since its first use or discovery… if the idea seems new and different to the individual, it is all innovation.

According to Trott (2012), most writers distinguished innovation from an invention by suggesting that innovation is concerned with the commercial and practical application of ideas or inventions. He aptly described inventions as the idea's conception, whereas innovation is the subsequent translation of the invention into the

economy. He further offered the following simple equation below to show the relationship between the two terms.

Innovation = theoretical conception + technical invention + commercial exploitation

The conception of new ideas is the starting point for innovation. A new idea by itself, while interesting, it is neither an invention nor an innovation; it is merely a concept or thought or collection of thoughts. Converting intellectual thoughts into a tangible new artifact (usually a product or process) is an invention. It is where science and technology lay a significant role. At this stage, inventions need to be combined with hard work by many different people to convert them into products that will improve company performance or, in the case of the study undertaken, advance the lifestyle of the people for sustainable development and social justice. What could be the other factors that need pooling to achieve innovation? These last activities represent exploitation. However, it is the complete process that represents innovation. It introduces the notion that innovation is a process with several distinct features (including competencies and factors) that must be uncovered and managed by the team members in an organization that the study explored.

Primarily, while innovation is the commercialization of new ideas, products, and processes, the invention is not directly linked with commercialization (Rogers, 1998). Somehow, Kalanje (2003) mentions that an invention is the generation of a new idea or knowledge which aims to solve a specific technical problem. Moreover, inventions are products or processes typically protected by trade secrets, utility models/petty patents, or patents. Therefore, it is clear that not all inventions are commercialized since not all inventions result in innovations. The mind continuously

conceives and creates new and brilliant ideas but, quoting Brandt (2002), “Most die a lonely death, never seeing the light of commercial success” because we never had the chance to bring them out. More often than not, according to Edquist (2006), innovation habitually happens outdoors and not in hypothetical (academics) locations due to inventive thinking and creative experimentation with various systems.

More so, this brings to mind Gabriel Tarde's statement in his theory on The Laws of Imitation: "Meanwhile, let us not forget that every invention and every discovery consists of the interference in somebody's mind of certain old pieces of information that others have generally handed down" (Tarde, 1890 [1993], p. 3). The invention is that individuals resemble each other because they imitate (or counter-imitate) each other (Djellal & Gallouj, 2014) and create social change within societies or cultures (Kinnunen, 1996). Hence, generation to generation who had the chance to imitate one's piece of work and make a difference could not help but be grateful to these inventors.

McCullough et al. (2002) and several other researchers conceptualized gratitude as an emotion directed towards appreciating the practical actions of other people to emulate those actions to benefit the people. Wood et al. (2010) also view gratitude as an emotion that occurs after people receive aid perceived as valuable and altruistic. Wood et al. (2010) adds to this idea that gratitude may have arisen from sources such as appreciation of one’s abilities or of a climate in which such successful work was possible.

To summarize, innovation depends on inventions, but inventions need to be harnessed to commercial activities before they can contribute to the growth and development of an organization or its end-users and bring social justice to humanity.

2.8.2 Governing Laws and Policies

Higher education institutions innovate through different contexts. They innovate because the law says so; they innovate based on their various resources and compel them to innovate due to current trends and issues. Innovation has become a hotcake in higher education institutions on various occasions, such as Accrediting Agency of Chartered Colleges and Universities in the Philippines (AACCUP), Quality Assurance (QA), and International Standard Organization (ISO), corporate meetings, performance-based output, administrative and academic council meetings.

According to Patricia B. Licuanan, former Chairperson, CHED, higher education has faced social and economic dynamics that have influenced the "architecture" dimensions of and approaches to research, innovation, and extension. In addition, several interlocking discourses also have nuanced definitions and approaches, such as (1) research for innovation vs. research on innovation; (2) partnerships between universities and industry.

As the Philippines enter another era of rapid change and faces a dynamic array of economic, social, global, and technological forces, there is a need to enable Philippine higher education institutions to participate in national transformation optimally. Moreover, the production and transfer of knowledge and technologies are fundamental to the country's engagement in the knowledge-based global economy in developing innovation products.

Philippine higher education institutions, particularly the universities, offer promising and unique platforms in Research, Innovation, and Extension, allowing them to engage in discovery and applied research, disseminate research knowledge,

inform government policies, and propel their overall competitiveness in the knowledge-driven global economy.

In connection with this, the Commission on Higher Education (CHED) is the key leader of the Philippine higher education system, effectively working in partnership with other major higher education stakeholders in ***building the country's human capital and innovation capacity*** toward the development of a Filipino nation as a responsible member of both the national and international community; hence, is governed by laws and policies such as CMO No. 52, Series of 2016 (Subject: Pathways to Equity, Relevance and Advancement in Research, Innovation, and Extension in Philippine Higher Education).

Under Republic Act of 7722 states that "…the knowledge economy characterizes the university not just a generator of knowledge, an educator of young minds and a transmitter of culture but also as a major agent of economic growth, a Research and Development laboratory and a mechanism through which the nation and its human capital to enable it to actively participate in the global economy" it is, therefore, imperative to inspire and enable Philippine Higher education institutions (HEIs) become platforms for research and development, innovation and extension in pursuit of inclusive social and economic development.

Further, this document affirms the value of collaboration and multidisciplinary (also known as inter-disciplinary and trans-disciplinary) approaches in research, innovation, and extension, which encourages a healthy ecosystem where among faculty members themselves, faculty and students can examine a phenomenon beyond the parameters of their respective disciplines through substantial research. We emphasize contextual knowledge-driven to better suit contextual innovation to

address the needs of Filipinos. The 21st Century HEI researcher is comfortable with contextual knowledge production and co-sharing, recognizes improbabilities, and entertains multiple hypotheses.

In pursuit of these desired ends, the CMO presents three interrelated pathways: Pathways to Equity, Pathways to Relevance, and Pathways to Advancement, which specify vital principles, programs, and mechanisms. These pathways provide the scaffolding for developing and articulating the innovation and research ecosystem in Philippine higher education.

Pathways to Equity. CHED shall provide grants-in-aid (GIA) for HEI faculty in developing the country's human resources as research and innovators.

Pathways to Relevance. Research, innovation, and extension in Philippine higher education must work contextually and purposively. Knowledge generation in HEIs should enable us to a) deepen our understanding of ourselves as a people and as a nation and b) discover practical, evidenced, and science-based answers that can address real-world, social, economic, and environmental challenges of families and communities. In particular, platforms based on the seventeen (17) Sustainable Development Goals (SDGs) in consonance with the United Nations 2030 Agenda for Sustainable Development. HEIs have to collaborate on common SDG platforms to establish a niche or expertise in those areas of interest (UNESCO (2017).

Pathways to Advancement. It is important to understand and segment Philippine HEI-based researchers along a competency continuum to efficiently steer public resources and investments in HEI-based research and innovation and effectively develop a pipeline of human resources in research and innovation.

Therefore, CHED shall support the enhancement of HEIs that demonstrate leadership and outstanding productivity in research, innovation, and extension.

CHED shall provide funding to eighteen (18) universities, public and private, clustered as Higher Education Research Regional Center (HERRC). HERRCs conduct research activities aimed to respond to the needs of their respective regions, undertake research capability building activities for HEIs in their region, promote and facilitate regional networking for research, participate in regional innovation clusters, and promote the utilization of research outputs and technology transfer/extension programs in their regions.

CMO, No. 52, Series of 2016 (Subject: Policy-Standard to become platforms for innovation and drivers of competitiveness and economic growth)

Pursuant to Republic Act 7722, An Act Creating the Commission on Higher Education (CHED), Philippines, the university in a knowledge society or knowledge economy is characterized as

> … not just a generator of knowledge, an educator of young minds and a transmitter of culture but also as a major agent of economic growth, through which the nation builds its human capital to and be at par in the global economy. It is therefore, vital to encourage Philippine Higher Education Institutions to *become platforms for innovation and drivers of competitiveness and economic growth* (CMO, No. 52, Series of 2016).

CMO, 46 Series of 2012 (Subject: Policy-Standard to Enhance Quality Assurance (QA) in Philippine Higher Education through an Outcomes-based and Typology-based QA.

Following the pertinent provisions in the 1987 Philippine Constitution, which assert that the state shall "protect and promote the rights of all citizens to quality education at all levels…" (Article XIV Section 1): "establish, maintain, and support as complete, adequate, and integrated system of education relevant to the needs of the people and society, thus, the need to observe and implement innovative activities.

In accordance with the pertinent provisions of Republic Act (RA) No. 7722, otherwise known as the Higher Education Act of 1994, to establish Centers of Excellence and Centers of Development that serve as potent catalysts in specific program areas needed for the development of world-class scholarships, nation-building, and national development, the following policies, and standards are hereby adopted and promulgated by the Commission, thus: The Centers of Excellence (COE) project is an inherent mandate of the Commission on Higher Education as outlines in Republic Act 7722. The EDCOM report of 1991 recommended the creation of the "Centers of Excellence and Centers of Development" to strengthen and further improve the quality of the COE/COD to the level of our ASEAN neighbors. These COE/CODs must become a resource to strengthen other local schools. The COE/CODs also envisioned becoming graduate education centers and research in their fields of strength.

CMO, No. 61, Series of 2007 (Subject: ISO (International Organization for Standardization) Certification as an Equivalent Criteria in Lieu of an Accreditation Requirement under Section 1, Rule VII of the Revised Implementing Rules and Regulations of Executive Order No. 566)

In accordance with the pertinent provisions of Republic Act (RA) No. 7722, otherwise known as the "Higher Education Act of 1994," and under the provisions of

Executive Order No. 566 directing the Commission on Higher Education to regulate the establishment and operation of review centers and similar entities and by virtue CHED En Banc Resolution No. 771-2007 dated November 12, 2007, ISO Certification issued to Higher Educational Institutions (HEIs) shall be considered as equivalent criteria in lieu of the academic program accreditation in the evaluation of requirements of HEIs applying to operate a review center as required under Section 1Rule VII of the Revised Implementation Rules and Regulations of Executive No. 566.

CMO, No. 33, Series of 2016 (Subject: Guidelines for Institutional Development and Innovation Grants under the K to12 Transition Program)

As the basic education sector moved towards the full implementation of the K to 12 Enhanced Basic Education Program, CHED, through the K to 12 Transition Program, has been preparing for the impact of the transition on the higher education sector. While also leveraging the transition to invest in the future of higher education, CHED has called for proposals for HEI development and innovation projects since 2016, the first year of the K to 12 Transition Period. HEIs intending to submit are encouraged to exercise creativity in crafting projects to maximize this once-in-a-generation opportunity. Research Agenda Set by CHED Based on Issues and Concerns in Higher Education.

One of the research agenda set by CHED based on issues and concerns in higher education is on Relevance and Responsiveness in which to undertake a study on the human resources situation in key development areas, especially in the fields of energy, marine science and technology, earth studies and environment, and Biotechnology.

CMO, No. 01, Series of 2005 (Subject: Revised Policies and Guidelines on Voluntary Accreditation in Aid of Quality and Excellence in Higher Education)

In accordance with the pertinent provisions of Republic Act (RA) No. 7722, otherwise known as the "Higher Education Act of 1994," the Commission on Higher Education hereby promulgates the Revised Policies and Guidelines on Voluntary Accreditation in Aid of Quality and Excellence in Higher Education for the information and guidance of all concerned as stated in Article 1 Section 1 on Statement of Policies: It is the declared policy of the State to encourage and assist, through the Commission on Higher Education (CHED) and Higher Education Institutions (HEIs) which desire to attain the standard of quality over and above the minimum requirement of the State.

2.8.2.1 UPLB Research Agenda. As promoted in UPLB's vision statement: "UPLB, a great university, taking a leadership role in developing a globally competitive Philippines. Driven by academic excellence and operational excellence; strong research and creative capability, supported by an expanded graduate program geared to address the country's problems." A good incentive and reward system encourage vigorous disciplinal research pursuits and inter-disciplinal and trans-disciplinal undertakings connected to food production, which the chancellor advocates.

European Commission (2014) studies demonstrate that finding solutions to societal challenges while boosting growth and competitiveness requires a fully functioning network of research excellence to ensure that every Euro spent on research will have the most significant impact. Hence, according to Cole et al. (2011),

the researcher must conduct intensive research for the innovation to become successful. Failing to do this will lead to an inescapable compounding of errors that will fail the innovation (Senivongse et al. (2019).

The research follows evaluation to ensure the impact of the project. Patton (2008) describes evaluation with the provocative phrase “empowerment” since the ultimate purpose of the evaluation is to expose problems due to imperfections such as inadequately assessed needs, fuzzy and conflicting goals, poorly defined targets, insufficient resources, and sloppy implementation of plans.). How do innovators cope when there are lapses in their research endeavors?

2.8.2.2 2016 Revised Implementing Rules and Regulations. 2016 Revised Implementing Rules and Regulations, hereinafter called the IRR. This law was promulgated pursuant to Section 75 of Republic Act No. (R.A.) 9184, otherwise known as the “Government Procurement Reform Act,” to prescribe the necessary rules and regulations for the modernization, standardization, and regulation of procurement activities of the Government of the Philippines (GoP). The provisions of this IRR are in line with the commitment of the GoP to promote good governance and its effort to adhere to the principles of transparency, accountability, equity, efficiency, and economy in its procurement process (Republic Act No. 9184).

There is a need for an established Memorandum of Agreement (MOA) when applying for government funds to finance the project. Alternatively, financing the project is done by soliciting various donors. Reichlmayr (2006) shares that soliciting sponsorship, vetting proposals, and collaborating with various agencies is tedious, but one has to make an initiative to materialize the project. Did the innovators somehow experience soliciting for possible donors to proceed with their projects?

2.8.3 Resources

2.8.3.1 Market-based View and the Resource-based View. There have been two divisions in contemporary debates over the last ten years in the literature on what' drives' innovation. These two schools of thought are the market-based and resource-based views. The market-based view argues that market conditions provide the context that facilitates or constrains firm innovation activity's extent (Slater & Narver, 1994; 1985). It delivers a secure basis for formulating innovation strategies for dynamic and volatile markets. The critical issue here is the organizations' ability to diagnose and understand opportunities in the marketplace. Sad to note that only a few firms have the facility to scan and explore and exploit their locus effectively (Cohen & Levinthal, 1990).

On the one hand, the resource-based view of innovation cogitates a firm's resources in providing a much more stable context in which to develop its innovation activity and build or shape its markets following its own (Eisenhardt & Martin, 2000; Grant, 1996; Conner & Prahalad, 1996; Wernerfelt, 1995). In short, the firm focuses on its capabilities, skills, and own resources in undertaking innovation activities. However, on the other hand, it argues that the valuable resources of the firms, when not easily copied, can accomplish a sustainable competitive advantage in the form of innovative new products (Eisenhardt & Martin, 2000).

How do these two compelling schools of thought drive innovation in UPLB Biotechnology? Do they significantly relate to the study? Innovators are not only concerned with the conditions of the market but are more concerned with the farmers' conditions and are conscious and responsive to the existing social-environmental problems that led to their innovation activity.

2.8.3.2 National Research Council of the Philippines (NRCP). The National Research Council of the Philippines (NRCP), as provided in the 9th Philippine Legislature Act No. 4120 passed on 8 December 1933, is a collegial body of over four thousand researchers, scientists, and experts is mandated to promote and support fundamental research in the country.

It is likewise mandated to provide advice on problems and issues of national interest (HNRDA, 2017-2022) and the reasons why higher education institutions continuously pursue to produce technologies for this purpose.

Along this line, the NRCP supports primary research results rooted in intellectual interest to seek new knowledge required for practical application in the future (Science Act of 1958 as amended by RA 3589), such as that of product innovation.

The NRCP's National Integrated Basic Research Agenda (NIBRA) for 2017-2022 prioritizes fundamental research supporting the Philippine Development Plan, the National Security Plan, and the Science for Change Program led by the Department of Science and Technology. One of the significant outcomes identified in the Philippine Development Plan 2017-2022, which needs immediate attention, is to escalate the country's potential growth by building the foundation for a globally competitive knowledge economy where increased technology adoption and have envisioned stimulated innovation. Thus, the conduct of this study is one of the reasons. To initially offer an innovation path model for HEIs. The HNRDA enunciates our national priorities and guides public investment in R&D while ensuring a cohesive convergence and integration of R&D efforts towards the shared

goal of inclusive socio-economic growth and a better life for Filipinos (HNRDA, 2017-2022).

Under Republic Act 7722 or "An Act Creating the Commission on Higher Education (CHED)," it is the mandate of the Commission "to inspire and enable Philippine higher education institutions (HEIs) in becoming platforms for research and development, innovation, and extension in pursuit of inclusive social and economic development." Accordingly, the Research and Innovation Grant-In-Aid (GIA) Program aims to build a strategic higher education research portfolio through collaborative and disruptive research and innovation projects among Philippine HEIs.

2.8.4 Trends and Issues in Innovation

With a view to analyzing the problems vis-à-vis the Research and Development (R&D) landscape in the country, the key players, their relationships and interaction mechanisms, and the existing support infrastructures,) in their study found out that the Philippines ranks low in innovative activity. They argue that this inevitably results from unaddressed challenges facing the Science and Technology (S&T) sector, such as lack of government support and private sector participation, low investment levels, lack of qualified personnel, and lack of technology transfer and commercialization. With Santiago et al.'s alarming and challenging findings (2012) in terms of the gaps in innovation endeavors, the researcher drove her attention to focus on the conditions of the organizational system, particularly factors and innovation competencies that led to successful innovation products. In addition, the Philippines ranks 50th among the 131 economies featured in the GII 2020.

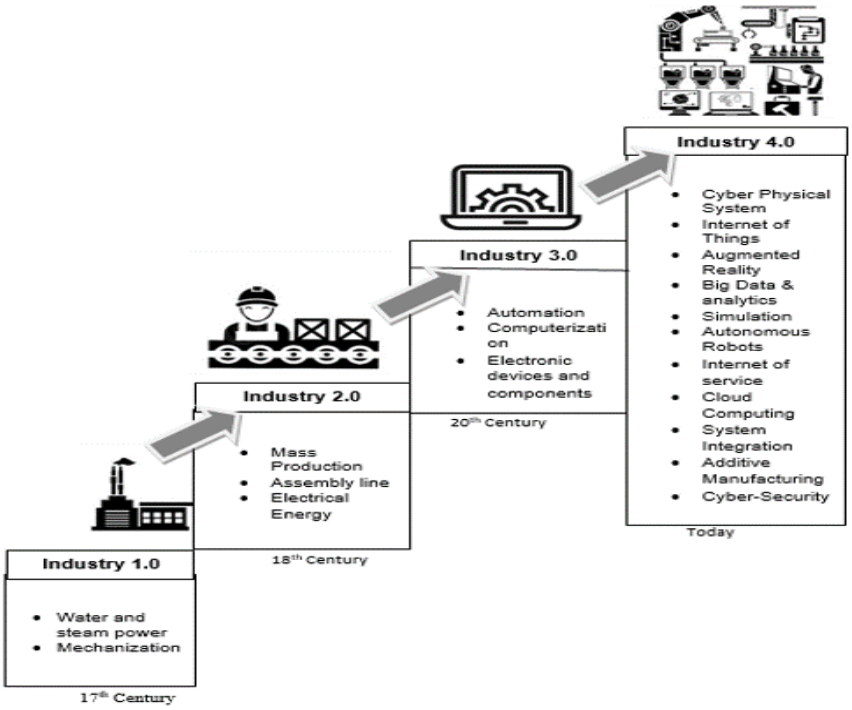
In addition, a formal nationwide survey Santiago et al. (2012) conducted includes gauging the awareness and use of patent pools. The survey affirmed the

identified significant challenges and made them conclude, among others, that given the actual level of innovation in the country, it is a must to have a massive education campaign on the use of patent information before patent pools can mainstream the innovation system in the Philippines. They finally posit that unprotected inventions may well be exploited in research or commercially without fear of patent infringement, flexibility proffered by the patent system that may be needed to boost competitiveness in the country. Considering this gap, how is the product innovation transferred and commercialized to the end-users without dreading the dangers of piracy and patent contravention?

2.8.4.1 Industry 4.0

Figure 2.11

The Industrial Revolution



Note. Adapted from Tay et al, 2018

Figure 2.11 illustrates the detailed diagram overview of the industrial revolutions. Three prior industrial revolutions have led to paradigm changes in the manufacturing domain before industry 4.0: mechanization through water and steam power, mass production in assembly lines, and automation using information technology (Tay et al., 2018). Industry 1.0 began around the 1780s with the introduction of water and steam power, which helped in mechanical production and improved the agriculture sector significantly.

Industry 2.0 entered when mass production was the primary production method. For instance, the mass production of steel helped introduce railways into the industrial system, consequently contributing to mass production.

During the 20th century, Industry 3.0 arose with the advent of Digital Revolution with industries learning on digital technologies in production. It is still a direct outcome of the gigantic development in computers and information and communication technology industries for many countries (Liao et al., 2017). In addition, this period for most of the workers brought efficiency and made the work easier and faster.

Industry 4.0 has enormously brought a drastic revolution to many occupations with a big bang. Aside from being obliged to learn new everyday tasks, employees and workers in all facets of life are constrained to use hi-tech gadgets that are fast becoming the most critical factor in their work and career life (Gorecky et al., 2014). According to Marcos et al. (2017), Industry 4.0 is a global change resented by digitalization and automation of every part of the company, organization, or firm and the manufacturing process. How does this giant leap impact the agricultural sector, and how do HEIs respond?

Giant and most influential national and international companies started to use concepts of unceasing development and have set high standards for research and development that address the challenges of Industry 4.0 and beyond and make themselves even more highly competitive in the market. Will the higher education institutions accept the concept of Industry 4.0 to be globally competitive?

2.8.4.2 Sustainable Development Goals. The Sustainable Development Goals (SDGs) is an ambitious and universal agenda to transform the country and the world. The universal, transformational and inclusive SDGs describe significant development challenges for humanity. It consists of 17 Sustainable Development Goals (SDGs). The 17 SDGs aim to secure a sustainable, peaceful, prosperous, and equitable life on earth for everyone now and beyond. The goals cover global challenges that are crucial for the survival of humanity. They set environmental limits and set critical thresholds for using natural resources. The goals recognize that ending poverty must go hand-in-hand with strategies that build economic development. They address various social needs, including education, health, social protection, and job opportunities, while tackling climate change and environmental protection. The SDGs address critical systemic barriers to sustainable development. It includes inequality, unsustainable consumption patterns, weak institutional capacity, and environmental degradation (UNESCO, 2017).

It also addresses all countries – from the Global South and the Global North – as target countries. All countries subscribing to the 2030 Agenda are to align their development efforts to promote prosperity while protecting the planet to achieve sustainable development. Thus, all countries considered developing need to take

urgent action (United Nations Educational, Scientific and Cultural Organization-UNESCO, 2017).

All sectors of the globe - governments, the private sector, civil society – young and old, and every species across the world must take action to achieve the set goals. In particular, higher education institutions must collaborate with various agencies to create product innovations through their scientists-innovators in helping address the 17 goals for a peaceful, just, and humane society.

In line with this, Reiss (1996) claims that typical features of Biotechnology have a solid science linkage, multidisciplinary, high innovation dynamics, and a modular production structure. These characteristics necessitate an appropriate innovation system to allow efficient diffusion of this crucial technology. Considering the significance and complexity of knowledge transfer in Biotechnology R & R&D, co-operations plays an essential role for the Biotechnology industry to respond to SDGs to achieve the universal agenda.

Along with this statement, there are a variety of entities such as non-profit organizations, local industry, and industry from outside the area, and other different government agencies like the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD) of Department of Science and Technology (DOST) that support the endeavors of Biotechnology in producing technologies.

2.8.4.2.1 Philippine Development Plan (PDP) 2017-2022-Ambisyon 2040. Philippine Development Plan (PDP) 2017-2022 builds a future where every Filipino enjoys a matatag, maginhawa, at panatag na buhay. Like any building construction, it begins by laying down a strong foundation for more inclusive growth, a high-trust and

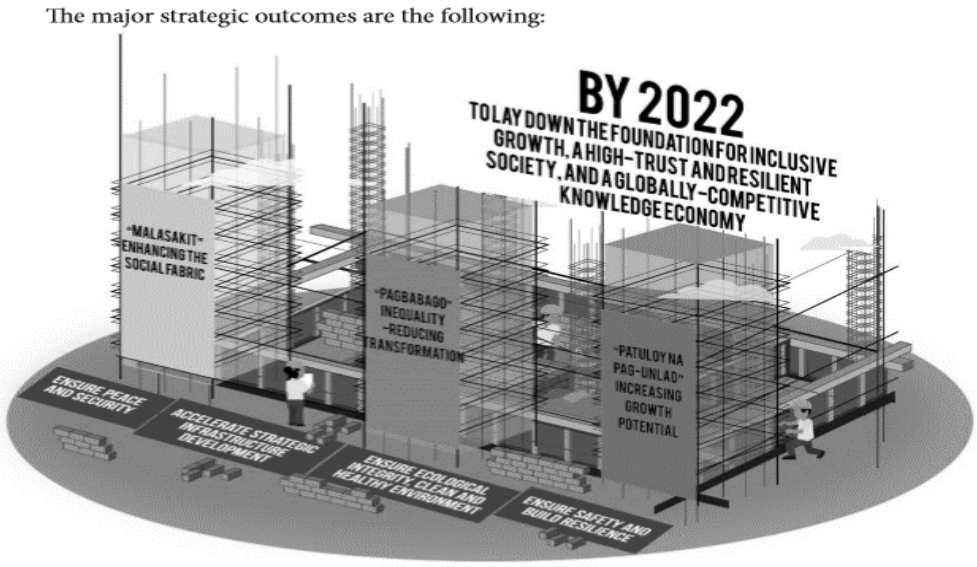
resilient society, and a globally-competitive knowledge economy. The impact manifest the following outcomes:

- The Philippines will be an upper middle-income country by 2022.
- Growth will be more inclusive as manifested by a lower poverty incidence in rural areas – from 30 percent in 2015 to 20 percent in 2022.
- The Philippines will have a high level of human development by 2022.
- The unemployment rate will decline from 5.5 percent to 3-5 percent in 2022.
- There will be greater trust in government and in society.
- Individuals and communities will be more resilient.
- Filipinos will have greater drive for innovation.

These foundational outcomes should be able to support the succeeding medium-term plans to 2040 and beyond.

Figure 2.12

Philippine Development Plan 2017-2022 Overall Framework



Note. Adapted from: National Economic and Development Authority, 2017

In a global context, the study supports the idea of a circular economy. The intent is to make better use of resources, close loops of resource flow by fully convalescing materials instead of wasting them, and design better products with longevity to prevent waste and pollution. This approach can provide a way to protect the environment and use natural resources more wisely, developing new sectors, creating jobs, and developing new capabilities (UNCTAD).

2.8.4.2.2 Harmonized National Research and Development Agenda (HNRDA). The Harmonized National Research and Development Agenda (HNRDA) is aligned with AmBisyon Natin 2040: matatag, maginhawa at panatag na buhay para sa lahat. It has three pillars: Malasakit (enhancing the social fabric), Pagbabago (reducing inequality), and Kaunlaran (increasing potential growth). AmBisyon Natin 2040 and the three pillars form the foundation for more inclusive growth, a high-trust and resilient society, and a globally competitive knowledge economy. In addition, a knowledge economy society geared at sharing and exploiting ideas and knowledge is necessary as a basis for research for the practical application of results.

2.8.5 National Context

To undertake research, engage in innovation, and conduct extension is among the core functions of any higher education institution under CHED Memorandum 52, S 2016. Moreover, as HEIs, there is an expectation to participate in pioneering efforts for national development and transformation; UPLB being the country's top university, seriously commits to fulfilling this mandate by introducing milestone innovations aligned to national development goals and promotive of social justice.

Further, innovation is a priority conduit to economic empowerment in a national context, as stipulated in Republic Act (RA) 11293 of the 17th Congress. This

Act adopts innovation as a vital component of the country's development policies to drive inclusive development, promote the growth and national competitiveness of micro, small, and medium enterprises, appropriating funds thereof, and for other purposes and as explicitly explicated in Section (2a), which articulates that 'the State shall place innovation at the center of its development policies, guided by a precise and long term set of goals that will take into consideration the key advantages of the country and the opportunities in the regional and global economic arena, and that as such, it shall harness innovation efforts to help the poor and the marginalized and to be able the micro, small and medium enterprises (MSMEs), to be a part of the domestic and global supply chain. By doing so, it helps in fulfilling some of the goals of the Sustainable Development Goals (SDG), such as (1) No Poverty- End poverty in all its forms everywhere; (2) Zero Hunger- End hunger, achieve food security and improved nutrition and promote sustainable agriculture (where technologies produced by the scientists-innovators serve their purpose); and (3) Industry, Innovation and Infrastructure-Build resilient infrastructure promote sustainable industrialization and foster innovation (UNESCO, 2017) and address the concerns of IR 4.0 as well.

2.8.5.1 Conditions for Innovation. Innovation plays a crucial role in an organization keeping an edge over its competitors. Firms that accord greater importance to innovation activity in recruitment, compensation, and promotion of employees are likely to achieve higher success (Gupta, 2007; Miller, 1992). Employee expertise, motivation, and self-management take on a more critical role in new product success. It follows that managers must nurture innovation processes around their employees to be successful in tapping employee and customer inputs (Schneider & Bowen, 1984).

Thinking of innovative products is constantly a top priority on the agenda of corporate meetings and general assemblies. The concept of innovation has emphasized various organizations' emphasis to sustain the innovative product. Moreover, research on the success/failure of new products has greater attention. What could have been the reasons for this success/failure? Meanwhile, Wang and Ahmed (2004) recommended looking at the interplay between various organizational factors and innovation conditions and suggesting elements that promote innovation.

Many research studies have attempted to discover the critical factors that can indicate the success or failure of a new product. Some have looked at success factors in new product innovation, some have looked at factors causing failure, and others have looked at both sets of factors (Balachandra, 1997). Balachandra (1997) noted that studies show a large number of factors influencing the success of a new product. While some studies collect data from actual projects, others ask executives to rate the contribution and importance of factors for the success of projects of which the executives have some personal understanding. A comprehensive model usually lists many factors contributing to the success or failure of a new product. Even from a cursory review of the literature in these areas (NPD and R&D project success), one concludes that there are several factors deemed critical for success or failure, which the research disclosed.

According to Rothwell (1992), despite more than three decades of empirical research designed to determine ‘the characteristics of technically progressive firms’ and ‘the factors associated with success or failure in innovation,’ there is no precise prescription or recipe for successful success innovation. Some of the many empirical studies undertaken have looked only at successful innovations, some only at failures,

while others have compared successes with failures; a number have taken the individual innovation project as the unit of analysis, while others conducted at the firm's level.

Moreover, according to the views of Cooper and Kleinschmidt (2007); Henard and Szymanski (2001); Van der Panne et al. (2003); Montoya-Weiss and Calantone (1994), firms have uncovered, accumulated, and synthesized the relevant success factors of innovation. Meta-analyses consistently found predictive factors for new product success in business firms (Rese & Baier, 2011), but none has been discussed in the context of the education industry. Rese and Baier (2011) further mentioned that new product development success factors within firms have been examined and described for decades. The key to success, the so-called success factors, such as organizational environment, management and leadership, and other conditions, was the focus of interest. However, other factors have not been taken seriously.

Blayse and Manley (2004) identified six main factors that influence innovation in construction: clients and manufacturers, the structure of production, relationships between individuals and firms within the industry and between the industry and external parties, procurement systems, regulations/ standards, and the nature and quality of organizational resources. These influences are the key factors driving or hindering business innovation. Therefore, attention given to them by businesses and public policymakers would be a key component of effective innovation strategy and policy. With this thought in mind, this paper explored the factors of innovation that promote innovation in higher education institutions.

Nurgraha and Mulyadi (2018), in their study, found that factors suspected to influence product innovation are a collaboration between customers through their co-

creation experience with the enhancement of creativity and innovation capability. Gima (1996) investigated the success factors for innovation of SMEs in Australia and concluded that these factors include (1) Newness of Innovation to Customers. The degree to which the new product/service varies from current customer consumption requirements and experiences; (2) Innovation-firm Synergy. The extent to which a new product or service fits the firm's competencies (Cooper & Kleinschmidt, 1995); (3) Proficiency of Development and Launch Activities. A prime innovation success factor is the proficiency in process activities such as idea screening, market, technical and financial assessments, and launch (Cooper & Brentani, 1991; Cooper & Kleinschmidt, 2007; Dwyer & Mellor, 1991); (4) Degree of Functional Coordination and Teamwork. Overcoming uncertainties in defining customer needs, design, quality control, or competition requires teamwork among departments; (5) Importance Accorded to innovation Activity in Human Resource Strategy. What could also be the factors suspected to influence product innovation in HEIs?

2.8.5.2 Conditions for Innovation in HEIs. Miles et al. (2009) comment that the social and economic conditions in which firms operate can ignite or stifle innovation efforts more than the robust management and ethical leadership that affects an organization's innovation capacity. However, innovation is influenced by different conditions in different ways regardless of any innovation, and assessing innovation is a challenging but essential task for any organization to sustain the life of the innovation projects. According to Phan (2013), regardless of any innovation, different conditions influence innovation differently. Therefore, to increase the quantity of most innovative universities, educational managers and leaders must critically examine and understand the conditions for innovation. However,

understanding the most acceptable conditions for innovation is still a challenge in an organization (Miles et al., 2009), including HEIs.

In this light, Miles et al. (2009) identify seven all-encompassing conditions for innovation as a start-up reference for researchers. They comprise the generation of new ideas developed into products and marketability and resources available to invest in innovation and dissemination. These conditions are public research, openness, entrepreneurship, demand, competition, and access to finance and skills. See Table 2.8 below.

Table 2.8

Wider Conditions for Innovation

Condition	***Description***
Public research	Both the amount spent on public research, and the strengths of business-industry links.
Openness	How quickly and effectively good ideas can diffuse and be absorbed. This includes both the physical infrastructure for openness (such as broadband internet) and its social underpinnings (such as how hierarchical workplaces are).
Entrepreneurship	How effectively new businesses spring up to take advantage of innovative opportunities, and how willing people are to take the risks necessary to innovate.
Demand	Whether customers are willing to buy innovative products. An important part of this is government's willingness to procure innovative products.
Competition	The overall level of competition in the economy.
Access to finance	Whether risky, innovative businesses can attract funding, in particular venture capital, but also other forms of finance such as business credit.

(Continued)

Table 2.8 (Continued)

Wider Conditions for Innovation

Condition	***Description***
Skills	Whether skilled workers are available to work in an innovative venture, and whether workforces have the necessary skills to innovate themselves.

Note. Adapted from Miles et al, 2009

The conditions are most important for companies through the National Endowment for Science, Technology and the Arts (NESTA). In his article "Creating the Right Conditions for Innovation," Doss (2017) says, "*We should understand innovation as an emergent factor of systems." From this reference, it is evident that* conditions cause outcomes. Doss goes on to say,

> But if we ask ourselves *what* we actually know about conditions and processes in our own organization, and *how* we understand and nurture optimal conditions and processes, we might find ourselves facing a big blank. What is it that we really know (and how do we know it) about our "systems," as opposed to "stuff we do" (Doss, 2017, p. 2).

OECD (2010a); EC, (2011); OECD, (2011a); OECD, (2011b); OECD, (2012) have posed the question: "What conditions impact on innovation?" According to them, "innovation crucially rests on a range of framework conditions. These include finance for innovation; skills for innovation; intellectual property rights; markets, competition, standards; and policy framework as described in Table 2.9 below.

Table 2.9

Framework Conditions for Innovation

Framework Condition	***Description***
Finance for innovation (Financing Innovation)	Access to finance is a key driver of the creation, survival and growth of innovative businesses. Lack of finance can prevent companies from investing in potentially profitable innovation projects.
Skills for innovation (Skills for Innovation)	Skilled labour plays a key role in innovation by generating new knowledge, adopting and adapting existing ideas to develop incremental innovations, and identifying relevant new business opportunities. Various different skills are required for innovation: technical skills; "soft" skills (e.g. ability to communicate, to work and interact in teams and heterogeneous groups); entrepreneurial skills (e.g. competences in risk assessment and strategic thinking, self-confidence, and ability to make the best of personal networks).
Intellectual property rights (Intellectual Property Rights)	The intellectual property system plays a critical role in innovation. Intellectual property rights (IPRs), such as patents, trademarks, designs and copyrights, give innovators ownership of their knowledge creations and can facilitate the transfer of knowledge and technologies.
Markets, competition and standards (Markets, Competition and Standards)	Markets for intermediate and final goods and relevant services are equally critical for innovation. Competition fosters innovation by giving firms incentives to innovate in order to be more effective and to survive.

(Continued)

Table 2.9 (Continued)

Framework Conditions for Innovation

Framework Condition	***Description***
Policy framework (Public Policy and Governance)	Policy rationales, objectives, and instruments define the nature of public intervention in support of innovation. The larger number of policy instruments used, the greater variety of objectives pursued, and the wider number of actors involved in innovation policy have increased the complexity of its policy landscape and enhanced risks of inconsistencies and redundancies between policies and programs.

Note. Adapted from OECD, 2010a, 2011a, 2011b, 2012 & EC, 2011.

Jong et al. (2013) identified eight (8) essentials of innovation: aspire, choose, discover, evolve, accelerate, scale, extend and mobilize. Furthermore, Slaughter (2000) and Dodgson (2002) distinguished four characteristics that can be related to conditions of innovation, namely:

(1) The notion of something "new" and transformational (Freeman, 1982);

(2) Implementation that has the "ability to effect change" (Abernathy and Clark, 1985); Schumpeter, 1947;

(3) The "first use" of a new technology (Tatum, 1987) or one that is new to the user (Harkola and Greve, 1995); and

(4) Provides "derived benefits" to their parties (Ling, 2003).

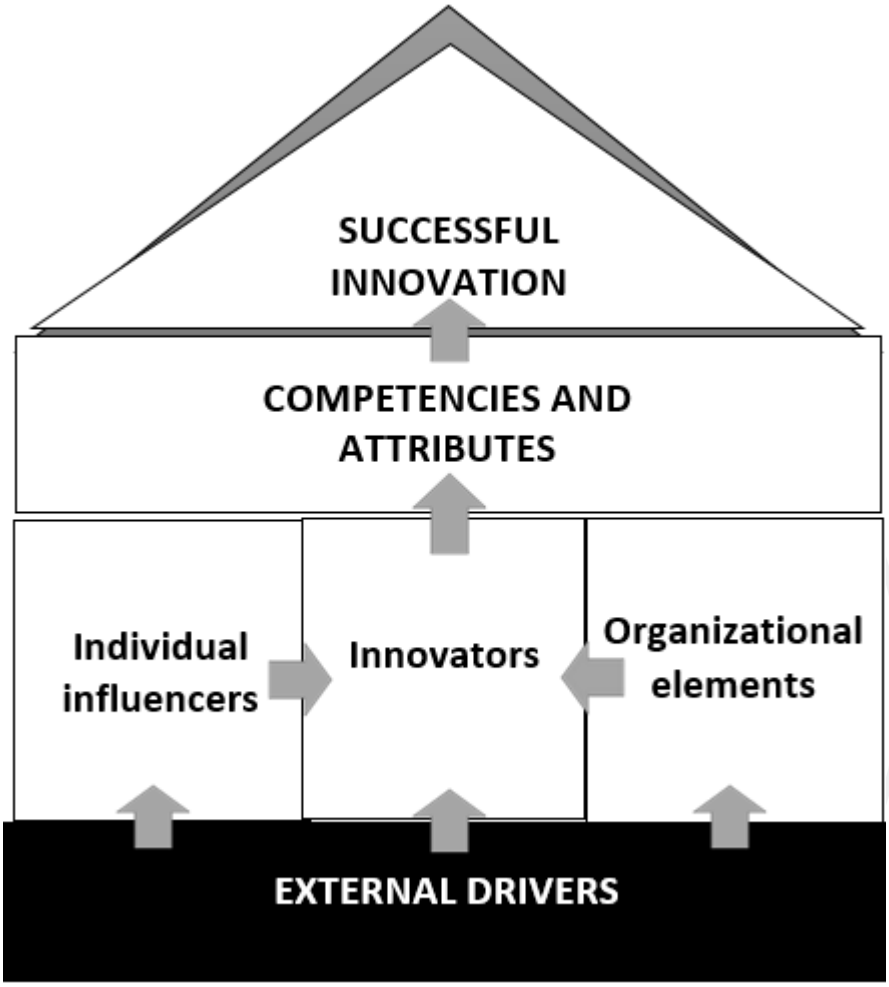
In the 2013 Education Innovation Summit, according to Michael Crow, President of Arizona State University in the United States, three natures of educational institutions have emerged: (1) Innovation is less necessary for the scholastically or socially elite institutions; (2) The industrial age institutions that keep trying the same things through and through with the hope to get mixed and improved results. They resist innovation. Thus, there is a need for exemplars to help them identify other possibilities and alternatives; (3) The innovator-those who are "breaking from the pack" (Crow, 2013).

In conclusion, there are no conditions of innovation designed explicitly in higher education institutions.

2.9 Conceptual Framework for this Research

Figure 2.13

The Conceptual Framework



A preliminary survey of the literature reveals that innovation is most common in the corporate, industrial world, primarily driven by the need to respond to increasing demands while also taking advantage of technological advancements and for the firm's economic growth and sustainable development to include competitive advantage. Through its Institute of Biotechnology, higher education institutions possess a wealth of expertise in research that industries can tap to level up their process or products, while standards for excellence also push institutions to innovate.

Therefore, universities seem to innovate in response to external forces [providing industry service and responding to required benchmarks for excellence]. However, new studies also suggest that institutional culture may also affect a university's innovation path. This study considers both scenarios while also being mindful of the mandate universities must fulfill as agents of change.

UPLB Biotechnology is a knowledge-rich community that addresses societal problems besetting the agricultural sector. These external drivers and relevant innovation factors push them to continuously produce technologies that create value for the end-users. Moved by their observations and unique characteristics called out as individual influencers, the scientist-innovators ignite their knowledge either to produce incremental or radical innovation backed up with the innovation competencies possessed by each innovator to be successful in their endeavor to produce technologies. All of these attributes contribute to the successful path to innovation.

This study attempts to discover the rational and practical motives for why and how R&D Biotechnology innovators in higher education institutions achieve success? Therefore, this study is conceived based on the framework above.

2.9.1 External Drivers

2.9.1.1 Agriculture Defined. Agriculture is the basis of all civilization upon which our traditions and values are built and shaped. It is part of everything, from the food we eat to our clothing. Agriculture is the science, art, and occupation of producing crops, raising livestock, and cultivating the soil. It is also the foundation for survival and for humanity to thrive. Moreover, agriculture is an area in rapid

development – both in terms of technological development and the development of alternative production systems (Hansen et al., 2001).

2.9.1.2 Status of Philippine Agriculture. With the admission of economic industrialization accompanying its irresistible benefits and challenges, an agriculture-based economy like the Philippines was left behind to enhance its agricultural richness. Why is it so? Almost everyone is enticed to work in air-conditioned offices or rooms, everyone wants to work in the city, and everyone would like to enjoy the advantages of industrialization. For this reason alone, there is less interest in tilling the soil and or investing in agriculture because of decreasing number of agricultural lands due to the gradual industrialization of the country, as stated by Samar Rep. Edgar Sarmiento (de Carbon, 2019).

Moreover, according to de Carbon (2019), the Philippines was ahead in Asia in the agriculture industry in the 60s and 70s. Agriculture is the largest user of the Earth's ecosystems and has the most significant impact on the environment and its biodiversity. Nevertheless, over the past half-century, more than a quarter of the world's 8.7 billion hectares of croplands, pastures, forests, and woodlands have been degraded through misuse or overuse.

However, we no longer enjoy the laurels of being the world's model and most productive in agriculture. Recently in the article of de Carbon (2019), she stated that agriculture is a dying sector in the country, considering that the Philippines was once the envy of its neighboring countries. In addition, one of the alarming reasons why only a few give more attention to agriculture is the sporadic climate of the country due to climate change. Farmers tend to be devastated when catastrophes hit crops, plants, or agricultural products. They do not know how to sustain their products when

environmental problems attack, like man-made or natural calamities. Are there any institutions or concerned citizens or individuals or groups of individuals who are more than willing to assist or extend help beyond their personal and professional lives?

The Philippine Statistics Authority (PSA) reported the performance of Philippine agriculture from April-June 2019. Due to the decline in crops production, agricultural output contracted by 1.27 percent in the second quarter of 2019. Increases, however, were recorded for livestock, poultry, and fisheries. At current prices, the value of agricultural production amounted to PhP 424.6 billion. However, it was 5.20 percent lower than the previous year's level. In the first six (6) months of 2019, agricultural output went down by 0.24 percent. In addition, in the third quarter, the country's economic growth – as measured by the gross domestic product (GDP) – slowed down to 6.1%.

Likewise, many of our daily newspaper commentators' revealed the distressing plight of our agriculture. For example, De Guzman's (2018) observation. The former cited that the agriculture sector lags among three major industry groups, contributing a mere 0.03% to the third-quarter GDP growth. It is also true to the study of Brown et al. (2018) released by the Food and Fertilizer Technology Center (FFTC) Agricultural Policy (2018), albeit its relative contribution to the Gross Domestic Product (GDP) has been declining over the years. On the other hand, the services sector, which contributed 4.1% to GDP, remained the economy's main driver. On the one hand, the industry sector, which contributed 2.1% to GDP, also grew slower by 6.2%. It is an adverse effect of the decline in agricultural outputs.

For instance, the massive increase in the price of sugar and tin cans caused the scarcity of necessities like food within a meager income of thousands of Filipino

households. While the latter significantly noted the devastating truth that agriculture is dying. Why is it so? It is because of the conversion of agricultural lands into industrial areas, shopping malls, and subdivisions. In addition, many of our agricultural schools produce office-oriented workers who would much rather do the paperwork than help improve the country's agricultural sector. Because of these callous reasons, according Brown et al. (2018), we are lagging in our long-term total factor productivity in agriculture.

In the Philippines, institutions and some universities have not been armed adequately in addressing problems related to food production. According to Spiertz and Kropff (2011), agricultural sciences started with a humble circumstantial beginning in philosophy, chemistry, or medicine. For instance, George Mendell (a monk with roots in farming) and Von Liebig (a chemist). They have highly made a significant contribution to the development of experimental research on agricultural sciences, which served as the foundation in Europe. In the Philippine setting, our very own national hero, Dr. Jose P. Rizal (a well-known physician), first embraced and introduced agriculture to Filipinos. In the Philippines, being gifted with cosmic and fecund lands until then, farming was almost Filipinos' primary source of living.

Hence, investment in technology and innovation and the necessary support services are essential to achieving successful agricultural transformation (Brown et al., 2018). What is the response of HEIs in this inevitable reality?

2.9.1.3 Effect of Climate Change to Agriculture. In a country report on climate change policies, green jobs, and decent work in the Philippines, Eross S. Ocampo (2001) Representative, Trade Union Congress of the Philippines Education and Project Officer, Philippine Government Employees Association Coordinator for

South East Asia, PSI-Asia Pacific Youth Network) mentioned that the Philippines are prone to natural disasters. Specifically, these disasters are typhoons, floods, landslides, volcanic eruptions, earthquakes, and tsunamis, lying as it does astride the typhoon belt in the active volcanic region known as the "Pacific Ring of Fire" and in the geologically unstable region between the Pacific and Eurasian tectonic plates.

The Philippines also suffers significant human-caused environmental degradation aggravated by a high annual population growth rate, including loss of agricultural lands, deforestation, soil erosion, air and water pollution, improper disposal of solid and toxic wastes, loss of coral reefs, mismanagement and abuse of coastal resources, and overfishing. As a result, the Philippines is third among the 173 countries globally in terms of the disaster risk index in a study conducted by a United Nations agency as cited by Alave (2011). Moreover, climate impacts and magnifies the risks and vulnerabilities that already afflict Philippine agriculture and food production and the vulnerable and marginalized families and individuals (European Commission, 2009).

Asian are experiencing an economic transformation—rapid growth, urbanization, and related technical and social changes (Khan et al., 2019), including the Philippines –and cannot escape the adversities brought about by natural calamities. For instance, Typhoon Haiyan in the Philippines was considered one of the strongest storms ever. Most disasters, being linked to atmospheric and hydrological processes, are recurrent, striking a country at infrequent intervals. Such recurrent shocks potentially have cumulative effects on both the rate and development pattern (Benson & Clay, 2003). How do we mitigate or address such alarming concerns besetting the state of our agriculture?

2.9.1.4 The Challenge to Higher Education Institutions. It is but befitting to provide further attention to agriculture because of its crucial role. All country sectors must take initiative actions to restore the moral fiber and good image our agriculture has started. For instance, the government must find ways to develop agricultural policies and infrastructure aligned with the industry's expectations. Universities offering agricultural programs must be conscious enough to instill in their graduates the remarkable contributions of their technologies in the market. The agricultural industry must be attractive and offer lucrative income so that more young people will be enchanted to pursue agriculture careers. Encourage more creative researchers and innovators who will produce advanced eco-friendly technologies and make the lives of the users better to sustain the natural and organic lifestyle of every Filipino.

UPLB Technology Transfer and Business Development Office (TTBDO), formerly known as Center for Technology Entrepreneurship (CTE), executive director Glenn Baticados said that agriculture today is more than just a farmer simply planting a crop, growing livestock, or catching fish. He said, “It takes an ecosystem and several actors to work together to produce and deliver the food we need. This dynamic and complex ecosystem will equip agriculture to cope with the competing challenges of addressing food safety and food security, creating inclusive livelihoods, mitigating climate change, and sustainably managing natural resources,” as quoted by de Guzman (2018).

Briseno and Zorrilla (2017) say that firms are increasingly responding to social and environmental claims from society. A major driving force behind the firm's innovation activity is the conditions in its environment (Capon et al., 1992). Innovation practices are encouraged to attend to poverty, work equality, renewable

energy, and food production, notwithstanding the hazardous effects of climate change, and frequent implementation to address impacts on sustainability. However, questions remain on how a firm's response, including HEIs, varies across disciplines. On the one hand, Benson and Clay (2003) say that major natural disasters can and do have severe negative short-run economic impacts; it also appears that disasters have adverse longer-term consequences for economic growth, development, and poverty reduction.

One of the Philippine Development Plans for 2017-2022 is to expand economic opportunities for those engaged in agriculture, forging partnerships with the private sector and business conglomerates for collaborative projects and knowledge sharing. As de Guzman (2018), it is essential for all concerned parties to work together to meet future challenges in agriculture in the "Pearl of the Orient Seas." In addition, the Department of Agriculture had a budget allocation for all the programs and projects, but according to de Guzman (2018), they do not seem to have the brains and the balls to get things going.

In the Philippines, generally, universities have not been equipped to address problems related to food production adequately. Agricultural sciences started with a background in medicine, philosophy, or chemistry, according to Spiertz and Kropff (2011). Good examples are George Mendell (a monk with roots in farming) and Von Liebig (a chemist); both contributed to experimental research development. The work of these pioneers laid the basis for agricultural sciences in Europe. However, in the Philippine setting, our national hero, Dr. Jose P. Rizal (a well-known physician), first embraced and introduced agriculture to Filipinos. In the Philippines, being gifted with

cosmic and fecund lands until then, farming was almost Filipinos' fundamental source of living.

2.9.2 Innovation Platform and Value Chain

An innovation platform is a space for learning and change. It is a group of individuals (who often represent organizations) with different backgrounds and interests: farmers, traders, food processors, researchers, and government officials. The members come together to diagnose problems, identify opportunities and find ways to achieve their goals. They may design and implement activities as a platform or coordinate activities by individual members. The university serves as the innovation platform whose focus is on agriculture, and researcher-innovators, farmers, university officials, government entities, and other significant others join forces in coming up with viable technologies or product innovations in response to their current thrust on food production as one of the societal concerns of Philippine government.

2.9.2.1 Individuals as Change Agents [Innovators]. Value chains comprise an entire production, processing, and marketing system, from inception to the finished product. It consists of a series of value chain actors, including farmers, traders, processors, wholesalers, retailers, and consumers, linked together by flows of products, finance, information, and services. The study includes various institution members – top to bottom officials, the organizational system – established framework, management style, innovators, experts, and beneficiaries of the technology. In addition, chain supporters such as government and private funding agencies, procurement law, extension, and transporters provide various services to the chain and enable it to function.

If innovators lack sufficient funds may venture into external capital, looking into potential investors that might be likely to finance the mass production of the technology for commercialization. Lebret (2017) describes that there are not enough paying customers, and the company will most likely need external capital (business angels, venture capital).

Change is inevitable, so to say, and organizations cannot escape this phenomenon. Therefore, organizations need to innovate to keep pace with the fast-changing environment and remain in the global market. In this connection, they need individuals or groups of individuals who are audacious enough to embark on either radical or incremental innovation. Change agents are transforming today's workplaces and firms' market value, allowing people in innovation leadership to become more aggressive in terms of innovation activities (Naughton, 2004).

Who are the agents of change or termed as innovation, and what is their role as innovators? Goldenberg et al. (2001) say that innovators are of chief significance in the life span of an organization. However, according to Fagerberg et al. (2005) most studies are mainly conducted on male innovations, such as technological processes and product innovations. There is a lack of explanation regarding gender perspective in innovation and a large extent, concerning the blind vision of individuals. Furthermore, communication around the profile and the role of the innovator is poor (Brännback et al., 2012).

Along with this thought, innovation is the result of a complex set of developmental processes, which depends on the organization's resources, networks, marketing ability, strategy, and processes it builds, together with the culture and leadership in the firm (Doyle & Bridgewater, 1988) and individuals who are more

than willing to get of their way to produce technologies that will make a difference in the lives of the people. Agüero and Sánchez (2010) and Montero-Fleta and Pérez-Sabater (2011) say that the construction of knowledge does not rely on machines and figures but is only possible as a human task, with every human embedded in their abstract information structure to initiate change.

A successful change that can convert knowledge and ideas into a benefit – in the form of new or improved products/services is capable of being innovative. Innovation can be a perceived level of change for a product, service, or process that maybe be incremental, radical, or transformational (Mudrak et al., 2004). For this paper, innovation is considered through product innovation or likewise known as a technology that is new to an organization and eventually makes a significant impact on the community's end-users.

Higher education institutions possess exceedingly high calibrated and educated knowledge workers who hold advanced degrees, many of whom are perceived as national experts in their fields and receive recognition for such expertise. Christensen and Eyring's (2011) discussion above explains what happens to innovation, particularly in the business setting. However, according to Drucker (2004), the innovator in the education sector does similar things, applies the same tools, and meets the same problems.

Brennan et al. (2014) have identified policy recommendations related to the changing landscape of teaching and learning in higher education to embrace the climate of innovation. Two of which become the focus of the present study: (1) Nurture an institutional culture of innovation that enhances creativity; and (2)

Consider incentives and rewards for members of staff (including but not limited to academics) who engage in innovative practices.

Individuals will collaboratively engage with a creative atmosphere to become knowledge-producers and creative beings and generate opportunities, capacities, resources, and incentives (Olsson & Mkandawire, 2009). Unfortunately, innovation in developing countries, including the Philippines, is challenged in understanding the process of innovation and its system.

2.9.3 Organizational Elements

The increasing shift of responsibilities of organizations to embrace change requires their effective adaptation to various factors and conditions, which necessitates innovations in organizational structure (Cohen, 1999). Teece (2009) further contends that firms' formal and informal structures and their external linkages have an important bearing on the rate and direction of innovation. Therefore, they must restructure themselves and shape the very foundation of innovative capacities, which will allow them to respond more rapidly to the needs of the external and internal environment (Cohen, 1999; Damanpour, 1996).

Innovation has become a hot cake, a debated, argued, and well-loved topic (Wang & Ahmed, 2004). Balachandra (1997) added that R&D funds are thrown at it because it is the resources and lifeblood of the company. However, becoming innovative requires an organizational culture that constantly guides organizational members to strive for innovation and a climate conducive to creativity (Wang & Ahmed, 2004). As Buckler (1997) suggests, innovation “is an environment, a culture – almost spiritual force – that exists in a company” and drives value creation. Wang and Ahmed (2004) conclude that the most innovative companies of

the future will be those which have created appropriate cultures and climates. Further, he said to look at the interplay between various organizational factors and conditions of innovation and suggest elements that promote innovation. Moreover, this calls for a paradigm shift in the organizational system.

Fundamentally all companies, including the academe, discuss innovation, the importance of "doing" innovation, and the end product of innovation. Nevertheless, unfortunately, many try to "do it," and only a few succeed (Wang & Ahmed, 2004). Moreover, these technologies are just displayed in cozy and fancy museums when they do so. Nonetheless, finding out some of the possible reasons for such efficacious results is the interest of this study.

2.9.3.1 Organizational Culture. Schumpeter (1934; 1939; 1942) was among the first economists to emphasize the importance of new products as an impetus to booming economic growth. To add, not just to the economic growth of companies but the economic growth of the end-users. Commence on innovation during the 50s was the accumulation of novel knowledge and its application in the development of products and processes (Trott, 2012). These studies revealed that firms behaved differently (Simon, 1957; Carter & Williams, 1957), including HEIs. In the 60s, studies confirmed findings significant and revealed variances in organizational physiognomies (Burns & Stalker, 1961; Cyert & March 1963; Woodward, 1980; Myers & Marquis, 1969). Other than considering the economic perspective, various factors were considered, such as business management strategy, organizational behavior, and other significant individuals responsible for the new product and organizational culture.

Creating an organization's culture comes from the fundamental assumptions and beliefs shared by an organization's members. It operates unconsciously, and it defines the organization's view of itself and its environment. It involves the values, principles, unwritten rules, norms, and procedures used within the organization (Stylianou & Savva, 2016). Bennet et al. (2018, p. 125) explain that "An enriched environment can produce a personal internal reflective world of imagination and creativity ... A rich environment entering the mind/brain/body through experience stimulates the mind to associate patterns and create new possibilities." In addition, Begley (2007, p. 58) says that "Exposure to an enriched environment leads to a striking increase in new neurons, along with a substantial improvement in behavioral performance."

The capacity for strategizing innovation is within the capabilities of any organization (Bate & Johnston, 2005) grounded in vast inquiry to support, sustain and respond to change (Alexander et al., 2004). However, innovation requires a technical preparation in material, financial and human resources, and without a transparent corporate culture, the technical side of innovation will hardly develop adequately (Claver et al., 1998), including its products.

The recent revival of academic focus on organizational culture may result from myriad contextual factors, the legitimization of corporate social responsibility, and growing consumer idealism (versus materialism) due to the economic recession (Bell, 2013). Kotler et al. (2010) and Gorenak and Košir (2012) postulate that organizations' values and cultures are increasingly a competitive differentiator because of collaboration [exchanging and transferring knowledge], with consumers demanding a more significant role in co-creation, including determining what

constitutes product value. Tannenbaum and Nash (2002, p. 101) agree by saying, "The firm's ability and the innovator's agility to apply knowledge and information towards the discovery of new products and technologies and other related endeavors of the organization whose aim is to optimize the generated knowledge and information results in new product development."

Erns (2002), Griffin and Hauser (1992), and Nonaka and Takeuchi (1995) say that in order for new product development to be effective, there must be a continuous sharing and utilization of knowledge to expand its breadth of usefulness to the organization and the community. According to Nelson and Winter (1982), an organization's technology should not be considered existing and remaining in some theoretical book of blueprints or with some assumed known individuals. Instead, it should embed an organization's system and habits of managing and harmonizing tasks to be optimized in the market. According to Nelson and Winter (1982), this procedural habit, also called organizational routines, ensures that products are fully optimized. Teece (2009) says that the performance of these routines is at the essence of an organization's technological capacity.

Changing the old values of keeping technologies is through a new vision or mission statement, suggests Cummings (2008). Leaders can do that by empowering their employees to implement the new vision into reality and increasing employees' motivation to share their knowledge. Doyle and Bridgewater (1988) say that culture and leadership are essential elements to consider in the process of innovation.

Leaders set the example for others; they directly impact the organizational culture and how the organization approaches and deals with knowledge-sharing practices (Sensky, 2002) to share their knowledge (Currie & Suhomlinova, 2006)

apart from innovation. Furthermore, people are the core of creating organizational knowledge because it is people who create and share knowledge. Therefore, it is critical to supervise or manage those willing to create and share knowledge (Sensky, 2002).

Other authors suggest that organizational culture is the prime font of driven and synchronized organizational activity that serves as a tool for solving problems and interpreting administrative proceedings. Moreover, it is a social glue that keeps employees and employers working together to increase the system's stability (Hauser, 1998 and Pervaiz, 1998), arriving at a successful innovation endeavor. In the study of Jaskyte and Dressler (2005), organizational culture and values are significant predictors of organizational innovativeness.

On the other side of the coin, Meyer and Goes (1988), Russell (1990), and Wolfe (1994) simultaneously observed that several innovation studies in diversified fields had provided only fragmentary and contradictory results that have not contributed much to the elucidation of organizational innovativeness. Reviews of current innovation models suggest that there is little attention paid to the role of organizational culture in terms of human factors conducting research and their corresponding competencies in innovation (Dougherty & Hardy (1996); Pervaiz, 1998; Schein, 1994). There is less attention to discussing the elements of organizational culture and its relationship to innovation.

2.9.3.2 Management Style. Management style is a way of life operating throughout the enterprise and permits an executive to rely on the initiative of the personnel of an entity (Uche & Timinepere, 2012). Effective management style is

how a leader continually and progressively leads and directs followers to a predetermined destination agreed upon by the whole group (Dubey et al. (2017).

The New Zealand Management (2001) points out that individuals operate better if they consider themselves part of a well-functioning, supportive organization to which all are happy to belong. However, Uche and Timinepere (2012) postulate that there is no one best management style, but it should be in tandem with achieving set goals, cultural values, and organizational peculiarities. How similar is this to HEIs?

Managing an organization must have a leader who is not just challenging but a leader with a heart and versatile qualities to succeed. Just as Lombardi Jr. (2001) quoted from his father, "Leadership is not just one quality, but rather a blend of many qualities; and while no one individual possesses all of the needed talents that go into leadership, each man can develop a combination to make him a leader" (pp.2-3).

The conventional practice claimed by leadership scholars and researchers is the top-down leadership approach, which was the historic customary paradigm in the leadership field emphasizing a vertical influence-related process in which subordinates are controlled, influenced, and managed by a single individual leader heading the team or organization, and her or his relationship with followers (Pearce & Conger, 2003). On the contrary, Pearce and Conger (2003) say that informal leadership is an activity that can be shared or distributed among members of a group or organization. It opens up new lines of thinking about informal leadership in organizations (Fletcher & Kaufer, 2003), where people are empowered to make decisions concerning their tasks at work and implement them (Conger & Kanungo,

1998). Teece (1997) says that firms' formal and informal structures and their external linkages have an important bearing on the rate and direction of innovation.

Deschamps (2005) mentioned that leadership [whether formal or informal] skills, charisma, and determination could lead to a significant innovation initiative and Carmeli et al. (2006) say that self-leadership skills affect innovative behaviors at work. While Gilley et al. (2008) claim that leadership effectiveness drives change and innovation along with the skills necessary. What could be the agreed goals or objectives of the leader that his or her constituents would generally agree upon and support at the same time?

2.9.4 Exploring Competencies

This section first focuses on defining the term competencies, then specifically looks at core competencies before delving into innovation competencies.

2.9.4.1 Defining Competencies. To empower the workforce to increase the chances of getting ahead of competitive advantage, innovation, and effectiveness, rely much on the competencies and skills of employees, their products, and behavior (Houtzagers, 1999). Beyond, unique competencies and skills are necessary for leaders in complex and multi-faceted working milieus with compound stakeholders. In this manner, various authors and researchers came up with their definitions of competencies.

Dubois (1998) describes competencies as those characteristics originating from knowledge, skills, attitude, mindsets, and thought patterns that result in successful performance. It means an individual bears with him or with her the necessary features of what it takes to be a competent worker to bring desirable results to the organization. In short, competencies embed the performance level of

individuals. Moreover, individual performance is evaluated rather than the displayed competencies.

Meanwhile, Marrelli (1998) takes a slightly different view in defining competencies. According to him, competencies are measurable human capabilities required for practical work performance demands. At the same time, Woodruffe (1992) supports the previous definition of competency. It is a set of behavior patterns that the incumbent needs to bring to a position to perform its tasks and functions with competence" (p. 17). Perrenoud (2000), on the other hand, has a more superficial understanding of competency. He defines it as a capacity to mobilize diverse cognitive resources to meet a specific type of situation.

Velayudhan et al. (2002) categorized competency into five groups: motive, trait, self-concept, knowledge, and skill, including aptitudes and other characteristics required to perform their task (Jackson & Schuler, 2005) effectually.

In conclusion, competencies refer to the skills or elements to achieve innovation, which eventually distinguishes from knowledge and creativity in higher education institutions. As defined in this research, competencies encompass the indispensable working habit and entirety of a person in the discharge of his duties and tasks responsibly to satisfy one's terms of reference adequately.

2.9.4.2 Core Competencies. In the 90s, Prahalad and Hamel (1990) suggested that firms must identify and develop their core competencies, which would play important roles in their future success and the next century. Likewise, Pavitt (1991) asserted that firms create their core competencies which are difficult for competitors to imitate and where firms could gain an innovative advantage.

According to the Association of Colleges Competency Framework, Core Competencies are personal attributes or characteristics that permit the delivery of a role/job when shared with technical or professional skills. They state the common areas and levels of performance of an individual or group and an organization or institution. For the competencies to become meaningful and relevant to the users, they need to be well-thought-of and structured logically and reasonably.

In a nutshell, core competencies are considered the indispensable working habit and the entirety of the innovators in the discharge of or her duties and tasks responsibly to satisfy one's terms of reference adequately for the people they serve.

Every organization determines innovativeness in different ways (DiPietro, 2012). Considering innovation's conditions and core competency is a severe endeavor of any organization (DiPietro, 2012), including HEI. However, in the case of higher education institutions (HEIs), there has never been an established innovation core competency to determine its innovativeness. In this light, the current paper specifically establishes innovation core competencies that disparately differentiate it from creativity. More importantly, it serves as a framework for HEIs to improve their craft in their innovation strategies.

In a nutshell, below are definitions of competencies offered by various authors.

Table 2.10

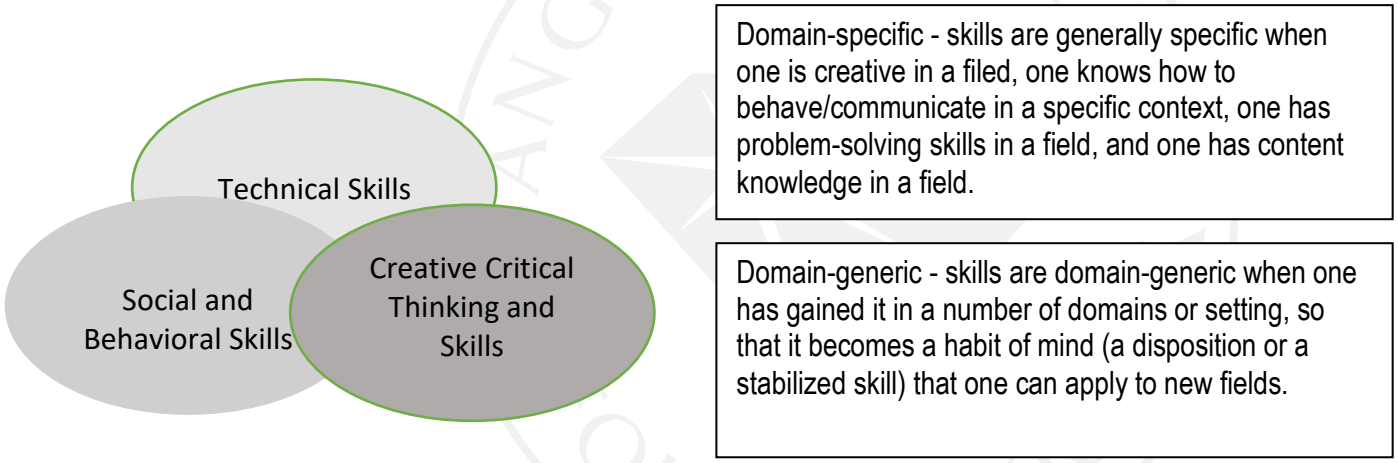
Key Definitions of Competencies

Scholar	Definition
McLagan (1980)	competency is the trait and knowledge that undergrounds the effective work and competency is
McClelland (1998)	it is one of the key factors that affect efficiency
Boyatzis (2008)	it is an underlying characteristic that could be a motive, trait, skill, an aspect of one's self-image or social role, or body of knowledge which an individual use.
Thornton (1992)	it is a bunch of behavior characters related to work performance.
Woodruffe (1992)	It is a set of behavior patterns that the incumbent needs to bring to a position in the order to perform its tasks and functions with competence"
Gonzi et al. (1993)	competence is an attributor factor to performance
Spencer & Spencer (1993	competency includes both implicit and explicit traits that are related to understanding and prediction of work performance
Eraut (1994)	competence refers to a person's overall capacity and the term competency refers to specific capabilities
Dubois (1998)	characteristics that originate from knowledge, skills, and attitude, mindsets and thought patterns.
Marrelli (1998)	competencies are measurable human capabilities that are required for effective work performance demands.
Gozzi et al. (2020)	capacity to mobilize diverse cognitive resources to meet a certain type of situation.

2.9.4.3 HEI Studies on Competencies Needed for Successful Innovation. Vincent-Lancrin (2017) described what individual skills education systems should foster through a diagram below.

Figure 2.14

Skills Education Systems Foster.



Note. Adapted from: Vincent-Lancrin, 2017

Technical, social and behavioral, and creative and critical skills are the skills education systems foster, and they overlap and may reinforce each other, but they are different, and reducing them to a single skill (or measure) is difficult. However, Kraut et al. (1989) say that if these skills and responsibilities are not clearly understood, managers will neither be able to coordinate work effectively, communicate expectations, deliver feedback, nor be prepared for job transitions or other training and career development activities.

2.9.4.3.1 Skills

To empower the workforce to increase the chances of getting ahead of competitive advantage, innovation, and effectiveness, rely much on the competencies and skills of employees [to disseminate knowledge], their product, and behavior (Houtzagers, 1999). Particular competencies and skills are necessary for leaders in complex and multi-faceted working milieus with compound stakeholders.

The richness of knowledge and information must be shared and put into action. According to Gurteen (1998), a person putting knowledge into action must be *competent*. It means three essential elements are necessary
- *knowledge* and *skill* and the right motivation and *attitude.* What could be the innovators' skills that drove them to put their knowledge into action in achieving the goal of product development? For the new product development to be effective, there must be a continuous sharing and utilization of knowledge to expand its breadth of usefulness in the organization (Nonaka & Takeuchi, 1995). Goldenberg et al. (2001) add that they are of chief significance in the life span of an organization.

Noe et al.'s (2015) discussion on skills refers to the level of performance of an individual on a particular task or the capability to perform a job well. Moreover, innovators carry two skills - technical elements and behavioral elements. Daud et al. (2012) say that technical elements measure "hard" technical skills while the behavioral elements measure "soft" skills, which include the attitudes and approaches applicants take to their work, such as the ability to collaborate on team projects. Do the respondents acquire both skills in the performance of their duties?

Technical skills are complex skills that individuals gain through intensive training and exposure to perform a task accordingly. Han (2015) says that hard skills are those that employees need to be able to perform a particular job. These often vary depending on the type of role employees perform or the industry in which they are working. Studying and training are ways to achieve hard skills. In addition, MacLeod and Clarke (2009) advocate that hard skills are an essential driver and focus on the quality of labor inputs.

On the other hand, *social skills* are the soft skills that individuals gain through their initiatives, such as engaging in reading materials, associating with various people, and self-reflection to perform a task accordingly. According to Han (2015), soft skills are usually self-taught and self-developed that individuals gain through their initiatives, such as engaging in reading materials, associating with various people, and self-reflection to perform a task accordingly. Moreover, Cimatti (2016) argues that soft skills are more than the amount of information that a person has acquired, nor even the 'kind' of knowledge, but the ability to act intelligently, continuously cultivating the ability to proceed for himself in a changing world through exemplar outputs.

Lumague (2017), Balcar (2016), Balcar et al. (2014), Bacolod and Blum (2008), Borghans et al. (2006), and Reber and Reber (2001) all claim that both types of skills significantly increase an individual's productivity. Moreover, Dewey (1938) states that the educational process has no end beyond itself; it is its end, which means that copious education is justified, an innate good emancipating the possessor's judgment. Through education and genre of technique and social institution, man liberates himself socially. It means that what he considers to be significant about an educated person is not the amount of information that the person has acquired, nor even the 'kind' of knowledge, but the ability to act intelligently on that information and knowledge, constantly cultivating the ability to proceed for himself in a changing world through exemplar outputs called soft skills.

In the Philippine setting, irrespective of one's job, both hard skills (technical skills) and soft skills (social skills) are equally important in the discharge of the terms of reference (TOR) attached to an individual's position, as articulated in the article by the then secretary of Department of Labor and Energy (DOLE), Rosalinda Dimapilis-Baldoz, posted by DOLE in May 2014. However, as she expressed, hard skills have little value if one has poor soft skills, which, as opposed to hard skills, tend to center on the ability to work with other people. These refer to capabilities in communication, enthusiasm, and attitude.

Moreover, Okoye and Caleb (2019) say that when people become more educated, their ability to engage, participate and understand increases. Resourcefulness takes more than cognitive skills; it takes the ability to process information emotionally and intellectually (Okoye & Caleb, 2019).

In a nutshell, the framework drives the path in exploring the success of R&D BIOTECH innovators in higher education institutions guided by the research questions raised in Chapter 1 (see 1.3).

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CHAPTER 3

METHODOLOGY

This study seeks to explore why and how R&D BIOTECH innovators in higher education institutions achieve success. Thus, the factors of innovation and innovation competencies that influence conceptions and practice of innovation in a premier university, mainly its BIOTECH, are explored and utilized in developing an innovation model for higher educational institutions. This chapter presents the research design, study participants, the research locale, the instrument used, and the data gathering procedure.

3.1 The Ontological Assumption

Before clarifying the type of ontology used in the study, it is vital to define ontology. *Ontology* is defined by (Crotty, 2003, p. 10) as "the study of being." It is concerned with "what kind of world we are investigating, the nature of existence, and the structure of reality." On the one hand, Guba and Lincoln (1989, p. 83) state that the ontological assumptions respond to the question 'what is there that can be known?' or 'what is the nature of reality?'

Based on the above definition of ontology, the study utilized ontological relativism, a social world of meanings, where realities are multiple; shaped by context, the truth evolves and changes and may use in similar contexts. Therefore, the researcher must assume that the environment to be investigated comprises actors who have their thoughts, interpretations, and meanings on innovation success. In order to understand their experiences and the context that shaped them, we conducted an in-depth interaction to create meanings. Thus, the researcher's investigation of this

environment is manifested in the interpretive design, such as in-depth interviews and observations to interpret the innovators' feelings and inner thoughts.

Innovators' success comes from the context of agricultural innovation in higher education perspectives.

3.2 The Epistemological Assumption

Epistemology is 'a way of understanding and explaining how we know and what we know, (Crotty, 2003, p. 3). Epistemology is also "concerned with providing a philosophical grounding for deciding what kinds of knowledge are possible and how we can ensure that they are both adequate and legitimate" (Maynard ,1994, p. 10) in Crotty, Ibid, 8).

The epistemological study used in this study is constructionism. Crotty (2003), p. 42, defined *constructionism* as "the view of all knowledge. Therefore, all meaningful reality is contingent upon human practices, being constructed in and out of the interaction between human beings and their world and developed and transmitted within an essentially social context." Thus, meaning is not discovered but constructed. Thus, the following reasons validate the use of constructionism: First, the researcher is trying to find an answer to the question "How and why does R&D BIOTECH achieve successful innovation?" by presenting case studies of eight innovators in their respective fields. Second, the construction of meaning is transmitted within an essentially social context, as shown in the interviews and observations. Third, the researcher interacted with the innovators to find out the meaning of their experiences and thoughts and explore and understand the context of their situation. Finally, constructionists view that there is no accurate or valid interpretation. The conclusion represents this as the researcher suggests a novel model

as a path to successful innovation in BIOTECH. However, these suggestions do not mean that they are valid. So, the present study is an invitation to reinterpretation.

3.3 The Theoretical Perspective

The theoretical perspective is “the theoretical stance informing the methodology and thus providing a context for the process and grounding its logic and criteria” (Crotty, 2003, p. 7). Since the epistemological stance of the study is mainly constructionist, thus, interpretivism is the theoretical perspective underpinning it. Further, the researcher argues that it is directly associated with the interpretative and social constructivist perspective for the following reasons. First, from an interpretive viewpoint, “people are deliberate and creative in their actions; they act intentionally and make meanings in and through their activity” (Blumer, 1969). Second, people actively construct their social world – “they are not ‘the cultural dopes’ or ‘the passive dolls’ of positivism” (Becker, 1970). Third, “the social world is studied in its natural state without the intervention of, or manipulation” (Hamersley & Atkinson, 1983). In addition, Cohen et al. (2002, p. 22) advocate the use of interpretivism, forwarding that (1) individuals are unique and largely non-generalizable, (2) there are multiple interpretations of and perspectives on single events and situations, and (3) examining situations through the eyes of the participants, rather than the researcher.

3.4 The Methodological Assumptions

Ontology dictates one's epistemology, which dictates one's methodology and methods. The methodology is "the strategy, plan of action, process or design behind the choice and use of particular methods and linking the choice and use of the methods to the desired outcomes" (Crotty, 2003, p. 3). It aims to describe, evaluate

and justify the use of particular methods (Wellington, 2000). The study's qualitative methodology employs a single case study research design. According to Adelman (2015), a case study is the study of an instance in action. Pring (2000, p. 40) defined it as the study of the unique case or the particular instant. Cohen (2007, p. 181) states that case studies provide a unique example of real people in real situations, enabling readers to understand ideas more clearly than presenting them with abstract theories. As Yin (1992) puts it, the case study used is evaluative (explaining and judging) to determine why and how R & R&D BIOTECH innovators in higher education institutes achieve successful innovation.

Qualitative research is the course of understanding grounded on distinctive practical traditions on analysis that discover a human or social problem in a likely setting (Creswell, 1998). Guba & Lincoln (1994); Lincoln (1995); Mackenzie & Knipe (2006) argues that it is upon the annotations and elucidations of people's discernment of diverse occasions and records snapshot of their view in a usual situation. Likewise, it is naturalistic (Lincoln & Guba, 1985) and interpretative, wherein the inquirer is classically involved in an unrelenting and thorough awareness of participants. It requires an array of ethical, strategic, and personal concerns in the qualitative research process (Locke et al., 2013; Lincoln, 1995).). The researcher in the study patiently took down notes of the experiences and stories shared by the innovators.

A *case study* is a qualitative process that underscores the assembly of in-depth information (Merriam, 2009; Savin-Baden & Major, 2013; Stake, 2010a) and data collected from interviews and document collection (Yin, 2008; Merriam, 2009).

Hence, it comprises the significant experiences, standards, values, and context as part of the inquiry process (Lekoko, 2002).

Thus, the case study approach was used within the interpretative pattern to identify factors of innovation and innovation competencies that led to a successful innovation product as elements of the innovation model.

In line with this, case studies are viewed and considered favorable as they facilitate researchers to scrutinize and present data (records, documents) of realistic situations at the micro-level. Further, they offer outstanding perceptions carried into the specific and thorough behaviors of the subjects of interest in research (Zainal, 2007). A case study approach facilitates a detailed description of the step-by-step process innovators perceived they went through (Dintoe, 2018) and experienced as they create innovative products.

Moreover, the qualitative case study approach was found effective in studying innovation. For example, Dintoe (2018) explored comprehensive hands-on and experiential immersion with technology and the orators who are primary adopters of technology and probed how informal learning occurs during innovation. Similarly, Mooney (2016) utilized the same design in her study to explore strategies in technology development marketing leaders used to commercialize new product innovations in the healthcare market and other various studies (Frattini et al., 2012; Hultink et al., 1997). These revealing indications prompted the researcher to utilize a qualitative single case study approach in developing an innovation model utilizing the University of the Philippines Los Banos (UPLB) as a case.

3.5 Methods

Methods are the techniques or procedures used to gather and collect data related to some research question (Crotty, 2003). The use of the qualitative employing a single case study research design justifies the use of the methods. Creswell (2009; 2014) found qualitative interviews useful for three crucial reasons:

1. They provide a wealth of data even when there is no direct observation of the participants.
2. The participants' can provide historical information.
3. The researcher has to control the sets of questions.

Scholars of case study research have emphasized that the methods used to collect data must be based on a specific research design (Creswell, 2009; Denzin & Lincoln, 2011; Lincoln & Guba, 1985; Merriam, 1998; Stake, 1995; Yin, 2014) and could answer the research questions in a manner that captures the thought of the study undertaken. As Dintoe (2018) says,

> "The methods used for data collection are based on the purpose, discipline, and approach of the study. From a qualitative case studies approach generally data is collected from a variety of sources such as interviews, artifacts/secondary documents, and observations" (p. 59).

3.6 Some Ethical Considerations

Ethics is defined by Simons (1995) in Pring (2000, p. 8) as "the search for rules of conduct that enable us to operate defensibly in the political contexts in which we have to conduct educational research." Chilisa and Preece (2005) highlight research ethics and legitimacy of knowledge, saying that ethical issues in research include codes of conduct concerned with protecting the researched from physical,

mental, and psychological harm. The codes of conduct to protect the researched include ensuring anonymity of the researched and confidentiality of the responses."

Ethically speaking, there are two different positions that most researchers follow: the utilitarian and the deontological. This study follows the deontological position as it sketches case studies of eight innovators, and its results cannot be generalized to each case study.

Ethical issues related to the study are as follow. First, the researcher prepared the survey questions (Appendix B) and administered them to the experts to filter the necessary questions required by the study. Second, based on the responses to the survey questions, the interview protocol (Appendix C), which contains the research instrument (Appendix D), was established. Third, the researcher presented the Informed Consent Form (Appendix F), which informed the participants of their rights before conducting the interview. Fourth, participants of the study were informed about the purpose of the study. Moreover, the data is made available to them. Fifth, the interpretations of the interviews conducted with the participants were submitted back to ensure accuracy and allow the participants to modify or change them (Appendix G). Lastly, the formed patterns, such as themes and categories, were sent to experts for validation (Appendix H).

Pseudo names were used to present data (innovator A to G) and respect participants' confidentiality (see Tables 3-8).

3.7 Participants of the Study

The study participants were eight (8) scientist-innovators from the Biotechnology of Elbi (a local term for UPLB) and have shared their profiles as to

their age, gender, awards, number of patents, and highest educational attainment. Tables 3.1 illustrate the participants' technologies.

Demographic Profile

N = 8

The succeeding figures describe the demographic profile of the respondents.

Figure 3.1

The Age Range of Scientist-innovator Participants

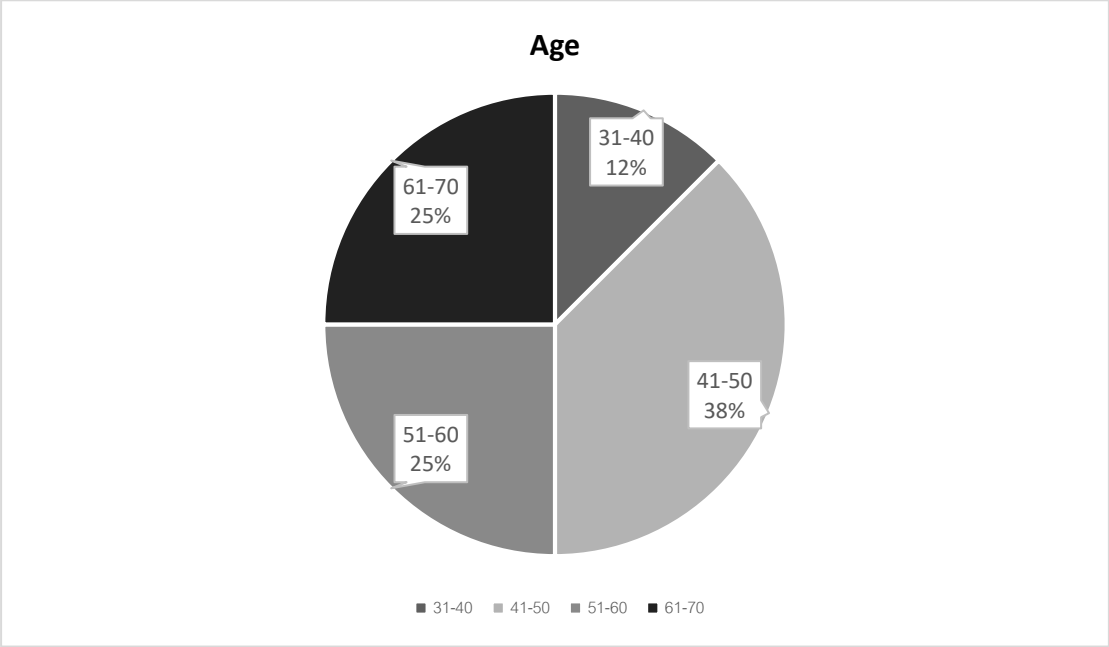


Figure 3.1 reveals that 25 % of the participants have an aged 51-60 years old. Based on the interview, they have grown up producing technologies. It is, therefore, significant to note that at this age, scientists-innovators still assume their responsibility for making viable products for society. 38 % of the population belongs to the 41-50 years of age bracket. It is vivid that their prime years were spent towards a noble cost. Meanwhile, even if nearing retirement age, as indicated above, where 25 % belong to 61-70 years of age, they still keep up with their commitment. One of the

participants, the youngest with a percentage of 12% proves that young or old, as long as one has a passion for working on something, one can make a difference.

When it comes to gender, there is an equal distribution of males and females. It means 50% of the participants are male and 50% female. It implies that there is no dominant gender in product development.

There were various local awards participants received. It includes recognition from their respective local communities and national arena through recognized and accredited government and non-government agencies. 50% of the participants received 1-3 awards, and 50% received 3-5 awards.

On the one hand, participants received various international awards as well. Almost all of them received an award from outside the country with 87.5%. In comparison, 12.5 % of the population received either one or none. Therefore, more than half of the participants have produced viable patents and technologies. Some of which have been utilized by the market with a percentage of 62.5 %, and the rest is 37.5 %.

Figure 3.2

Highest Degree Obtained by the Scientist-innovator Participants

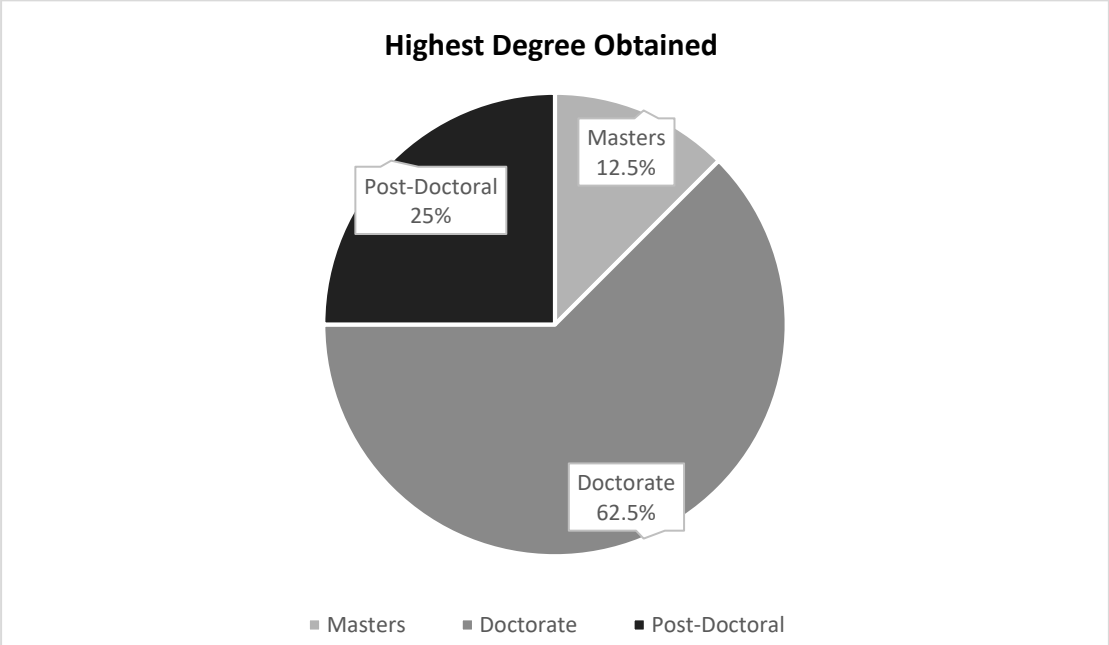


Figure 3.2 shows the degree attained by the participants. 62.5 % of them are Ph.D. holders, while 25 % are post-doctoral, and only one with a percentage of 12.5 is still doing her doctorate, thus, categorized as a master's degree holder.

Figure 3.3

Field of Interest/Expertise of the Scientist-innovator Participants

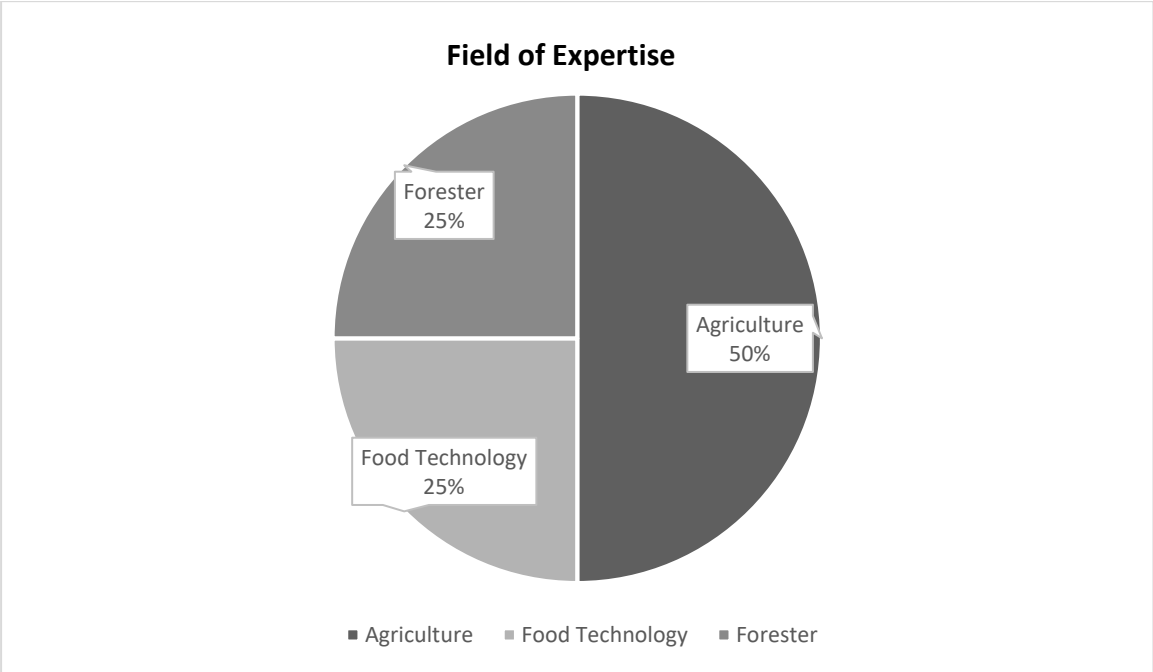


Figure 3.3 shows the innovators' field of expertise/interest. 50 % are into agriculture, and 25 % are engaged in food technology and forester.

Table 3.1

List of Innovators with the Description of their Technologies

Innovators	Patented Innovations	Brief Description
Innovator A	Dwarf Saba Variety	Dwarf Saba Variety are clearly fruiting, high yielding, and more resistant to typhoon damage.
Innovator B	Meat Detection Kit	iDetect, a meat detection kit is used to identify the kind of animal meat that is being tested in adherence to the Food Safety Act and to address food fraud.
Innovator C	Microencapsulated Fruit Bioactive from Bignay (Antidesma bunius L.)	Microencapsulated Fruit Bioactive from Bignay is an exotic Philippine fruit used in the manufacture of red wine. Its properties which constitute excellent flavor and color, and high level of total phenol and antioxidant, contribute to the beneficial effects of the product to human health when consumed in moderation.
Innovator D	Mykovam	Mykovam is a soil-based biofertilizer for fruit trees, agricultural crops, reforestation species and ornamentals.
Innovator E	Probiotic Guava Tea	Probiotic Guava Tea is a probiotic drink that boosts the human's immune system. It is a ready low-cost drink against radicals that weakens the body which affects the performance of the people.

(Continued)

Table 3.1 (Continued)

List of Innovators with the Description of their Technologies

Innovators	Patented Innovations	Brief Description
Innovator F	Rennet (Milk Coagulant)	Rennet is an enzyme preparation which may substitute animal rennet as milk coagulant in cheese making. It can offer 37 to 54 percent higher benefit per 100 liter of milk processed into cheese compared with animal rennet.
Innovator G	SNAP Solution for Hydroponics System	SNAP Solution for Hydroponics System is a low-cost and simple hydroponics system adapted to local conditions in the Philippines, which make growing crops hydroponically possible anywhere even under an urban environment.
Innovator H	WiltCure	WiltCure is a biopesticide, can effectively control fusarium wilt in tomatoes, eggplants and hot pepper, thus resulting in more vigorous growth and higher yield.

Included also as secondary participants are: Three (3) Project Development Officers of Technology Transfer and Business Development Office (PDO-TTBDO), Deputy Director of Agricultural Systems Institute (DD-ASI), Development Management Officer III of Technology Transfer and Business Management Program (DMO-TTBMP), University Extension Research Specialist II (UERS), Director of Technology Transfer and Business Development Office (D-TTBDO), Vice Chancellor for Research, and the Chancellor.

3.8 Research Locale

University of the Philippines Los Banos (UPLB) was purposely selected because its innovation paradigm is firmed up and for its proven and successful innovative product. UPLB, colloquially termed Elbi, is a non-profit institution that is supported by the State. As a result, it has become a premier education and public research institution widely known in Southeast Asia. Moreover, it is known for its influences on agriculture and food science throughout the country and the world. Its educational impact is mainly felt through its patented technological innovations, which focus on bringing primary food to the market and Philippine consumers in response to the rising necessity for agribusiness and the demand to take actions to attain the sustainable development goals (SDG) and Ambisyon 2040.

Moreover, UPLB has unswervingly secured more top-notch places in licensure examinations than other universities and achieved passing rates way above the national percentage rate in all courses and a 100% passing rate, particularly for education, forestry, and nutrition-dietitian courses. What best qualifies the University as a respondent are its breakthrough innovations that have effectively ameliorated

people's economic and social conditions, particularly those in the rural areas. These characteristics account for the researcher's intentional selection of the University for its case study. Thus, the study was conducted at *The National Institute of Molecular Biology and Biotechnology (BIOTECH)***.** According to Patton (2002), participants must be selected from an institution or organization a researcher can learn more from in conducting a study. Likewise, research locale with vital information, purposively selecting the participants in which criterion and convenient strategies are applied (Lekoko, 2002).

BIOTECH was formerly known as the National Institutes of Biotechnology and Applied Microbiology, at first functioned as an integrating mechanism in mobilizing several disciplines departments in chemistry, applied microbiology, and engineering for training, research, and extension. BIOTECH presently serves as the national research and development (R&D) institute specializing in health biotechnology, food and feeds, environmental, and agriculture. It capitalizes and exploits on the usage of the country's diverse collection of rich natural resources and agro-industrial waste and by-products and microorganisms to develop, cultivate and advance alternative technologies and product innovations towards improved and value-added agro-industrial productivity. Its vision and mission (Appendix A) serve as an anchor and lighthouse to achieve its mandate of producing high-value and functional innovation products.

Dr. Marilyn Brown, director of the National Institute of Molecular Biology and Biotechnology (BIOTECH), proudly shared the accomplishments of BIOTECH in the past four decades, citing its 47 products and technologies, 17 patents, 15

pending patents, 18 approved invention disclosures, 16 trademarks, 13 trademark applications. In addition, shared and cited by Gloria (2019), "Many of our products and technologies are now being used by the industry and farming sectors, and are currently contributing to overall growth and development of these sectors."

An example of this is the Mykovam. Mykovam is very effective in improving plant growth and increasing the yield and survival of several agricultural and fruit crops and forest trees. It can also increase plant tolerance against root pathogens (Aggangan et al., 2013).

3.8.1 Governance

UP Board of Regents elects a chancellor who administers, directs, and manages the institution within three years and may only serve two terms. In addition, there are five vice-chancellors responsible for administration, instruction, planning and development, research and extension, and community affairs with him or her.

3.8.2 Accreditation

The Commission of Higher Education (CHED) identified UPLB as a Center of Excellence (COE) in Agriculture. On top of its recognition as COE, UPLB has produced voluminous innovations that have influenced and made a significant impact on the lives of the community. Among the manifestations of its extraordinary technologies are encapsulated in what they call *AghamBayan.*

AghamBayan is a rare opportunity that brings together Government Policy-Makers, Industry Decision-Makers, and the Academic Science Community under one roof. Different stakeholders and partners, who recognize and support the importance of Science & Technology, and Research & Development for sustainable and inclusive

national development, converge in one place to participate in Panel Discussions, Pitch Sessions, Poster Exhibits, Partnership Signings, and Open Networking.

It has also been recognized by the Intellectual Property Office, Philippines (IPOPhl) because of its initiative in putting a dynamic and aggressive intellectual property office among leading state universities. Over and above, their numerous unbeatable technologies are applauded.

3.8.3 Impact to the Community and Beyond

UPLB Biotechnology is known for its influences on agriculture and food science throughout the country and the world. Its educational impact is mainly felt through its patented technological innovations, which focus on bringing primary food to the market and its consumers in response to the rising necessity for agribusiness and the demand to take active actions to attain sustainable development goals (SDG) and Ambisyon 2040.

Indeed UPLB has exhibited an influential and significant role in Asian agriculture and Biotechnology. Henceforth, UPLB has bestowed the Ramon Magsaysay Award for International Understanding in recognition of its work since 1977.

3.8.3.1 Technology Transfer and Business Development Office (TTBDO). A message delivered by Dr. Rex B. Demafelis, vice chancellor for research and extension, on behalf of Chancellor Fernando C. Sanchez, expressed UPLB's support for the promotion of entrepreneurship and innovation during the event known as Bagong Sibol Pitch 2019, as quoted by Arana, 2019, "Our Technology Transfer and Business Development Office (TTBDO) and its many projects and initiatives are

testaments of our commitment in transforming the fruits of research into products for improving the communities and enriching lives."

To date, UPLB does not rest on its laurel. Instead, it continues to fulfill its mandate of producing significant organic and eco-friendly innovation products for the people, the society, and the country.

Such noteworthy stature cannot be wrought abruptly but is a product of the persistence of specific principles and practices within the system and has become part of the institution's culture. On this premise, the researcher has chosen the university as a case for study.

3.9 Research Process

After a thorough survey of related literature and an in-depth review of some documents on innovation, there were no traces of research conducted on innovation and innovation competencies and innovation models in a specific academic organization, particularly agricultural innovation. Therefore, it impelled the researcher to conduct a novel study contributing to the body of knowledge in knowledge and innovation management. The study was guided by the following research steps, as shown in the diagrams below.

Figure 3.4

Research Steps

3.9.1 Identifying Higher Education Institutions with Designation as Centers of Excellence/Development in Agriculture Education

The researcher gathered and secured data from the Commission on Higher Education (CHED) list of Centers of Excellence/Development in Agriculture Education. Likewise, the Intellectual Property Office, Philippines (IPOPhil) was requested to provide a list of institutions with patents and assist the researcher in identifying the top institutions with remarkable innovations. A brief conversation with the staff of IPOPhl concerning invention and innovation is practically the same because both respond to a pressing problem. However, the researcher posits significant differences between the two, especially in the case of higher education institutions that are anticipated to generate new and innovative existing knowledge in support of national development goals. Both agencies recommended the University of the Philippines Los Banos, Laguna.

3.9.2 Sending Communication Letter to the Chancellor of University of the Philippines Los Banos, Laguna, Requesting for Key Informants for the Study

A letter of request was sent and approved at the office of the Chancellor. Then it was referred to the Technology Transfer and Business Development Office (TTBDO), the unit responsible for identifying the respondents. Respondent innovators who served as key informants were then carefully selected based on their skills and performance in producing technologies and their willingness and cooperation to participate.

The selection criteria were very limpid – scientists-innovators whose technologies have been utilized and commercialized. Initially, there were ten (10)

identified respondents, but two (2) had a prior commitment abroad for training; thus, the final respondents totaled eight (8). However, the two prospective respondents assured the researcher that they supported whatever would be the result of the study based on data gathered from the respondents since they operate within a well-established set of principles, guidelines, and practices embedded in the organizational structure culture.

Whether qualitative or quantitative research, the sample represents the entire population on the characteristics of interests (Burns & Grove, 2009; Creswell, 2014). The researchers may have identified different criteria unique for qualitative and quantitative research, but the common thing construed by Neuman (2009) is that sample depends upon the population characteristics, types of data, and its accuracy, like its degree of confidence. Whether small or big, it is not the volume or the quantifiable number of subjects. More vital is the subjects' relevance to the research topic rather than their representativeness which determines how to choose the sample.

3.9.3 Interviewing the Key Informants

Request letter (Appendix E) was sent individually to the respondents through their respective directors for an interview at their most convenient time and place. Respondents enthusiastically accepted the invitation, so the interview schedule was immediately arranged. The researcher did not find any difficulty during the scheduled one-on-one interview because the respondents allotted time specifically for this interview activity. Instead, they showed warmth and gladness when the researcher arrived at the designated venue. Honestly, while she was doing the introduction of the study, they could not contain their excitement of sharing their experiences and some

personal stories. She felt like she was playing two roles – a researcher and a confidante.

Generally, they asked her to conceal their achievements and personal information because they wanted to stay as simple citizens doing their responsibility for the people. However, some specific details were asked and reflected in the study to support the results and findings. They do not even recognize themselves as innovators because their task is to respond to the call of duty and the sense of accomplishment when they accomplish their mission of serving the marginalized through their unique technologies. Therefore, they were happy and contented in their niches.

On the other hand, they felt appreciative because a tiny fellow got interested in what they were doing through the years and finally documented their unique capabilities and skills in terms of their products. We should not also forget to mention that they were indebted to their forefathers, who sacrificially mentored them throughout their journey until they mastered the product.

One significant observation she had noted was that they acknowledge that there is a Supreme Being who is all-knowing and guides them along the way. They invoke the intercession of the Supreme Being now and then. They often pray that their technologies function as designed, and they have a strong faith that their outputs will benefit the users.

At the end of the interview, they radiate an inner peace as if they did not get tired of what they were doing, and she asked about their secret of staying calm and positive. Their secret weapons are prayer and faith. Her overall impressions of this

great experience interviewing the gurus of innovation taught her to become meek and humble, stay focused on one technology and keep on innovating, work for the people and not for her self-gratification, and, more importantly, to become an agent and advocate of nature conservation vis-à-vis agricultural living.

3.10 Data Collection

The interview was the primary method used for data collection. Rubin and Rubin (2012) agree that interview is an essential and appropriate tool for qualitative research. They stated that interviews provide researchers with rich, indispensable, and comprehensive qualitative data for understanding participants' experiences, how they describe those experiences, and the meaning and importance they make of those experiences.

The interviews and the observations were analyzed using the constant comparative method in which categories were coded and then compared across similar incidents in the same category. Their spoken words were analyzed to uncover the tacit ideologies at work in innovators' talk. The words and terms innovators employed were important because words are a powerful tool for characterizing, sanitizing, or intensifying a categorization or an interaction.

3.10.1 Data Collection Method

The interview is the utmost collective method of data gathering in qualitative research, according to Savin-Baden and Major (2013). Various authors gave a standard definition of interviews. They form a pattern of specialized interaction for a precise purpose and focus on particular content (Alase, 2017; Creswell, 2009; Merriam, 2002; Stake, 2006b; Yin, 2014). Therefore, data collected in a qualitative

interview are comprehensive and reliable, with depth and immense, holistic and authentic.

Moreover, according to Creswell (2009), qualitative interviews are designed in four ways:

1. Face-to-face - one-on-one, in-person interview
2. Telephone interview – researcher interviews by phone
3. Focus group design – researcher interviews participants in a group
4. Email – researcher uses the internet to interview the participants through email communication

The study utilized an interview to elicit the factors to which innovation success of the university can be attributed. Therefore, face-to-face, one-on-one, person interview interviews were done, complemented with observations through visits to their offices and laboratories.

On the premise that innovation in BIOTECH is closely linked with social justice, the study adopted the qualitative interview as the primary method for data collection. According to Baškarada (2014), Jamshed (2014), and Baker and Edwards (2012), qualitative case study interview is directly associated with the interpretative and social constructivist perspective. Using such type in this study allowed participants to express themselves in their context and usual habitat. Moreover, according to Maxwell (2012) and Merriam (2001), qualitative interviews allow for more freedom and liberty. As Remler and Ryzin (2011) argue: "that one-on-one interviews are generally preferred because they show respect, establish rapport, allow

for visuals or hand-outs, and capture body language and voice tone among the participants involved."

3.10.2 Data Collection Procedure

To get factual data, "an interview protocol" (Appendix C) is needed to guide the interview with semi-structured one-on-one, open-ended questions for answering questions and recording answers of the participants (Stevens, 2013; Adhabi & Anozie, 2017). The overall process of conducting an interview's ethical implications is considered (Brinkmann & Kvale, 2015; Patton, 2015); hence, an interview protocol is pushed (Castillo-Montoya, 2016). As Creswell (2009) suggests:

> "Using interview protocol to record observational data including physical setting, accounts of particular events, reflective notes and demographic information about the time, place, and date of the field setting where the observation takes place "(p. 182).

In this case, to identify factors of innovation and innovation competencies, the interview protocol which contains demographic profile (age, gender, number of significant awards received both local and international, number of patents, highest degree obtained, and field of expertise or interest) and the interview with semi-structured one-on-one, open-ended questions were prepared. The respondents were interviewed according to their own most convenient time in their respective places of work. Primarily at the location of the technology.

The conduct of preliminaries like greetings, an introduction of the study, and a statement of the purpose of the study signaled the start of the interview. Following the conduct of qualitative data preparation and interview protocol

Data gathering lasted approximately four (4) months (February to June 2019) in sessions lasting between 30-and 60 minutes. It took place in the respective institution identified. All interviews and impressions of the participants' experiences, thoughts, and feelings were recorded using the researcher's mobile recorder with the participant's consent. Data collected were entirely treated with utmost care and confidentiality, reviewed, analyzed, transcribed, and coded appropriately to identify themes and descriptive information and interpret the meanings behind the emerging themes**.**

3.10.2.1 Interview Protocol. Each participant signed the Informed Consent Form (Appendix F), which informed them of their rights as participants before conducting the interview protocol, which contains the research instrument. "The interview protocol component of the data collection process allowed the researcher to gather in-depth, rich information on the views and use of innovation and the factors that influence it" (Stevens, 2013) and the factors of innovation and innovation competencies that shape the key elements and core competencies of innovation and develop a model that helps determine the innovativeness of higher education institution. The interview protocol consists of the following as identified by Creswell (2009): a heading that includes the place, date, time started and time finished, interviewee's name, standard procedure for the interviewer to maintain consistency, space between the questions to record responses, and a thank you statement for the interviewee's active participation and valuable time and expertise. The interview results provided insight into the patterns and themes that emerged during the sessions.

The researcher thanked the participant for their time and expertise to conclude the interview. After which, they were asked to review their transcript (Appendix G) to check on discrepancies. Surprisingly, transcriptions were quickly approved, encouraging the researcher to fast-track because they were equally excited to see the results.

3.11 Data Analysis

The interviews were helpful, as the one-on-one, open-ended questions allowed the participants to speak and share their experiences freely regarding innovation, mainly what factors drive them to innovate and maintain their commitment. Moreover, qualitative research interviews adhere to their goal: to grasp the research topic from the interviewee's standpoint and comprehend how and why they have reached this particular viewpoint, thus avoiding biases (King & Horrocks, 2010).

Implementing descriptive analysis and reporting for each participant interviewed using coding and content analysis. In order to ensure quality output, the process of content analysis involved tagging the text to other qualitative data using a system of categories or coding scheme and enabled sorting, counting, and other qualitative analysis without any quantitative analysis (Remler & Van Ryzin, 2011).

3.11.1 Coding and Content Analysis

The qualitative research method of grounded theory was adopted in analyzing, coding, and forming patterns out of the data. Charmaz (2008) built an argument explaining how and why social constructionists can adapt grounded theory guidelines to deepen and broaden their analyses in addressing the research questions. A social constructionist approach to grounded theory encourages researchers to make

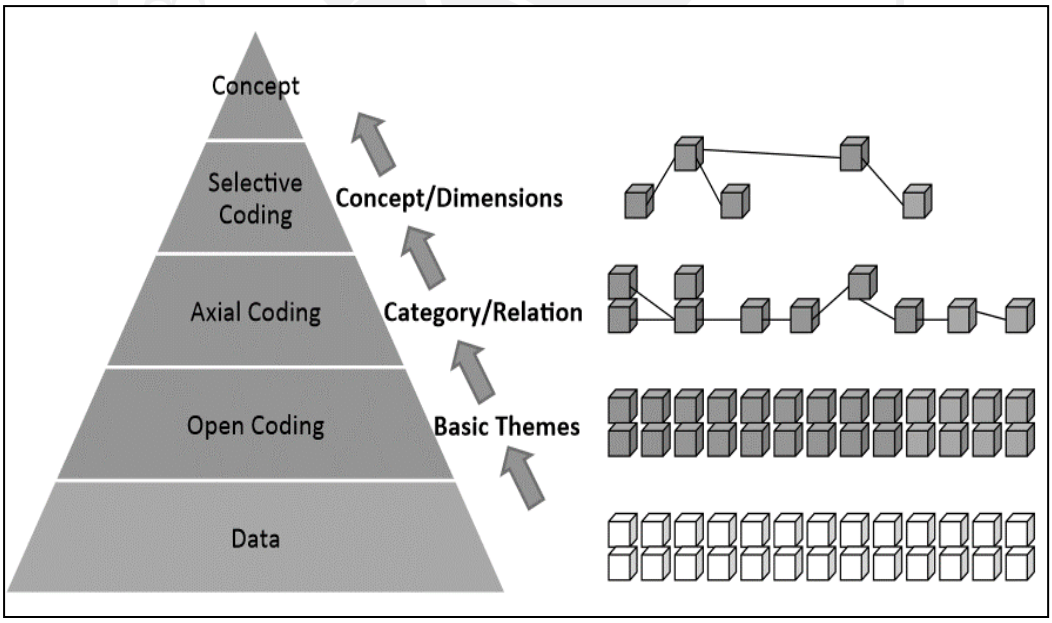
measured assessments of their methods and themselves as researchers. Her assumptions are as follows:

1. Reality is multiple, processual, and constructed under particular conditions.
2. The research process emerges from the interaction.
3. Positionality of the researcher and the subjects.
4. The researcher and participants co-construct the data—data that are a product of the research process, not simply perceived stimuli.

Researchers are part of the research condition, and their privileges, perspectives, positions, and interactions affect it.

Figure 3.5

Process of Analyzing and Coding Data in Grounded Theory

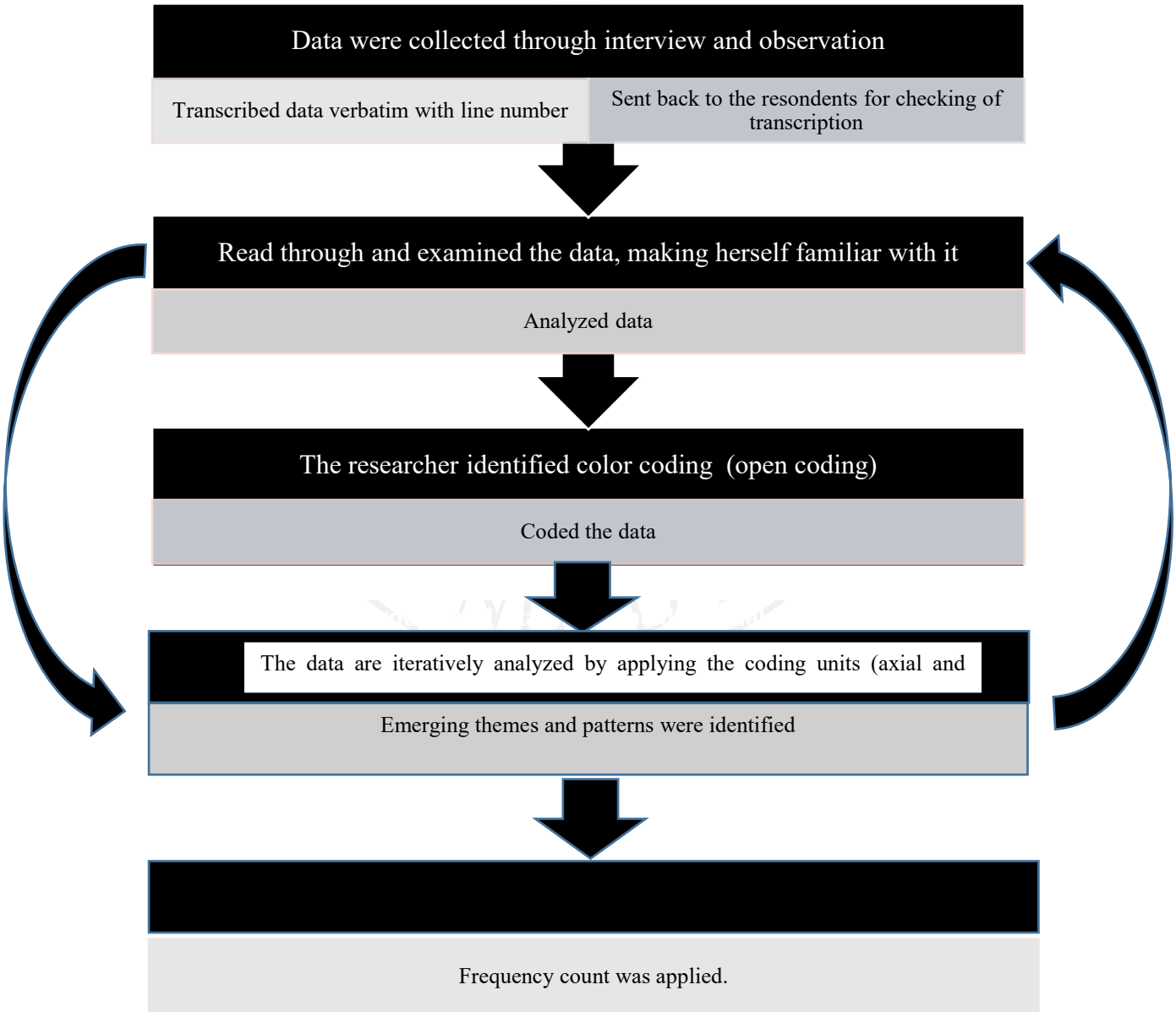


The interviews were recorded and transcribed verbatim, and coded. The researcher performed the cyclical analysis of the data into categories from which the

research themes emerged. The coding process consisted of analyzing and combining data collection to mark related ideas that became themes grouped into categories. The data were repeatedly read, reviewed, and analyzed in a cyclic process. Below is the diagram showing the process of analyzing the data.

Figure 3.6

Data Analysis and Interpretation Procedure



3.11.2 Transcription and Translation

There is a significant difference between transcription and translation. Transcription is considered a written (printed) copy, a representation that imitates the oral responses of the interviewees. Nonetheless, the researcher optimized Filipino and English languages during the interviews. The initial verbatim transcriptions in Filipino included

1. verbal expressions such as “ah” or “umm,”
2. asides from the researcher or others whose immediate needs required breaks in the interview process,
3. noting of sighs and laughs, and
4. other reflective expressions of the interviewees were not necessarily pertinent to the subject being addressed.

In conversation, the spoken word carries with it. Translation has a richer meaning. It connotes the transference of meaning, expressing the sense and intent of words and passages in a different language (Oxford, 2002). In translating this response into English to share the learnings in this qualitative study, the researcher followed the international guidelines of the World Health Organization on the process of translation.

The first principle is that while the translator knows the English-speaking language and culture, their first language is the primary tool of the target language and culture engaged in the interview process. The second principle is that the focus needs to be on communicating the concept rather than a literal, word-for-word translation and that the words and phrases selected need to be both natural and

acceptable for the audience of the translation. As the guidelines forward, translators "should consider the definition of the original term and attempt to translate it in the most relevant way" (Course Hero, 2017; Markert, 2019.) Additional considerations in the translation included striving to be simple, concise, and clear and avoiding jargon.

Following this guidance, the researcher has conveyed the primary concepts through this translation and has engaged a native English-speaking editor to confirm the correct grammatical conveyance of this translation. Note those translations in some instances, where a laugh or a pause appeared to convey additional meaning and context to what was being said.

3.12 Research Instrument

As mentioned earlier, data were collected through observation and interviews using the open-ended interview guide:

1. What are the unique characteristics of the R&D BIOTECH agricultural sector that influence innovation?
2. What innovator competencies and attributes enable successful R&D BIOTECH innovation in HEIs?
3. How is innovator success in R&D BIOTECH supported and encouraged in HEIs?

All the responses of the successful innovators were transcribed verbatim and assigned line numbers for validation using the Interview Transcript Validation Form (Appendix G) for the respondents. The results of the validation were precise. No one among the respondents argued nor questioned their transcribed responses.

The verbatim responses of the successful innovators were color-coded in which blue represents the factors while yellow represents the competencies and other colors for concepts that cannot be distinguished as either factors or competencies. In addition, there was a tabular representation of the transcribed interview.

In order to establish the data, open coding was first employed. In open coding, data were read several times, and then tentative labels for chunks of data were created. Data were summarized based on the meanings that emerged from the data. Axial coding was then used. Axial coding identifies relationships among the open codes, and the bonds among codes were established vis-à-vis the verbatim responses. Finally, selective coding was utilized. In this stage, core variables that include the data entirely were identified. The transcriptions were reread and selectively coded, and any data relating to the core variables were identified. A verbal description of the themes was constructed based on data properties extracted from the responses. The frequency count of the responses was also done to tighten the shreds of evidence gathered.

3.13 Strengths and Limitations of Methodology

There are strengths and limitations in every method used in a study to allow the conduct of future research. According to Creswell (2009), "conducting interviews whether face-to-face, by telephone or via focus group are advantageous when there is no possibility of direct observations, and there are more chances of collecting supportive historical information." In addition, Stevens (2014) has a similar understanding regarding interviews. He says the strength linked with interviews includes gaining a considerable amount of information quickly, getting in-depth and substantial responses, and clarifying obtained responses immediately. In contrast, the

limitations or weaknesses in using interviews include interviewee cooperation, the researcher's lack of experience in conducting interviews, scheduling interviews and follow-ups, and the quality of data can be questionable. In addition, it requires monetary funds to finance travel and expenditures any travel and transcription requirements.

3.14 Reliability and Validity Interview Tool

Generally, *reliability* is defined as the consistency of scores, while validity measures what it purports to measure. Creswell (2009) has differentiated these tools in a qualitative design. Qualitative reliability is assured when different researchers and projects' scores are consistent. On the other hand, qualitative validity is achieved when the accuracy of the results uses definite procedures and strategies such as member checking, peer debriefing, and triangulation of information. The study has observed the following to ensure the reliability and validity of the results: (1) minimizing errors and biases through the formation of interview protocol; and (2) logging, monitoring, and reviewing the interview data collected and analyzed. In addition, formed patterns were sent to experts for validation (Appendix H), and interviews were conducted with secondary participants to corroborate the findings.

3.15 Conceptual Framework

A preliminary survey of the literature reveals that innovation is most common in the corporate, industrial world, primarily driven by the need to respond to increasing demands while also taking advantage of the opportunities of technological advancements and for the firm's economic growth and sustainable development to include competitive advantage. Through its Institute of Biotechnology, higher

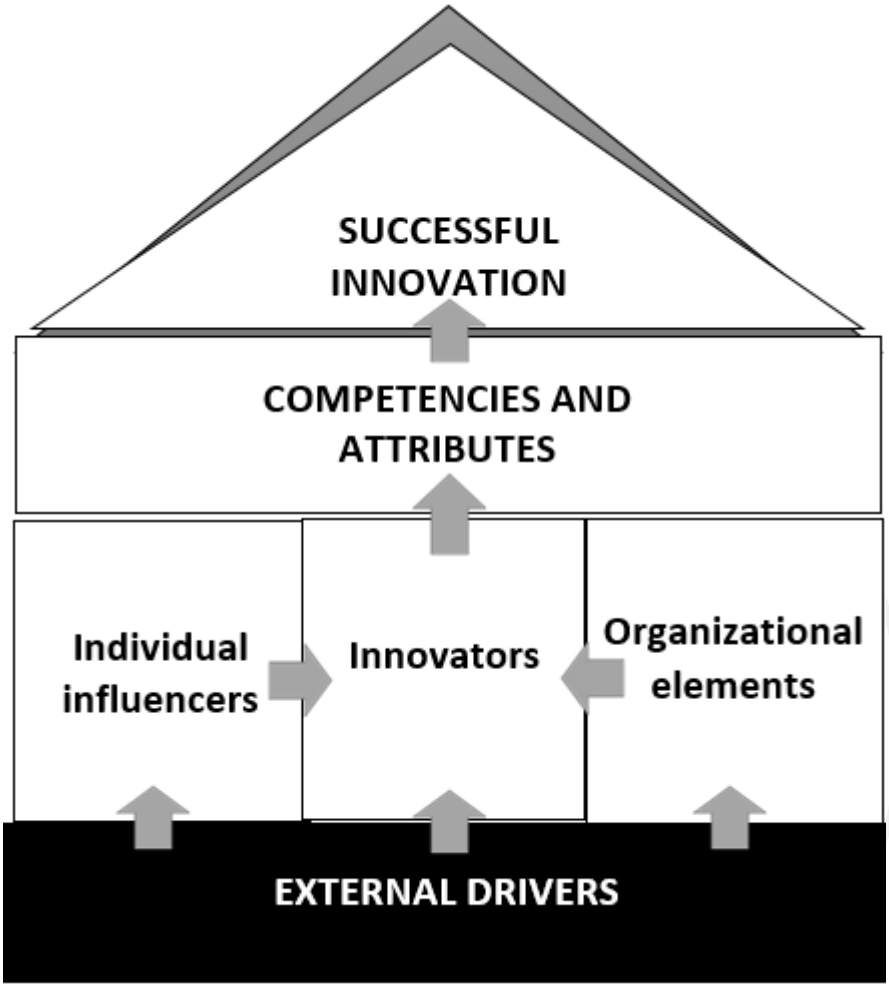
education institutions possess a wealth of expertise in research that industries can tap to level up their process or products, while standards for excellence also push institutions to innovate. Therefore, universities seem to innovate in response to external forces [providing industry service and responding to required benchmarks for excellence]. However, new studies also suggest that institutional culture may also affect a university's innovation path. This study considers both scenarios while also being mindful of the mandate universities must fulfill as agents of change.

UPLB Biotechnology is a knowledge-rich community that addresses societal problems besetting the agricultural sector. These external drivers and relevant innovation factors push them to continuously produce technologies that create value for the end-users. Moved by their observations and unique characteristics called out as individual influencers, the scientist-innovators ignite their knowledge either to produce incremental or radical innovation backed up with the innovation competencies possessed by each innovator to be successful in their endeavor to produce technologies; all of which attributed to the successful path to innovation.

This study attempts to discover the rational and practical motives of why do R&D Biotechnology innovators in higher education institutions achieve success? Therefore, this study is conceived based on the framework below.

Figure 3.7

Conceptual Framework



CHAPTER 4

RESULTS AND FINDINGS

"There are no idle lands, only idle minds".
UPLB Mantra

UPLB BIOTECH is a knowledge-rich community that addresses societal problems besetting the community's lives and wellness. It is composed of various experts, including scientists-innovators who are endowed with a vast knowledge that, when utilized, could and does—as evidenced by the success of products and the awards recognizing that success—turn into successful innovation.

This study aims to determine why and how R&D BIOTECH innovators in higher education institutes achieve success, highlighting the interweaving association of knowledge, creativity, and innovation towards the development of an innovation model for higher education institutions. Although extensive research has been carried out on drivers of innovation and innovation competencies, no single study exists in which these concepts have been established that lead to successful product innovation in the context of Biotechnology in higher education institutions.

Fundamentally, all organizations, including those in higher education, have a running dialogue about innovation, the importance of "doing" innovation, and the end product of innovation. Many try to "do it," with only a few succeeding (Wang & Ahmed, 2004). Finding out some of the possible reasons for such efficacious results was interesting to this study.

The first three chapters of this dissertation introduced the problems surrounding creativity and innovation and a review of literature adjoining factors of innovation and innovation core competencies. Responses to the interview questions provided in Chapter 3, directly related to the research sub-questions, are provided

hereunder based on the collected, analyzed, and interpreted data. Each of the open-ended interview questions relates directly to a sub-research question. Thus, this chapter is organized in terms of the interview questions, including the responses of all eight innovators and related observations.

4.0 Demographic Profile of Participants

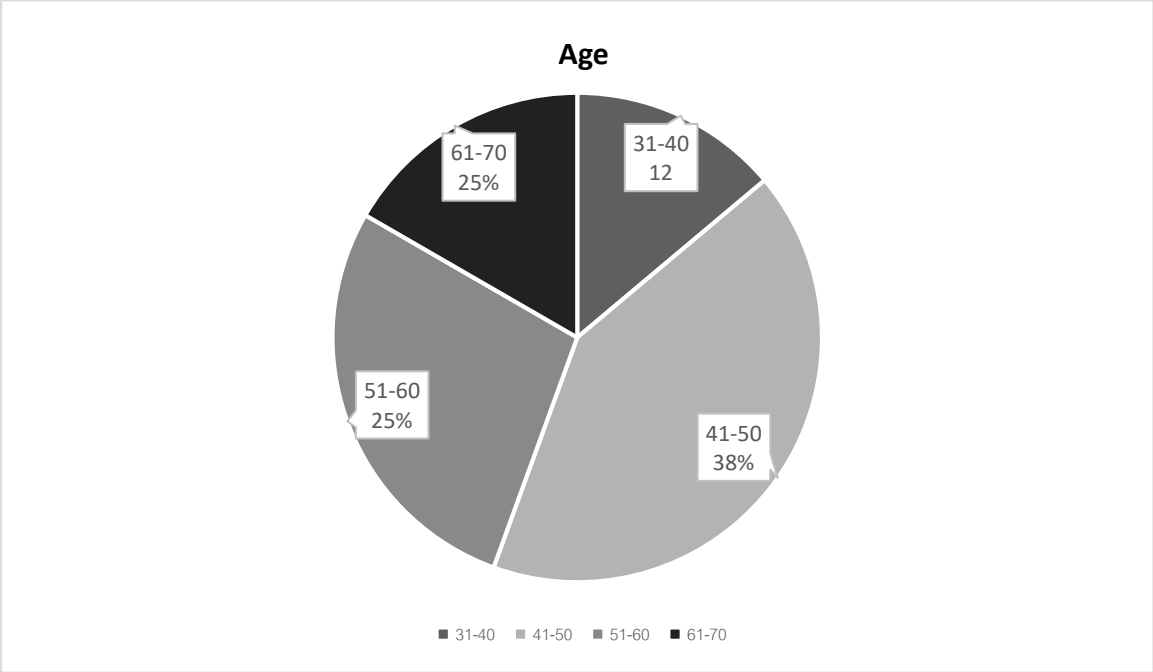
The eight scientist-innovators, the principal focus of this case study, are based at The National Institute of Molecular Biology and Biotechnology (BIOTECH), which serves as the national research and development (R&D) institute specializing in health biotechnology, food and feeds, environmental, and agricultural. Recognized as a Center of Excellence for Research, it capitalizes and exploits the country's myriad collection of rich natural resources and agro-industrial waste and by-products and microorganisms to develop, cultivate and advance alternative technologies and product innovations towards improved and value-added agro-industrial productivity.

4.0.1 Age Range of Ten Scientist-innovator Participants.

Figure 4.1 reveals that 25% of the participants are 51-60 years old. Based on the interview, they have grown up producing technologies. It is, therefore, significant to note that at this age, scientists-innovators still assume their responsibility for making viable products for society. In connection, 38% of the population belongs to the 41-50 age bracket. It is vivid that their prime years are spent towards a noble cost. Meanwhile, even if nearing retirement age, as indicated above, where 25 % belong to 61-70 years of age, they still keep up with their commitment. One of the participants, who is the youngest with a percentage of 12%, whose age bracket age is 31-40, proves that young or old, as long as one has a passion for working on something, one can make a difference.

Figure 4.1

The Age Range of Scientist-innovator Participants



4.0.2 Gender of Scientist-innovator Participants.

Fifty (50%) were male, and fifty (50%) were female. This equality in the number of male and female participants—and among the total number of BIOTECH scientist-innovators—implies that there is no dominant gender in product innovation. According to Fagerberg (2005), most studies are mainly conducted on male innovations, such as technological processes and product innovations. There is a lack of explanation regarding gender perspective in innovation and a large extent, concerning the blind vision of individuals. Furthermore, communication around the profile and the role of the innovator is poor (Brännback et al., 2012).

4.0.3 Awards of Scientist-innovator Participants

There is a consistent recognition for scientist-innovators for contributing to their fields. From the local frame of reference (referring to within the Philippines), 50% have received recognition 1-3 times, and 50% have received recognition four times. Local recognition includes awards from their respective local communities and from the national arena through recognized and accredited government and non-government agencies. At the international level, 87% of the participants have received an award from outside the country, while the rest is 13%. BIOTECH has received more than 200 international and national awards and numerous publications.

4.0.4 Number of Patents Held by Scientist-innovator Participants

More than half of the scientist-innovator participants have filed and received viable patents that the market has used. Specifically, five of the eight participants, or 61%, have one patent, and 3 or 39% hold two or more patents. Dr. Marilyn Brown, director of the National Institute of Molecular Biology and Biotechnology (BIOTECH), proudly shared the accomplishments of BIOTECH in the past four decades, citing its 47 products and technologies, 17 patents, 15 pending patents, 18 approved invention disclosures, 16 trademarks, 13 trademark applications. Dr. Brown shared and cited by Gloria (2019), "Many of our products and technologies are now being used by the industry and farming sectors. And are currently contributing to overall growth and development of these sectors."

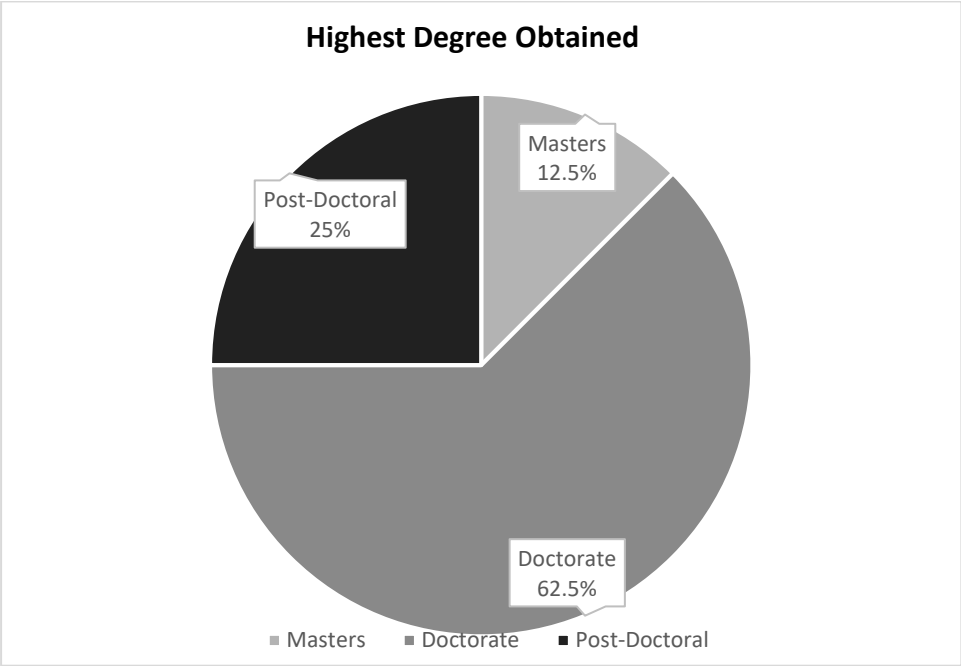
An example of this is the Mykovam. Mykovam is very effective in improving plant growth and increasing the yield and survival of several agricultural and fruit crops and forest trees. It can also increase plant tolerance against root pathogens (Aggangan et al., 2013).

4.0.5 Highest Degree Obtained by Scientist-innovator Participants

Of the eight participants, 5 or 62.5% are Ph.D. holders, 2 or 25% have completed post-doctoral work, and 1 or 12.5% hold a master's degree and are currently completing a Ph.D. Further, the majority of the innovators' technical skills are developed and nourished through further studies in reputable institutions abroad. These skills were carefully honed and cultivated through time, which made them extraordinary from the rest of the professionals in UPLB because they became agents of change and increased innovation productivity by the university (see 4.2.1). As supported by their educational qualifications, training, and exposure, the innovator's intensive and massive education background made them adept at their current work, especially in sharing the essential information and taking action (knowledge) in producing sophisticated and contextual technologies. In addition, their education played a significant role in fostering the skill sets required for each particular endeavor (see 4.2.3.1.2.2).

Figure 4.2

Highest Degree Obtained by the Scientist-innovator Participants



4.0.6 Field of Expertise of Scientist-innovator Participants.

Of the eight scientist-innovator participants, the field of expertise (interest) is agriculture, 4 or 50% is agriculture, 2 or 25% is food technology, and 2 or 25% is forestry. Family history triggers the innovators to specialize in a specific field. For instance, two of the innovators come from a family of farmers, and they saw the adversities these farmers directly experience, which provides a close relationship with, and understanding of the needs of this segment of the population. Innovators are grounded in their field of expertise in addressing environmental problems, meaning that their activities in producing technologies are due to their in-depth expertise. For instance, Innovator D optimized her expertise as a forester to improve on the product she carried over from her forefathers (see 4.2.2.1).

Figure 4.3

Field of Interest/Expertise of the Scientist-innovator Participants

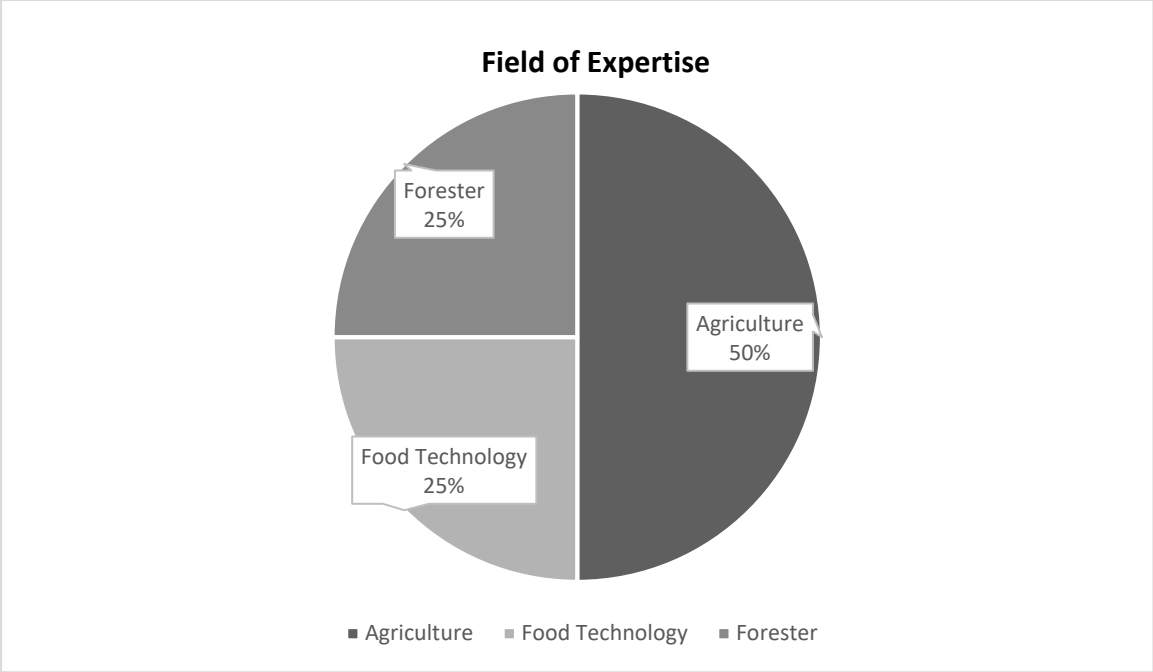


Table 4.1 below lists the scientist-innovators with their designator used in this study, the name, and a brief description of their patented innovation.

Table 4.1

List of innovators with the description of their technologies

Innovators	Patented Innovations	Brief Description
Innovator A	Dwarf Saba Variety	*Dwarf Saba Variety* is fruiting, high yielding, and more resistant to typhoon damage.
Innovator B	Meat Detection Kit	*iDetect,* a meat detection kit, identifies the kind of animal meat tested in adherence to the Food Safety Act and addresses food fraud.
Innovator C	Microencapsulated Fruit Bioactive from Bignay (Antidesma bunius L.)	*Microencapsulated Fruit Bioactive from Bignay* is an exotic Philippine fruit used in the manufacture of red wine. Its properties which constitute excellent flavor and color, and a high level of total phenol and antioxidant, contribute to the beneficial effects of the product on human health when consumed in moderation.
Innovator D	Mykovam	*Mykovam* is a soil-based biofertilizer for fruit trees, crops, reforestation, and ornamentals.
Innovator E	Probiotic Guava Tea	*Probiotic Guava Tea* is a probiotic drink that boosts the human immune system. It is a ready low-cost drink against radicals that weakens the body, which affects people's performance.

(Continued)

Table 4.1 (Continued)

List of innovators with the description of their technologies

Innovators	Patented Innovations	Brief Description
Innovator F	Rennet (Milk Coagulant)	*Rennet* is an enzyme preparation that may substitute animal rennet as milk coagulant in cheese making. It can offer 37 to 54 percent higher benefits per 100 liters of milk processed into cheese than animal rennet.
Innovator G	SNAP Solution for Hydroponics System	*SNAP Solution for Hydroponics System* is a low-cost and straightforward hydroponics system adapted to local conditions in the Philippines, which make growing crops hydroponically possible anywhere, even in an urban environment.
Innovator H	WiltCure	*WiltCure* is a biopesticide that can effectively control fusarium wilt in tomatoes, eggplants, and hot pepper, thus resulting in more vigorous growth and higher yield.

From the participants' descriptions above, we can derive that, indeed, they qualify as subjects of the study. It is because they possess the essential educational background and, more importantly, the innovations obtained here and abroad, which have proven to improve the lifestyle of Filipinos and beyond with the awards they received.

Not to disregard the two other identified participants who could not participate in the one-on-one interview due to obligations that they cannot cancel anymore. However, they assured the researcher that they support whatever would be the result of the study based on data gathered from the respondents as they are all operating within a well-established set of principles, guidelines, and practices embedded in the organizational culture (see 3.9.2).

4.0.7 Secondary Participants

There were nine interviewed secondary participants because of their specific jobs, which are in direct relationship to the mission and focus of BIOTECH. These individuals hold the following positions at the University of the Philippines Los Banos, Laguna:

Three (3) Project Development Officers of the Technology Transfer and Business Development Office (PDO-TTBDO)

Director of Technology Transfer and Business Development Office (D-TTBDO)

Deputy Director of Agricultural Systems Institute (DD-ASI)

Development Management Officer III of Technology Transfer and Business Management Program (DMO-TTBMP)

University Extension Research Specialist II (UERS)

Vice-Chancellor for Research and Extension

Chancellor of UPLB

In the discussion below, the three (3) Project Development Officers of Technology Transfer and Business Development Office (PDO-TTBDO) were identified with numbers 1- 3, the eight (8) Innovators were labeled as A-H and two (2) other innovator respondents as Innovator Respondent 1 and Innovator Respondent 2. In addition, included in the interviews were: the Deputy Director of Agricultural Systems Institute (DD-ASI), Development Management Officer III of Technology Transfer and Business Management Program (DMO-TTBMP), University Extension Research Specialist II, Director of Technology Transfer and Business Development Office (D-TTBDO), Vice Chancellor for Research and Extension and the Chancellor.

4.1 Characteristics of BIOTECH that Influence Innovation

4.1.1 External Drivers (ED)

External drivers such as environmental aspects and external relations appear to drive success in innovation in BIOTECH powerfully. The two themes related to environmental aspects that emerged from the interviews fall in natural calamities (mentioned by all eight participants) and societal problems (mentioned by seven of the eight participants). The two themes related to external relations are state-of-art facilities and funding agencies. These areas are shown and further explicated below.

Table 4.2

Characteristics of BIOTECH that Influence Innovation

Category	Sub-category	Themes	Verbal Description	F N=8
External drivers	Environmental Aspects	Natural Calamities	Refers to environmental problems which serve as the impetus for producing technology	8
		Societal issues	Refers to the issues that hamper agricultural growth in attaining economic growth, achieving sustainable development, and mitigating climate change.	7
	External Relations	State of the Art Facilities	Refers to the location of technology development. It has two kinds: (1) on-site (laboratory), the storage of specimens such as fungi and bacteria; (2) off-site (field) where root crops, grains, or fruit-bearing trees are grown.	6
		Funding Agencies	Refers to interested parties who wish to finance the development of technology	6

If proper care and protection are permitted, possible mitigation happens of these external drivers beyond the innovators' control. BIOTECH responds according to the community's needs, especially in alleviating the aftershock of natural calamities to people's livelihood. The Chancellor focusing on these issues compels the innovators to coordinate with the TTBDO (as mentioned in section 4.1.1.1) to participate in knowledge sharing by working closely with the farmers and other end-users to address these calamities.

As forwarded in 2.9.1.4, these findings agree with Briseno and Zorrilla (2017), who say that firms are increasingly responding to social and environmental claims from society. A major driving force behind the firm's innovation activity is the conditions in its environment (Capon et al., 1992). Innovation practices are encouraged to attend to poverty, work equality, renewable energy, and food production, notwithstanding the hazardous effects of climate change; thus, intense implementation of practices more frequently to address impacts on sustainability. However, questions remain on how firms' responses, including HEIs, vary across disciplines. Since the prime mandate of BIOTECH is on agriculture, innovators in this study cater to the issues of food production.

In the subsequent discussion, the Chancellor shifted the focus to food production so that they could serve best the interest of the people, and their technologies could respond to society's problems. Quoting the statement of the Chancellor: *I told my team, with the presence of Dr. Glenn Baticados, Director of TTBDO, to shift our focus onto food production so that we can serve the best interest of the people. The technologies they are doing respond to problems in society.* It was also mentioned in section 4.1.1.2.1 by Innovator E that the Chancellor, together with

the Vice Presidents (VPs), sets the university's strategic direction towards successful innovation. As Innovator E says: *Our Chancellor and the vice president set the university's strategic direction toward a successful innovation. Moreover, our Chancellor likes that our products are focused on food production.*

External drivers are focused on the areas of Environmental Aspects and External Relations.

4.1.1.1 Environmental Aspects (EA). In a country report on climate change policies, green jobs, and decent work in the Philippines, Eross S. Ocampo (Representative, Trade Union Congress of the Philippines Education and Project Officer, Philippine Government Employees Association Coordinator for South East Asia, PSI-Asia Pacific Youth Network) mentioned that the Philippines are prone to natural disasters. Specifically, these disasters are typhoons, floods, landslides, volcanic eruptions, earthquakes, and tsunamis, lying as it does astride the typhoon belt in the active volcanic region known as the “Pacific Ring of Fire” and in the geologically unstable region between the Pacific and Eurasian tectonic plates. In addition, the Philippines also suffers significant human-caused environmental degradation aggravated by a high annual population growth rate, including loss of agricultural lands, deforestation, soil erosion, air and water pollution, improper disposal of solid and toxic wastes, loss of coral reefs, mismanagement and abuse of coastal resources, and overfishing (2.9.1.3).

This destructive reality compelled the scientists-innovators to develop technologies that somehow mitigate such disasters, if not assuage the aftermath to society and the people greatly affected by them. In the following discussion, Officer 1 of TTBDO mentioned in section 4.3.1.1.1 that it is pretty clear to the resident

scientists-innovators that what they are working on is to respond to the calamities that destroy the agriculture. As she says: *It is pretty clear to our resident scientists-innovators that what they are working on is to respond to the calamities that destroy agriculture and are related to food production.* In this regard, Innovators D and H work on bio-pesticide, while Innovators A, C, E, and F work on food production. Innovator G works on a technology that produces organic food, and Innovator B works on a technology that mitigates food fraud.

The two themes related to environmental aspects that emerged from the interviews fall in natural calamities (mentioned by all eight participants) and societal problems (mentioned by seven of the eight participants). These two areas are further explicated below.

4.1.1.1.1 Natural Calamities (NC). The innovators have observed that natural disasters pose a severe threat to the world's economies, especially developing countries, in terms of economic losses and physical damage, including the present society. As Innovator G says, we *are aware of the enormous effect of different natural disasters. Yes, most especially like our country, which is often experiencing calamities.* Likewise, Benson and Clay (2003) state that major natural disasters can have severe negative short-run economic impacts. Disasters also appear to have longer-term consequences for economic growth, development, and poverty reduction. However, as forwarded by the innovators, negative impacts are not inevitable, especially in the agricultural sector. Hence, innovators respond more aggressively to competitive threats and environmental concerns. Specifically, in this regard, Innovator A says: *And please know that here in the Philippines, we are visited by more than 20*

typhoons every year. So, we need a technology that is resistant to calamities to help the agriculture sector.

Although the Philippines has disaster-mitigating agencies that manage the devastating impacts of such disasters across sectors of the country, they still need technologies, which the innovators can offer, to help them in their task to mitigate disasters. In line with this, the expertise and innovativeness of the innovators are sought one after the other through their agricultural innovations. PDO-TTBDO 1 shared: *Our researchers' expertise is seen and felt during this time. Yes, they are our innovators and, at the same time, researchers. Therefore, they do research first in order to create technologies.*

Most of the innovators shared the current state of the country's agriculture [which the researcher coined as SONA-State of the Nation's Agriculture]. There is a decline in Gross Domestic Product (GDP), which includes a scarcity of staple products like rice, root crops, and organic plant-based foods, and insufficiency of poultry and aqua products; conversion of multi-hectare lands into industrial businesses like casinos, malls, and condominiums; land-grabbing of giant companies and influential individuals serving their interest; and corruption of government funds allotted for agriculture. For instance, the political motivation that stirs innovator E the most, causing her to direct her attention to this issue, is the selling or leasing of lands of the underprivileged fellows to produce the placement money needed for them to work abroad as domestic helpers (DH), even though the majority of them are graduates of a four-year degree (most of which are graduates of education), with the hope of getting them out from poverty. As Innovator E shares: *It feels sad* [shows sad face] *to see our fellowmen, especially our education graduates, you know, to work*

abroad as a domestic helper to rise above poverty. It is clear that these issues are essential to the innovators and fan their passions for improving living conditions across society through their worthwhile technologies. As innovators consistently mention, with this specific quote voiced by Innovator D: T*o ease their hardships in life, we are responding to the needs of the Filipino farmers because of the effect of the calamities on their crops.* In particular, Innovator H says: *I keep repeating that our product is to help the way of living of our fellowmen. It is being used by all, not only those we call poor individuals, especially when some Filipinos prefer organic food.*

In addition, innovators revealed a heart-breaking truth that after robust negotiations from developers, small-time landowners perceive that their only recourse is to sell their piece of land. We convince the people of the value of monetary property over a piece of land that they perceive can never be productive. Innovator D shared one encounter with the farmers: *They prefer to sell the lot because there is money in it over the lot where it is not productive. Ahhh…I feel sad.*

Furthermore, Innovator G said: *Another thing; they do not have the skills to till or make the land productive. They do not have enough capital to buy seeds, fertilizers, and other materials needed for agriculture.* These people do not have agricultural training and cannot, therefore, till and optimize their lands. Additionally, they lack capital for seeds, fertilizers, and other related agricultural machinery needed for planting and harvesting, an inexorable effect brought about by natural calamities. About his technology, Innovator G says: *This is advantageous, especially for those with small space. It is beneficial even to those who prefer vegetables.* [Directed to the researcher] *All those plants you can see are organic.* Furthermore, Innovator E states: *This technology will help, especially those poor, to have a job and earn*

decently. Maybe, they need not go abroad. We have lots of guava trees. They are everywhere. We need to learn how to maximize them.

The innovators are aware that the vulnerability to change is shifting quickly. It is evident in countries like the Philippines, which are experiencing an economic transformation—rapid growth, urbanization, and related technical and social changes (Abbas et al., 2018) –and that cannot escape the adversities brought about by natural calamities. For instance, Typhoon Haiyan in the Philippines was considered one of the strongest storms ever. Most disasters linked to atmospheric and hydrological processes are recurrent, striking a country at infrequent intervals. Such recurrent shocks potentially have cumulative effects on the rate and development pattern (Benson & Clay, 2000). This relentless reality pushes innovators to create potential technologies. On the other hand, one innovator revealed that the need for industry triggered her to create an innovative product (see 4.3.1.3.1).

It is noteworthy and striking that instead of feeling appalled at the frequent visits of natural calamities, innovators use these events as a springboard to their research (see 4.2.3.1.3.1), finding solutions and offering substantial technology to assuage the effects on humankind and the society in general. Henceforth, in this study, *natural calamities***,** as one of the elements of environmental aspects perceived as factors for innovation, *refers to environmental problems which serve as the impetus for producing technology.* Innovators are motivated and challenged to produce technology to address the condition of the environment and erratic weather and for sustainability. However, it is the needs of society that impel them to create and co-create products that have potential market value. As Innovator H states, sustainability drives *us to produce technology amidst calamities.* Innovator A adds: *There are risks*

because of the environment, like calamities. Yes, just like what I have mentioned earlier, the problem with the saba is that it is prone to calamities. For instance, if plants are short, there is less vulnerability to a typhoon, which is prominent in the Philippines, especially in Luzon. There are lots. So, the idea is that the technology should be shorter to be resilient and protected from being damaged due to calamities. Moreover, the bonus is early maturing; it is fast and easy to harvest.

4.1.1.1.2 Societal Issues (SI). Significant findings in the study tell us that innovators are taking their time seriously to study (see 4.3.1.1.2) the endemic problems (see 4.2.1.1.1). Beneath this reality, they conduct massive investigations (see 4.2.3.2.1.1), rule out the cause of the problems, and earnestly search for solutions to help the farmers (see 4.2.1.1). For instance, there is a general awareness of the deleterious effects of chemical pesticides on the human body and the environment. As Innovator H says: *We know the deleterious effects of using chemical pesticides in our body and the environment, so the government's thrust is to look for alternatives like biocontrol strategies such as bio-pesticides.* This fact ignites the innovator's eagerness to produce technologies that use safe alternatives like biopesticides so that they are pro-environment and support a conscious and healthy lifestyle. As forwarded by Innovator H and discussed in section 4.3.1.3, produced biopesticides are natural, meaning there are no added chemical contents. Innovator H advocates a natural way of producing vegetables. He points out that this approach helps elevate the lifestyle of the poor, who could not afford to bring palatable and mouth-watery foods onto their plates. As he says, the *health benefits of the plants are essential. To feel the freshness of what we eat, it is but right that plants must grow naturally. They are fresh yet affordable. Even our less fortunate brothers and sisters will benefit from this.*

Undeniably, endowed with different kinds of comparable bodies of water, lush and fertile lands, and a climate that is somehow favorable for agricultural products, the Philippines used to be a leading exporter of crops. However, with the entry of economic industrialization, accompanied by its irresistible benefits and challenges, the agriculture-based economy of the Philippines was enticed to industrialize. Several innovators voiced this underlying cause of the current agriculture issues. In a similar tone, Samar Rep. Edgar Sarmiento also expressed his concern over the decreasing number of agricultural lands due to the gradual industrialization of the country (de Carbon, 2019). As one innovator expressed, priorities have changed, almost forgetting the fundamental need for survival.

In addition, climate change is also a significant challenge as its adverse impacts such as increased flooding incidence, drought, soil degradation, water shortages, and increased pests and diseases constantly threaten agricultural output and productivity. The Philippines is third among the 173 countries globally in terms of the disaster risk index (Alave, 2011). Climate impacts are magnifying the risks and vulnerabilities that already afflict Philippine agriculture and food production and the vulnerable and marginalized families and individuals (European Commission, 2009).

UPLB Technology Transfer and Business Development Office (TTBDO), formerly known as Center for Technology Entrepreneurship (CTE), executive director Glenn Baticados said that agriculture today is more than just a farmer simply planting a crop, growing livestock, or catching fish. He said, "It takes an ecosystem and several actors to work together to produce and deliver the food we need. This dynamic and complex ecosystem will equip agriculture to cope with the competing challenges of addressing food safety and security, creating inclusive livelihoods,

mitigating climate change, and sustainably managing natural resources," de Guzman (2018) as forwarded in 2.9.1.4. He refers to several factors, including the scientists-innovators, who play a crucial role in restoring the agricultural sector through their product innovations. An example is the Meat Detection Kit. It is a Deoxineo (DNA) test to determine what kind of animal ingredient is present in food and to detect the presence or absence of specific animals in food. Since there is fraud in detecting the kind of animal in the food we eat, the innovator developed a detection kit for eleven (11) kinds of animals. As Innovator B says: *It is because we develop two techniques that would have the same purpose, which is to detect the presence or absence of specific animals in food, a DNA test to determine what kind of animal ingredients are present in food. So, I developed detection for eleven animals. Yes, if one wants to ask, one can use it to verify labeling because there are false labeling problems. And then there are meat adulteration problems. It seems to be beef, but it is a mixture of beef and pork. So, food safety-wise, it is not a big deal to mix beef with pork. However, that is a fraud because one claims it for a higher price by declaring it is 100%. And then, it seems false to claim that it is pure beef, yet there is pork in it. We want to be honest in our test … and then there is a bigger market now that I have presented it to the public because we already filed the patent. Yes, the Halal community, Muslim community. Because they want no pork, there is a move to perform DNA testing; although we have not done it yet, the government is already investing in DNA testing facilities. Yes. It is marketable because there is a need; people need it. Nevertheless, we are not operating yet in large-scale production.* This finding is consistent with Brown et al. (2018), saying investment in technology and innovation and the

necessary support services are essential to achieving successful agricultural transformation.

Agriculture is the largest user of the Earth's ecosystems and has the most significant impact on the environment and its biodiversity. Over the past half-century, more than a quarter of the world's 8.7 billion hectares of croplands, pastures, forests, and woodlands have been degraded through misuse or overuse (de Carbon, 2019) as forwarded in 2.9.1.2. In other words, agriculture constitutes the foundation of food security.

As the chancellor stressed during an interview with him, it is imperative that all concerned bodies work together, innovate continuously, and collaborate in research and development to meet future challenges in agriculture albeit innovation. In his words*: It is pretty essential that all sectors of the community, including the education sector, work together, conduct collaborative research and continue to create technology that would best serve the people's interests.*

In short, the innovators target to produce product innovation that addresses the national appeal and the university and government's thrust to establish economic growth and attain sustainable development. Thus, societal issues as factors for successful innovation *refer to the issues that hamper agricultural growth in sustaining economic growth, achieving sustainable development, and mitigating climate change.*

4.1.1.2 External Relations (ER). Another factor under external drivers is external relations, which has two sub-clusters: (1) state-of-the-art facilities and (2) funding agencies. These factors play essential roles in the performance of the innovators in producing technologies. For example, though innovators appear eager

and exceptionally optimistic in their response to the innovation activities of the university, if the facilities and equipment available are not in sync, the labors of the innovators would be futile. Moreover, the facilities have to support their skills because these are essential means to access and understand knowledge. Innovator E says: *It is imperative to have a laboratory. Unlike us, we share a laboratory. Our target is to make one if we have significant income already* [laughs]. Innovator H says: *It is an advantage if there is a laboratory because we can care for our technology. No matter how patient we are in what we are doing, if there is not the right and enough equipment, nothing, it is hard, and I would not have a product.*

To produce exemplar technologies, innovators would find potential funding (see 4.2.1.2) from either a public or private entity to help them finance their projects. As Innovator E says: *Because the funding agencies like that there is a product when we propose, we think of a possible product that we can make from the research. So that is how we can get funded, but it is all about the research at the start. It is like this; there are those coming closer here at bio-tech to just fish for information* [laughs]. *So funding is vital in running the project. So, we need to scout different funding agencies to fund our project.*

Emergent themes associated with external relations are (1) state-of-the-art facilities (mentioned by six interviewees) and (2) funding agencies (also mentioned by six interviewees). Below is a detailed discussion of each theme.

4.1.1.2.1 State-of-the-Art Facilities (SAF). The study revealed that facilities such as laboratories, and the equipment provided in those laboratories, are primacy factors for successful innovation. People man the laboratories, each of whom has their expertise (see 4.3.1.2.2) on how expertise and as forwarded by innovator F in section

4.3.1.1 and elaborated by innovators B and G in section 4.3.1.2.2, can be classified as on-site and off-site. The former refers to the laboratory (see 4.1.1.2.1) located within the university, where specific specimens are stored and treated with the utmost care. The laboratory is equipped with sanitary systems and kept at a well-maintained temperature to preserve the lifeblood of the technology. Everyone has to be barefooted inside the laboratory because of the sensitivity of the organisms and because there are exclusive and rare microorganisms (e.g., WiltCure – Calus and Microbe Co-Culture as a Novel Source of Biopesticides against Fusarium Wilt of Solanaceous Crops) have to be placed in an isolated room with the right temperature. Otherwise, they will die and defeat the purpose of the technology. As Innovator H explains: *Kindly remove your shoes because our laboratory is highly hygienic. You may wear the slippers indoors. We also have to maintain a specific temperature, and I am sorry if you feel a bit cold.*

Since the Philippine government's thrust is to produce desirable alternative innovations to treat pesticides instead of using chemical pesticides which are hazardous to health and the environment, these innovators ceaselessly do research (see 4.2.3.2.3.1) and experiment to come up with a healthy and eco-friendly way of eradicating insecticides. An example of technology that is free from using chemicals is the Wiltcure, a biopesticide that can effectively control fusarium wilt in tomatoes, eggplants, and hot pepper, thus resulting in more vigorous growth and higher yield. Farmers then are oriented and educated on the benefits of using these technological alternatives. As Innovator H says: *I always say that it is possible to go for natural farming. I explain the benefits of this to our health and our environment.*

While on-site refers to the laboratories located within the university, off-site refers to the natural field where innovators grow their technologies until they mature—similar processes and considerations in the on-site laboratory when engaged. The only difference is that some product innovations like Dwarf Saba Variety have to be planted and grown in soil. The researcher asked Innovator H: "What caused you to venture to the Dwarf Saba Variety?" He responded that the taller the plants, the more vulnerable they are to wind damage; they cannot resist strong winds (see the example provided in 4.2.1.2.1.3**)**. On the other hand, damaging the shorter plants is rare because the direction of the wind is going up. Since the Philippines is known for exporting bananas, the researcher thought of bananas that could survive amidst inclement weather: the Dwarf Saba Variety (technology). Dwarf Saba Variety is fruiting, high yielding, and more resistant to typhoon damage.

In addition to the on-site and off-site facilities, computers with Wifi connections help innovators connect with the virtual world. As Innovator F describes: *Good enough, I know already how to use the computer with a Wifi connection. I was able to reply right away to the one interested in my technology from Australia.* Aside from connecting with their potential clients virtually, innovators utilize IT systems and processes to store and transfer knowledge. What is good about maximizing IT is that innovators design their processes for personal comfort and ease of use, yet everyone has access to information. It is consistent with the concept of trust and confidence to use and share knowledge (see 4.2.3.1.1.2).

When there are systems or programs in which the innovators are not technologically savvy, they depend on one another to access what is needed, clearly recognizing the value of IT in terms of sharing the knowledge. As Innovator G says, *I*

am pretty old to learn the dynamics of IT; that is why I depend on my colleagues. They help me understand what the IT tells us while—most of the time—I am out closely monitoring the progress of our product. But it helps to be equipped with IT. It makes things fast, easy, and convenient. "On the one hand, innovator B, who is the youngest among the innovators, enjoys IT and is very much thankful that though their IT system is diverse, it matches her skills in terms of its functions and processes. *On the other hand, I must admit I function well in the presence of IT. First, I can work anytime and where ever I am. I can easily communicate with my team even if I am outside attending seminars or training. Second, when I miss or forget something on the procedures of developing the technology, I access my computer and review the recorded demonstration and mentoring."*

Many scholars emphasize the role of ICTs as a valuable means for facilitating knowledge sharing and communication by reducing time and distance and consequently increasing the quality and reach of reliable knowledge (Fichman et al., 2011). However, the critical issue is choosing and implementing appropriate ICTs that provide a close fit between workers and their requirements. Sufficient technology skills, maintenance of ICT systems, and compatibility between ICTs and processes cause substantial knowledge sharing. Lack of these issues can lead to knowledge sharing failure even when having appropriate ICTs in place (Bradley et al., 2013; Aron et al., 2011; Guah & Currie, 2004). Participants of the study were quite thankful for the advent of technology because they can actually inform each other of the product's progress through emails and even use it to keep track of the activities of their members. Innovator F said, *"At my age, I am very thankful that I managed to learn ICT. I can send emails to my sponsor in Australia who got interested in*

financing my product; without it, I would lose the chance of this opportunity in sharing my product." Innovator was very grateful also and said, *"Since I am a bit young, it is an advantage for me to use all these apps because I have an easy access to my team, and through these apps that wire them, we can share and discuss things anytime and anywhere."* All of the innovator-scientists are grateful to the management for providing them with both the traditional and technology-based equipment.

Innovator G shared another worth capturing finding, who was able to build a space (small office) out of the small share he gets from the technology. We use this office to hold meetings as needed. As he says: *This office is the fruit of our little share of return of investment. We build this office so that we have a place to stay whenever we hold meetings).* So, the innovators do receive royalties. Asked where they get their return of investment (ROI), innovators said they receive a royalty (40% goes to the inventor and 60% goes to the institution), although they stressed this is just a secondary reward. What counts most for them is knowing their products are utilized (see 4.2.2.5). Innovator E explains: *(After the market gets the product, 40 percent will go to the scientist, then 60 percent to the university. The 40 percent has to be divided among the inventors, depending on the number of inventors).* Innovator F says: *Because they are* [laughs] *... Inventors have royalty, and even the institution UPLB receives one. So, they divide it accordingly. Yes, because in the beginning, either one publishes or perishes here. If one does not have a publication, one will not become successful* [laughs]. *You will not get promoted, although, for us, we are not promoted* [laughs]. *None. However, then you are happy with what you are doing. You have contentment with what you are doing because it leads to something; you can*

already see that people are waiting to utilize it; it is as if those who will be using it are just around [laughs].

In other words, ***the combination of the on-site (laboratory) specimens, such as fungi, bacteria, and the off-site (field) where root crops, grains, or fruit-bearing trees are grown, referred to as state-of-the-art facilities***, are essential factors in the development and success of technological innovation.

4.1.1.2.2 Funding Agencies (FA). Funding agencies play significant roles in the development of technology. During the sharing and transferring of knowledge in mastering the creation of technology, innovators try to look for agencies that can finance their projects. While it is true that this task is daunting, innovators are left without a choice since a significant number of feasible technologies are available; they are not all commercially competitive without government subsidies or other support. As shared by TTBDO Officer 2: *We have several potential technologies. The problem is funding, which most of the time comes from the government. Nevertheless, the release of funds is relatively slow.*

Findings in this study reveal that most of the innovators sought government funds but underwent the policies of the procurement law. As Innovator B shares: *The first year then, you know procurement and government. To start, it is prolonged. So, I think that is one of the dilemmas of researchers. Procurement?* [laughs] *The one that funds. Yes. My advantage before I joined animal science is that for two years, I was a contractual researcher … when I was still younger* [laughs]. *So, I already have experience in procurement. So, when I started working here, we had a strategy for procurement because the law did not change. Procurement law is always there, so you know you need to be good at it. That is why we were able to move ahead, because*

of that experience in procurement. When I was younger, Madam, when you buy Mongol, you need to wait for three months. At times, it will take six months. So, when it is one million for equipment, I know we have to wait for about one year. So, you do not have to propose, and you promise that there is already a result in one year. However, then, there is no equipment within one year. Like that, you need to strategize the procurement! [Laughs] Actually*, I taught my research assistant, and my R.A. was the one who taught the other young R.A. on that procurement. And then the law changed* [laughs], *but at least they were able to follow and understand the changes. They are good in procurement* [laughs]. *That is, it, Madam. Yes, results may not be possible because you could not buy the materials. After all, procurement can either expedite or delay the project.*

Policy refers to the guidelines concerning innovation in the university. As forwarded by the innovators, one particular law that innovators need to know and understand is the 2016 Revised Implementing Rules and Regulations, hereinafter called the IRR. This law is promulgated pursuant to Section 75 of Republic Act No. (R.A.) 9184, otherwise known as the "Government Procurement Reform Act," to prescribe the necessary rules and regulations for the modernization, standardization, and regulation of the procurement activities of the Government of the Philippines (GOP). The provisions of this IRR are in line with the commitment of the GOP to promote good governance and its effort to adhere to the principles of transparency, accountability, equity, efficiency, and economy in its procurement process (Republic Act No. 9184).

As observed by the researcher and described by the innovators, the university is strict in its implementation to maintain smooth sailing and peace and order in

technology development. There is also a guideline on purchasing equipment needed to develop the technology. Since this is a state university where funding comes from the government, the individual is accountable for the disposal of funds. After producing the technology, one submits the liquidation and the technical reports to the accounting office as clearance from their monetary accountabilities. As Innovator H says: *The procurement procedure is rigorous in the guideline wherein you need to satisfy the specification of the materials. Then, you have to use the funds properly and adequately to avoid problems when auditing comes. Over and above, it is about the technical report that will clear you from anything.* However, circumstances arise when funds delay due to unavoidable events like the late signing of a purchase request due to officials being on official business (O.B.). As noted previously, innovators say they often shell out money from their own pockets to beat the timeframe allotted for the disposal of the technology. As Innovator D says: *It is like that. If you love what you are doing, you are more than willing to spend. Do not wait anymore for the signatures because it will go through a long process. Sometimes it takes a long because officials are on official business (O.B.).* As Innovator E shares: *I know that funding is significant. However, it takes some time for the funds to be released; I need to shell out from my pocket to proceed and sustain the project.*

In the context of the non-availability of government funds, innovators may opt to forge other agencies to finance their technology, meaning they individually look for their own possible financer considering already the rigors they have gone through in coming up with the technology (see 4.2.1.2). Similar to what was related by various innovators, Innovator A said: *Funding of projects is one of our difficulties of procurement law, but then it is an excellent factor in the development and best result*

of the technology. Innovator C shared: *The project has started, but we cannot proceed that far because it needs funding for you to operate and travel.* Innovator G: *Eventually, we had a project, then The Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development (PCAARRD) funded it.* Innovator H provides an example: *There was one private individual who is well-known in the Department of Science and Technology (DOST). He helped me look for funds at the Department of Agriculture-Bureau of Agriculture Research (DA-BAR). He did not only help me get funding; he floated the idea that the tissue culture of moringa is one of the essential nutrients. It was as if he was saying that the moringa industry is profitable. You noticed there were lots of moringa capsules.* Innovator F also provided an example: *Actually, the project stopped. However, I looked for* [funding] *because I felt as if it was hanging. Then PCHRD funded it, but unfortunately, it has to stop. I went to PCAARRD because they have something like a livestock division there; they funded my thesis. I started my project with my thesis, then I said that PCAARRD gave me funding, but as I have said, I felt like something was hanging or something was lacking, meaning I wanted to prove that my production could scale up. Then they gave me a tiny amount of money, so I was able to prove it.*

Findings also revealed that innovators would attend exhibits or a technology fair as a first step in introducing the technology to the market, aside from looking for other agencies. As Innovator C narrates: *The Department of Science and Technology funded my research. Two years ago, we had to put up a booth where we displayed the products, we had considered using indigenous materials, knowing that the townspeople would use these. I had to develop labels for the products, and the most*

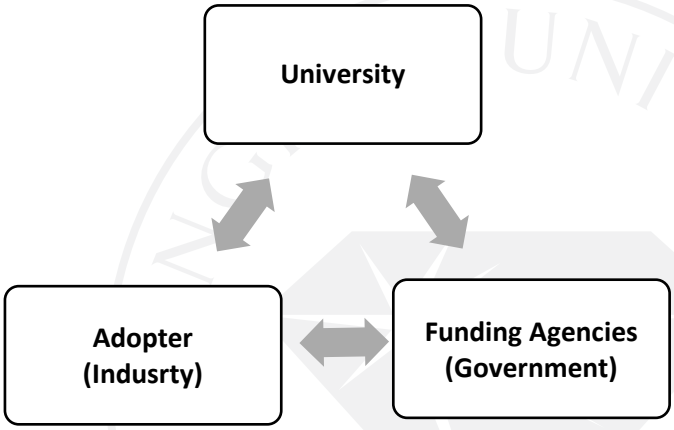
excellent experience was when Secretary Dela Pena of DOST toured the facilities and stopped where we displayed our products. And he talked to the journalists covering the event about the product and what the potential impact of the product was on the end-users. Afterward, I got in touch with individuals who showed interest in the products.

If and when agencies showed interest in the technology, they would finance the project. However, the innovators had to go through forging a partnership managed by the Technology Transfer and Business Management Program (BMP) to create a Memorandum of Agreement (MOA), as shown in Figure 4.4 below. It is similar to the view of the triple helix model, where universities, industry, and governments closely collaborate in sharing resources to improve efficiency in the process of innovation (Etzkowitz, 2005). In the case of the current study, the university serves as the technology provider (rooted in the indigenous knowledge passed on by the forefathers to the innovators), and the government provides the financial aspect to achieve successful product innovation. The industry's role is to adapt the product for mass production. An interview with Development Management Officer III of the Technology Transfer and Business Management Program (DMO-TTBMP) tells the process: *First, the inventors conduct research, and after thorough research, they create technology. Yes, most of their projects are government-funded. When the product is ready to be utilized, it undergoes various processes; inventors know better. We look for interested industries to do the mass production because the inventors do not have the machinery for this endeavor. Because of that, we can say knowledge comes from the university because they are based here and can use the university's different resources. They share with society through their products.* It supports

Etzkowitz (2003), who says the university is a source of new knowledge and technology and that industry and government have always been significant institutions in modern society for successful product innovations.

Figure 4.4

University-Government-Adopter (UGA) Cycle



One significant finding was that one innovator preferred to have a local funding agency rather than an international agency to fund their project because her team wanted to produce their local product. Choosing and prioritizing local partnerships to retain the local identity of the product shows nationalism, which this innovator explicitly exhibited. As Innovator B shares: *Hmmm… Initially, I had dialogue with local funders, but there was a perception that we had already talked with some people in Australia about funding as if it* [that product] *was all right* [laughs]. *So, then what do you like? The one in Australia, or will we make our own? PCAARRD, the funding agency, wants to tell them … as if we are in connivance. I disapproved of Australia being the one to fund the project because they*

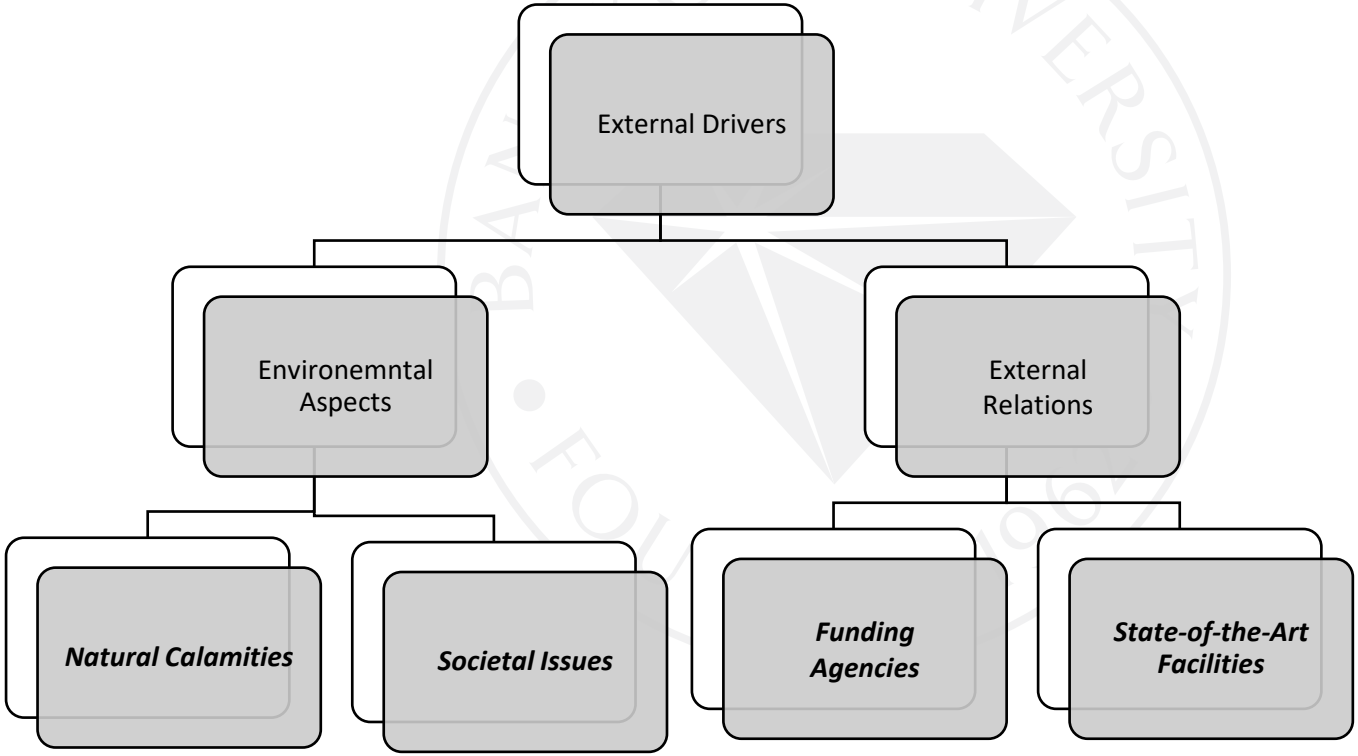
like it. They will use it after I produce it. Moreover, beside the point, it is not my intention to do business out of my technology.

In the case of the study, innovators interviewed opted for technology transfer managed by the TTBDO for the intended beneficiaries of technology. All of them mentioned that it is vital that they work on products that can be utilized and, with that in mind, facilitate the smooth flow of knowledge sharing and optimize knowledge to the fullest. Hence, they collaborate closely with funding agencies to sustain projects until they reach the end-users. *Funding agencies refer to interested parties who wish to finance technological development. As validated* by the findings from this research, funding agencies play an essential role in advancing technologies.

In a nutshell, BIOTECH's specific characteristics influence innovation, as illustrated in Figure 4.5 below.

Figure 4.5

Characteristics of BIOTECH that Influence Innovation



4.2 Innovator Competencies and Attributes

Competencies and innovation competencies have a direct effect on the success of innovation. Research literature introduced in Chapter 2 discussed competencies involving human resources and pieces of machinery. In addition, various recorded competencies of teachers, doctors, engineers in the firms, and other related professional allies are noted but not innovation competencies in higher education institutions. As used in this study, competencies refer to the skills or elements to achieve innovation, which eventually distinguishes from knowledge and creativity in higher education institutions. Competencies encompass the indispensable working habits and the entirety of an innovator in the discharge of his or her duties. However, for the competencies to become meaningful and relevant to the users, they need to be well-thought-of and structured logically and reasonably. Thus, ***competencies*** are considered attributes in a person's wholeness that would support him/her attaining ***innovation competencies***.

We define innovation competencies in the context of the intent and focus of HEIs. As a working definition for this work, *innovation competencies are considered sets of concrete and explicit capabilities, abilities, and skills which serve as the compass to achieve the organization's goals consistent with the country's thrust of raising awareness and response to issues locally and globally, particularly environmental issues besetting the society and the country in general, through their notable product innovation.* The innovators interviewed in this study, who were carefully selected based on their significant technologies, are equipped with these competencies to achieve UPLB Biotechnology's advocacy of uplifting the economic

growth of the Philippines, thus bringing extraordinary breakthroughs in history. Other than the consistent example of Mykovam in the study, which was commended for getting the highest sale all over the country (see 4.2.1), additional examples are the Dwarf Saba and I-detection kit. For this study, *core competencies are considered the indispensable working habits and the entirety of the innovators in the discharge of or her duties and tasks responsibly to adequately satisfy the terms of reference for the people they serve.*

Based on the findings, the study revealed a unique competency pattern. It means there are core competencies identified under those core competencies and then the evolving innovation competencies of the innovators to push towards successful innovation.

Core competencies generally fall into three key areas: technical skills, social skills, and transcendence. Core competencies in technical skills include problem-solving skills and creativity skills. The area of social skills related to leadership skills in mentoring, collaborating, and management skills, and the area of transcendence relates to the competency of altruism or being altruistic in terms of advocacy and commitment. Innovation competencies are the subsets of core competencies, that is, specific elements related to these core competency areas that the innovators' exhibit, which led to successful innovation. Table 4.2 shows the key areas of innovation, the related core competencies, and the specific innovation competencies that led to the successful innovations in BIOTECH.

Table 4.3

The Tabular Summary of Innovative Skills responded to by the Scientists-innovators.

Core Competencies	Competencies	Innovation Competencies Emerging from Research
	Problem-solving skills- the ability to recognize prevalent problems and find a solution to overcome them	**Focusing skills -** the ability to develop products one at a time to avoid mixed-up and shambolic output **Evaluating skills**- The ability to assess the impact of product innovation in the community
Technical Skills – the ability to apply the expertise and training gained to develop a product that addresses societal issues	**Creativity skills -** the ability to produce novel technology from the acquired information and knowledge.	**Critical thinking skills**- The ability to discern and make sound decisions in finding effective solutions to social problems. **Resourcefulness** - the ability to source knowledge, think outside the box, and the maturity to deal with the complexities of the technology.
Social Skills – the ability to make extra efforts to learn on their own and learn from others (forefathers), the rigors of developing the technology, and negotiating for funds to run the project	**Leadership skills** – the ability to exemplify responsible leadership skills to maintain a mentor-mentee smooth interpersonal relationship in leading a transformative project	**Mentoring skills -** the ability to mentor and guide the next generation of innovators in producing profitable products. **Collaborating skills** - the ability pool various resources or expertise and forge potential partnerships to fund the project.
Transcendence –the ability to respond to the needs of the community to achieve social justice without expecting anything in return	**Altruistic skills** - the ability to forget oneself in favor of the much less fortunate who will benefit from the technology	**Advocacy -** the ability to inspire the local people to utilize the product and transform their lives. **Commitment**- the ability take charge and be responsible for the notable impact of technology in the community

Table 4.3 gives the tabular summary of innovative skills responded to by the scientists-innovators. The result identified technical skills, social skills, and transcendence as core competencies of innovation. The result also lists each identified innovation competency's competencies or key indicators (sub-variables) with an analysis of each sub-variable.

The findings reveal that successful innovations lie in the skills applied by the innovators. From research observations, recognition of the skilled workers is evident for delivering high-quality output, particularly innovative products. It is consistent with the work of Susen and Turner (2011) and García-Goñi et al. (2007), who argue that innovation depends mainly on the professionals who can create and apply new ideas and knowledge in daily work. Strong reflection on the emphasis on skills and innovation by several efforts to bridge and narrow the current skills and productivity gap (Audretsch et al., 2012; Nakamura et al., 2010), including innovators in a school setting.

4.2.1 Skills

To empower the workforce to increase the chances of getting ahead of competitive advantage, innovation, and effectiveness, management leaders rely much on the competencies and skills of employees [to disseminate knowledge], their product, and behavior (Houtzagers, 1999). Beyond, unique competencies and skills are necessary for leaders in complex and multi-faceted working milieus with compound stakeholders.

The richness of knowledge and information must be shared and put into action. According to Gurteen (1998), a person putting knowledge into action must

be *competent*. It means three essential elements are necessary
- *knowledge* and *skill* and the right motivation and *attitude.* What could be the innovators' skills that drove them to put their knowledge into action in achieving the goal of product development? In order for the new product development to be effective, there must be a continuous sharing and utilization of knowledge to expand its breadth of usefulness in the organization (Nonaka & Takeuchi, 1995), and Goldenberg et al. (2001) adds that they are of chief significant in the life span of an organization.

The innovators seemingly carried out two vital types of skills to be able to develop technology and deliver successful innovative products. These skills were carefully honed and cultivated through time. Through their rigorous efforts and commitment, they can deliver powerful technologies to society. These skills are both 'hard skills,' which refer to technical skills, and 'soft skills,' which refer to social skills. Lumague (2017), Balcar (2016), Han (2015), Balcar et al. (2014), `Bacolod and Blum (2008), Borghans et al. (2006), and Reber and Reber (2001) all claim that both types of skills significantly increase an individual's productivity. The innovators interviewed in this study have increased their productivity and have generated equitable productivity for the entire campus and even the whole nation. For instance, to repeat part of a quote presented earlier, take the technology on Mykovam, for which the innovator was commended for getting the highest sales all over the country (see 4.3.1.1.2).

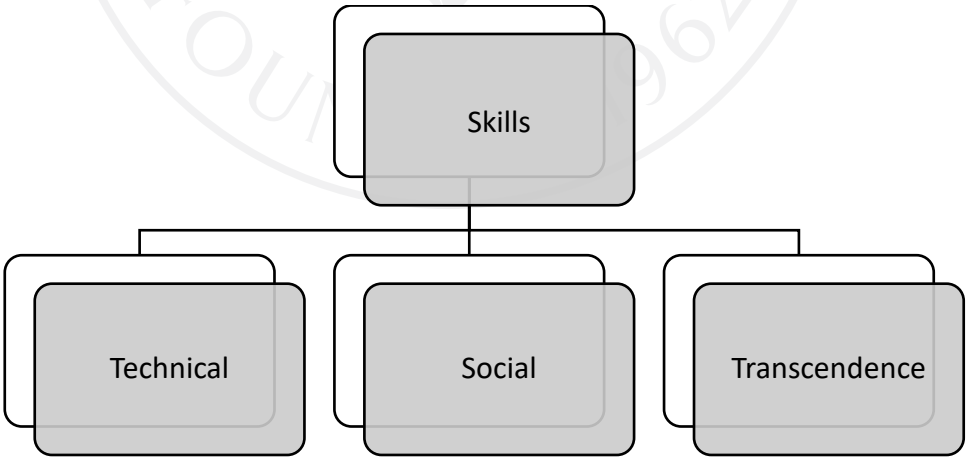
In the Philippine setting, irrespective of one's job, both hard skills (technical skills) and soft skills (social skills) are equally important in the discharge of the terms

of reference (TOR) attached to an individual's position, as articulated in the article by the then secretary of Department of Labor and Energy (DOLE), Rosalinda Dimapilis-Baldoz, posted by DOLE in May 2014. However, as she expressed, hard skills have little value if one has poor soft skills, which, as opposed to hard skills, tend to center on the ability to work with other people. These refer to capabilities in communication, enthusiasm, and attitude.

Although technical and soft skills seemed to be the most popular and documented skills in the literature, in this study, throughout the discussion, consistently mentioned and stood out is the concept of transcendence and cannot be classified as either a technical or soft skill. An illustration of this concept is in Figure 4.6 below.

Figure 4.6

Vital Skills that Lead to Successful Innovation



4.2.1.1 Technical Skills (TS). The first core competency is technical skills. As forwarded in Chapter 2, technical skills are complex skills that individuals gain through intensive training and exposure to perform a task accordingly. Han (2015) says that hard skills are those that employees need to be able to perform a particular job. These often vary depending on the type of role employees perform or the industry in which they are working. Developed hard skills can usually be through studying and training. Examples of hard skills include accountancy, fluency in a foreign language, knowledge of specific software, or experience in a particular industry sector. This study used the term technical skills to refer to hard skills. As applied to this research—and understood from the interviews—*technical skills refer to the ability of the innovators to apply the expertise and training gained to develop a product that addresses societal issues.* For example, Innovator H said: *I used all that I have learned from my professors in Japan in making a product that will help resolve the problems brought about by different calamities.* As Innovator C shares: *So, when I came back, after getting my Ph.D., that is when I thought of developing a product that could not just be an endpoint application of a technique that I learned abroad, but something that could improve the lifestyle, the health of many Filipinos.* Moreover, as Innovator G narrates: *So, it happened that I was one of those who were sent to Israel to study hydroponic. I started to think of hydroponics and what is helpful to the community.*

Technical skills are found essential to knowledge sharing. They are powerful tools to facilitate knowledge sharing speedily and successfully. Further, the majority of the innovators' technical skills are developed and nourished through further studies

in reputable institutions abroad. Following are excerpts from the innovators' responses. Innovator C says: *For instance, I took my training abroad. I had training on how to use novel techniques to make products for food processing and the developed products that may impact human health.)* Innovator G says: *So, I started to think about hydroponics. Then, when I had the opportunity to be sent to Australia for my doctor of philosophy (Ph.D.), I took up Plant Nutrition; and studied nutrition. The tool is hydroponics.*

Aside from their training abroad, their forefathers exposed them to technology through mentoring (see 4.2.1.2.1.1). As introduced previously, forefathers are those former project leaders regarded as senior mentors, innovators who started the technology and worked hand-in-hand with study leaders (now called the young innovators), who likewise underwent the rigors of developing the technology. Because of this process, by the time the forefathers retired, the young innovators continued developing the technology, improving it, and changing it depending on the community's needs.

In other words, innovators' technical skills gained through advanced studies and national and international training are enhanced further through mentoring, which leads them to become adept and resilient in creating technologies for the people.

4.2.1.1.1 Problem-solving Skills (PS). The first competency under the technical skills is problem-solving skills. As confirmed throughout observations and from the interviews, it appears to be innate that the innovators are sensitive to the needs of the people (see 4.3.1.3.1) and, from there, find the responsibility to create solutions to appease difficulties in their daily living. Moreover, they appear to be

gifted (see 4.2.3.2.1.1) in how to find solutions to tormenting societal issues in the agricultural field.

When creating technologies for solving problems, these innovators take into consideration existing facts and make a comparison of previous data. For instance, in using hydroponics technology, the innovator found that existing materials are quite expensive to create hydroponics because of importation. Farmers who would adopt this technology would find it hard to achieve because of its costly maintenance. Eventually, looking into indigenous or discarded materials like Styrofoam, this innovator found out that recycled Styrofoam has a purpose. Instead of throwing Styrofoam containers of goods like fruits in the trash (which will take hundred years to decompose and is detrimental to the environment, adding to the impact of climate change), he buys the containers and uses them to grow his plants. As Innovator G explains: *I used to throw Styrofoam away. Do you know the boxes of fruits? Yes. I will show you later how it looks. I am already hoarding styro* [laughs]. *The experiment was good. My plants are alive. I am happy because it is affordable, and most of all, I am not using pesticides on my plants. I am proud of it because they are all organic.*

In addition, Innovator G does not use chemically made fertilizer for his plants; he is proud to say that they are all organic. This example of solving a problem is consistent with the findings of Isaksen (1987) that intuitive problem-solving styles simultaneously tend to process information from different paradigms and argue Jabri's (1991) position that intuitive problem-solving ability focuses on problem-solving not tied to existing rules with multiple ideas. The innovator of hydroponics

followed his instincts rather than tied to what the literature said. This new technology is affordable and aggressively gains profits, and, foremost, it is eco-friendly.

A different example is the creation of Bignay wine. Upon studying the process of the old version of Bignay wine, the innovator found out that solutions to prolong its life are too short because of the chemicals used. Because of this, he disregarded the previous approach and started to create his version of Bignay wine. As Innovator C shared in the above discussion, and we quote a few words again: He used logic and reason to justify his claims, which were accompanied by hard facts and data, using scientific explanation to support the cell life of the product and describe the benefits of the said technology. Such an instance agrees with Jabri's (1991) conceptualization of problem-solving, which is that the structured problem-solving style based on associative thinking follows a set of rules and can be resolved reasonably and logically.

Based on the examples given, innovators use their structured problem-solving styles based on associative thinking focusing on a set of rules, resolving problems reasonably and logically, and their intuitive problem-solving ability focusing on problem-solving itself and not tied to existing rules with multiple ideas. Jabri (1991) describes these as the two independent thinking styles of problem-solving: structured problem-solving styles and intuitive problem-solving ability.

Moreover, through decades of research data, various organizations have studied competencies needed for successful innovation, one of which is problem-solving skills (see 2.3.1). As introduced in the literature review, Kim et al. (2018) collated

definitions of problem-solving abilities from various authors, as shown in Table 4.4 below.

Table 4.4

Definition of Problem-solving

Publication	Definition
Spivack et al. (1976)	The ability to discover and create technologies and methods that can maximize new and diverse problems in everyday interpersonal relationships
D'zurilla and Nezu (1990)	A cognitive, emotional, and behavioral process that attempts to find the best effective response when an individual has a specific problem in their daily lives
Stevenson and Jarillo (1990)	Basic entrepreneurial skill
Warner (2002)	The ability to create the best solutions to problems while working
Shane (2003)	The ability to define opportunities with new information, such as puzzles

Note. By Kim et al. (2018)

The definitions of problem-solving presented in this table are limited to identifying individual problems and being able to find solutions to them. However, findings in this study seem to have a larger perspective in looking into problems that need to be attended to by the innovators, offering a wider scope to the meaning of problem-solving skills. In the BIOTECH, problem-solving skills are seen as, specifically, the ability to recognize prevalent social issues and find solutions to overcome them to sustain the way of living of the end-users. Several innovators shared some problem-solving experiences. As Innovator A shared: *We personally*

attend to local problems and find solutions to overcome them to help the victims of calamities and sustain their healthy living. For example, this Dwarf Saba Variety is resilient against heavy wind brought about by typhoons; yes, they will survive and there will be a bountiful harvest even after a calamity. As Innovator D says: *We explore what needs to be done to help the people in regard to the identified needs of the community. Take for instance, those plants that die amidst fertile soil or how to grow plants amidst dry* [laughs] *land.*

These findings therefore strongly advocate that problem-solving abilities are an important ability to drive innovation and sustainable growth and development in the industry and is a contributory factor for successful innovation products.

4.2.1.1.1.1 Focusing Skills (FS). The first innovation competency under the problem-solving skills is focusing skills. The innovators interviewed ascertain that research conducted is of no waste. Before conducting and focusing on an intensive area of research, innovators first identify the technology they tend to develop based on the immediate concern about agricultural problems besetting the environment. They then conduct research based on what they think is best for all**.** Here is an excerpt from the response of Innovator C: *You try to study the needs of the people and the community, and from there, you can identify a human need, and that is the one you need to do. Then, focus on that. Do not keep doing many things, because you will waste many things. Moreover, if you do not do this, you will miss the opportunity of helping. Look, you can create, but if the community will not use it, then it is a waste.*

Headed by the project leader, the team (see 4.3.1.2.2) surveys the community regarding concerns that need immediate attention and, one at a time develops the

technologies to address those needs. They prefer to concentrate and dedicate resources like time, energy, and monetary expenditures to a single project rather than attend to so many product innovations that they cannot reach the finish line. As Innovator F says: *We have lots of things to think about to work on.*

Yes, we should work on one product at a time to take care of the technology. So that we will not get confused and we are organized. You know what, I wanted to do a detection kit, then bio-pesticides, until I ended up with micro-organisms, good bacteria. So, you need to focus on only one so that you can at least finish it [laughs]. Thus, as defined in this study, *focusing skills are the ability to develop products one at a time to avoid mixed-up and shambolic output.*

From observation and the interviews, it is a noteworthy finding that innovators have the heart to produce technology and, in order to focus clearly on their endeavors, innovators give their full attention and follow a timetable on when to achieve their goals. On top of their teaching loads and other related tasks like managing staff (most are understaffed), reviewing the procurement process, and visiting sites, they manage to give ample time to research (see 4.2.3.2.3.1), to improve the product. They also involve their staff and students in securing vital information concerning the technology and delegating tasks according to the expertise of the available human resources. For instance, Innovator F said she used to divide tasks among her students, such as going to the library looking for references, gathering data, and going to the sites to monitor the use of the technology. As she says: *The advantage that I can see is that I can direct research; I can give suggestions to the staff, or even lead them to something that may go somewhere or may have a result.* [Interruption] *Wait for a*

while; these are my students, and I will attend to them first. [Pause] *I gave them their assignments related to Rennet, like going to the library to look for references, gathering data, going to the sites to monitor the use of the technology. You know, I involve them in the process of making this technology.* [Shows researcher the Rennet] *It is exposure so that they will have training already.* These innovators identify and utilize valuable sources of information to support wise decision-making, with gathered and well-thought-out information as a result of academic research appropriately interpreted and given relevant meaning. For instance, technology on Rennet, which was used as an example earlier, information gathered is discussed within the team to enhance the technology. *All of the gathered information* [questions] *like: 'Why does the cheese taste sour? Why it is that it gets easily spoiled? How about those people with diabetes who would like to eat cheese?' There must be answers to all these questions. It tastes sour because of the vinegar. We have to consider the life span to avoid spoilage. That is why we need a dietician to know the amount of sugar to be added.*

Within the domain of their team (see 4.3.1.2.2), innovators share the results of continuous research in various expertise and related fields to discover new and audacious technology and assimilate and accommodate information that brings light to refine the technology. If the technology fails, they gladly accept failure with clarity and start anew, trying possible options to improve the technology. For example, Innovator C said: *We could not revive the old technology anymore, so the team discarded it.* Hence, the creation of Microencapsulated Fruit Bioactive from Bignay (Antidesma bunius L.). As Innovator C continues: *So, I called my teammates, and we*

decided to terminate it. It took us about 2½ years to finally come up with our technology. In order to retain its freshness and nutrients, the first thing we consider is the cell life of the technology. We calculated every single data and interpreted it accurately. Of course, we do not want to disappoint the end-users, so we did our very best. Yeah, yeah, we had experts in our team. The innovators anticipate change, accurately predict essential changes, and exploit results-based research to adjust the technology until they achieve the desired results. They venture into possibilities confidently and prosper in future directions. In line with this, innovators have the focusing skill such as what specific goals and objectives they need to achieve to ensure that every centavo spent on research will benefit the people and have the most significant impact.

At this juncture, keeping some unique information is necessary to safeguard the trademark and uniqueness of the product. Otherwise, sharing is open to all. Confidentiality is one trait that is observed and respected. As Innovator H said: *We say this comes from a novel fungus. I am doing the process of producing a bio-pesticidal or bio-pesticide; I cannot tell where it came from* [laughs]. *From a novel source, just like that against fusarium wilt, which is a disease of plants, particularly solanaceous plants, tomato, eggplants, and chili. Because we have a problem with the fusarium wilt, our farmers use chemical pesticides.*

These findings are similar to the European Commission (2014) studies demonstrating that finding solutions to societal challenges while boosting growth and competitiveness requires a fully functioning network of research excellence to ensure that every Euro spent on research will have the most significant impact.

Moreover, innovators set clear targets and make a time frame to finish the project and for the community to utilize. Focus is a necessary skill for them because few innovators are addressing various community concerns on top of other university-related functions. Strikingly, the findings revealed that producing technology is indeed an opportunity to be of service to Filipinos. As Innovator E said: *When the project proposal was approved, I felt happy! We need to meet our promise that the technology will come out after a year. Even if I have lots of things to do because I am also teaching like Dr. F, right Dr. F? We need to focus on what we are doing because people are waiting for it. You know this is our way of serving Filipino humanity. That is the mandate of UPLB. Yes, our legacy, too. The guava leaves. Yes, I extracted it.*

Because of the innovators' focusing skills, they concentrated on developing environmental-friendly technologies, which they come to equate with legacy—something to be proud of after improving, commercializing, and making an impact (see 4.2.1.3.1.1 and 4.2.1.3.1.2).

4.2.1.1.1.2 Evaluating Skills (ES). The second innovation competency under the problem-solving skills **is** evaluating skills. Findings revealed that innovators are considering the advantage of evaluation. For them, evaluation is potentially empowering. The innovators are directly involved in the impact assessment of technology. As Innovator F says, the evaluation part is challenging to assess *the product because it is a bloody thing. My students are there with God's grace* [laughs], *helping when we need to repeat a process. It is like when you go back to your data. There might be data* [that is wrong]. *Anything goes through an assessment before you*

can say to the people that your product is fine. You are accountable if the data that you bring out is not correct.

Similar to the work of Patton (2008), who describes evaluation with the provocative phrase "empowerment evaluation," braced with the basic principles of confronting failures along the way, innovators succeed. However, since the ultimate purpose of the evaluation is to expose problems due to imperfections such as inadequately assessed needs, fuzzy and conflicting goals, poorly defined targets, insufficient resources, and sloppy implementation (Patton, 2008), actions are taken for evaluation. For the innovators, these evaluations surfaced problems they could resolve, which supported their goal to contribute to society.

To avoid difficulties, innovators review their projects, and the Technology Transfer and Business Development Office (TTBDO) officers ensure alignment with their vision mission (see 4.3.1.2.1). If innovators respond to the thrust of the university set by the chancellor (e.g., the current administration's thrust is on food production) and if their technologies address the needs of the community (see 4.1.1.1, 4.1.1.1.1, and 4.1.1.1.2), then the questions become: Are funds sufficient to subsidize the project? How long will they take to achieve their target? How will it be accomplished? Before the innovators proceed, these are just a few immediate considerations to circumvent conflict and waste time and energy (both human and financial). More importantly, innovators allot time during the planning stage to foresee potential difficulties and are ready to address technical difficulties when they occur. Here is an interview excerpt from the DMO-TTBMP 2: *There are fundamental questions to consider before starting the project. For instance, can it be funded? How*

many years will it take to finish it? How will it be achieved? Does it respond to the problem of society, most especially agriculture?

Furthermore, innovators conduct try-outs of the technology with some potential clients before finally launching it onto the market. They also provide gratuitous lecture demonstrations and explain how to use the technology. Through their evaluating skills, innovators can determine any weakness of the product and take the opportunity to improve or enhance the technology. As logical and rational, innovators see the evaluation results as valid for improvement. The example of Hydroponics was detailed above in paragraph 4.2.1.1.1**.** As Innovator G says: *Oohhh…yes, I give a free demonstration on the technology. I come right away if they say our plants are dying. Your grandfather* [laughs] *would give a lecture and demo.* Paragraph 4.2.1.1.1 details WiltCure as another example. Innovator H says: *I try out with the farmers. I saw Dr. Santos doing his demo simultaneously as a try-out of his technology. He is industrious. Did he make his demo for you?*

As mentioned earlier in the discussion, one of the off-sites is adjacent to the innovator's laboratory, meaning farmers are given a portion of the land within the campus area to toil using the technology, which provides the opportunity for the innovator to monitor the effect of the technology regularly. This placement alone shows that innovators personally see and observe the immediate effect of the technologies. As Innovator D says: *I can see from a distance our farmers* [laughs]. *I can quickly go to them if they have a problem, like when I excused myself before we started. I went to them first because of the amount of fertilizer needed.*

House (1996) says that the emergence of evaluation as a profession means assessing needs, identifying solutions, targeting populations, setting goals, procuring resources, implementing programs, and evaluating results. Specific to this study*, evaluating skills is the ability to assess the impact of product innovation in the community.* Excerpts from the response of the innovators that support this expanded definition include the following: Innovator F says: *When you assess yourself, you have to learn it because you have basic principles. First, try to see where you failed. At least you can trace where you failed; then, you can explain where and why it could be that way. In the beginning, it was like that when I taught the end-users how to use the granules rennet, and we partnered in making the impact assessment.*

It is conclusive that evaluating skills is a potent skill in achieving successful innovation because, through the result of the assessment, innovators were able to avoid difficulties and improve on the technology along with their members and even the end-users.

4.2.1.1.2 Creativity Skills (CS). The second core competency under the technical skills is creativity skills. By definition, this competency is imperative for innovation. It underlies the manufacture of something new, something novel. Out of the many things that the innovators learned from their mentors and their training, exposure outside and socialization from the masses, and the predominant environmental issues (see 4.1.1.1) that affect the agriculture sector, they come home with something new to work on based on various knowledge gained. Through their massive research (see 4.2.3.2.3.1), they arrived at a solid product innovation grounded on the needs of the society and working within the social context of the farmers and

laborers (see 4.3.1.3.1). We cannot survive the aftermath of industrialization in the Philippine environment. Various pandemic problems such as environmental issues, poverty, violence, drugs, ethnic strife, natural calamities, and diseases beset the 21st-century generation; hence, they can mentally, emotionally, and physically destroy humanity.

Moreover, the jam of environmental issues and the most alarming is climate change, affecting food production needed for survival. The innovator's creativity offers the opportunity to move through these problems through research. For example, innovator G on hydroponics is alarmed by the issue of climate change himself. As he says: *Ah no, the challenges, the things that you can see and do something about. It can be that what you can see to work on for now is the government's priority. And one of those right now is climate change, which is a big concern in our environment.* Furthermore, the innovators sensibly select and ponder on those products that alter the lives of the end-users. Similarly, Mermiri (2009) firmly adheres that products and services are carefully selected based on how they alter people's lives, affect rational thoughts, and make decisions. Apart from the practicality of the technologies, the newness of the innovator's technologies adds value to the innovation products. Hence, innovators not only engage in creativity but exemplify the skill of creativity in UPLB Biotechnology. In this light, the study upholds Plucker et al.'s (2010) notion of both novelty and usefulness as descriptions of creativity (see 2.3.1). It signifies that there must be uniqueness and, at the same time, use of those ideas produced to be engaged in a creative endeavor.

As the interviews with the innovators progressed, the researcher came to realize that these are people constantly searching for knowledge (see 4.2.3.2.1.1) through reading, doing research, listening to one another and mentoring each other, learning from feedback loops, socializing, traveling, working with farmers, joining expos, and presenting papers. For instance, Innovator C says: *I just thought what I know would stay the same. However, what I currently know may be proven wrong or ineffective in the long run, and I just had to read as much as I could to keep myself updated. I listen to other people and get to travel to different places.* Innovator H says: *I listen to various opinions, and feedback from clients is essential.* Innovator D says that *it's a big thing if you get to mingle with the farmers. I'm happy to work with them; they are simple, like me* [laughs]. *And I think I have attended almost all pieces of training either as a participant or lecturer* [laughs]. And Innovator B says: *I am happy if I am invited to attend seminars and training because I do learn from other scientists.* The innovators have many memories to write about and develop new knowledge.

Moreover, through mingling with the farmers, innovators build social relationships, which bring better results to the success of their technology. As a result, their contextually crafted technologies show novelty and carry greater usefulness. Generally, in most cases, the innovators get in touch with the end-users and discuss with them the technology, thus making it more contextually based. As Innovator A says: *I always talk with the farmers, and we exchange ideas and opinions so that we can address precisely the technology based on their contextual needs (gasping for his breath). Right now, I just came from the field.* As Innovator E says: *Indeed, we often*

visit times the people so that we can see and study their immediate needs and utilize what is available around them, like the guava trees. This finding is consistent with Chełmecka (2018) saying that creativity influences the emergence of new, socially accepted solutions reinforced by favorable social relationships, and affirms the study of Plucker et al. (2010), who forwards the widely adopted relationship of creativity to the social context in the literature and broadens yet contextualizes the traditional definition in several ways.

On the one hand, findings in this study exposed that creativity includes the ability to produce novel product innovation (for possible patterns) emerging out of acquiring information and knowledge from their mentors, which is indigenous knowledge rooted in the forefathers. According to Chełmecka (2018), one can express this ability through openness, originality, and flexibility (see 2.3.1). On the other hand, noticeably among innovators, creativity is articulated altruistically (4.2.1.3.1), meaning these innovators have the disposition to share everything without counting the cost and without expecting anything in return. This newness of the product produced is optimized or used by the market; hence the product becomes innovative. To this research, creativity is a trait to produce invention and innovation.

Over and above, they exude a distinct personality of thinking beyond their imagination, meaning they do not settle for what already exists but go out of their way and take the challenge of finding more accessible and affordable solutions to endemic issues that are thrashing Filipino farmers. Moreover, they have a strong desire to alleviate the farmer's burdens and uplift their way of living through product innovations. Take, for example, the technologies on Wiltcure, Dwarf Saba variety,

and iDetection kit. Hence, the study offers a novel definition of creativity. ***Creativity includes the ability to produce novel technology of the acquired information and knowledge.***

4.2.1.1.2.1 Critical Thinking Skills (CTS). The first innovation competency under the creativity skills is critical thinking skills. The findings revealed that finding solutions to problems allowed the innovators to become reflective yet aggressive in seeking information. Critical thinking is about thinking and acting not only for one's good but also for the social good, free from stereotypes, acting in accordance with moral principles, and being fair and open-minded (Norris 2014; Mason 2007; Phelan 2001). Through their proficiency, they interpret, analyze, and evaluate information and viable knowledge and develop a solid project to address the problem at hand. An excerpt from Innovator D, in particular, supports this finding. *We already expect the effect of typhoons, floods, and drought... Instead of crying* [laughs] *over it and blaming each other, we try to study how to respond to the challenges brought by these calamities. We gather information and exchange ideas until we find a solid project to solve the problem. For instance, how the farmers maintain the different plants amidst dry soil.* After exhausting all their efforts and time and finding something still missing, they pray. To the point that they still miss something, for instance, Innovators D and F said that when they think that they have done everything already and things seem not to work well, or when they seem to lose hope, they pray (see 4.2.2.9). And they both said it works! In the words of Innovator D: *It is still important to pray because if you know that you did everything and it looks like there is still*

something missing, it won't work, and you have to meet the timeframe, pray … pray … pray … and yes, prayer works!

Innovators use their critical thinking skills in their decision-making, leading to their successful innovation. The innovators take a rational method as the foundation of their work, accompanied by their social interaction with people and their psychological and spiritual preparation, which are practical thinking skills enabling them to distinguish the accurate and valuable information from the vast amount of gathered and accumulated data and information. As Innovator D says: *My interaction with the farmers was a big help in my decisions to enhance this Mykovam. I always accompany my decisions with prayers. I feel happy because, at times, I join others in prayer. Even my RAs. Did they ask you to join the bible sharing while waiting for me earlier?* Thus, the findings are consistent with Zhou (2018) and Wen et al. (2009), claiming that critical thinking is conscious and reflective thinking to includes spiritual guidance.

The findings are similar to Zhong (2002), who said that critical thinking guides people's beliefs and actions by observing, reflecting, reasoning, and communicating psychological processes. Innovator C describes: *You know this is what I usually do. I reflect first on the current problems. I think I am gifted in that. What I mean is that I am a reflective person. And that is why when the first technology did not work already; I did not find it hard to decide that I needed to change it with a new one. I studied the steps in taking such action from all angles--materials, funding, people with whom I would be working. I try to think of a problem, and what the possible solution could be, then I try to compare the solution I have in mind with what*

can be feasible in the Philippines now. The present situation—where innovators continually seek solutions to problems—revolves around the idea that society cannot escape the upshot of calamities and leave the poor with nothing. Aware of their responsibility to society, the innovators ponder these problems. Through cohesive teamwork (see 4.3.1.2.2), they put all their resources together, each functioning according to their expertise and guided by the project leader and top management support (see 4.3.1.1.1) and taking the risk on the possibilities of the technology. The innovators thoroughly discuss the problems, look at things from different perspectives, exchange ideas and opinions, and finally decide how to solve existing social problems. Before modifying any existing technology, they discern whether to continue with it or design another technology that will suit in answering the current problem. Throughout the process, they work collaboratively, maximizing the members' contributions. As Innovator C describes: *So, you could see the illustration, there is an idea, and you develop it. You try to critique the concept or the idea from a personal perspective—for example, the skills, competencies, and knowledge. But you stay critical; you do not just organize the ideas; you try to look at the ideas from a standpoint that will allow for a collaborative approach.* Moreover, Innovator B, following a scientific approach with a gradual development process over time, says: *And that is what I am usually very interested in, current research that modifies what we have known all along. I try always to consider those possibilities; then, I always try to ask questions.*

Nonetheless, giving justice to the originator of critical thinking, which comes from the Greek word *critique* and refers to questioning, analysis, evaluation, and so

on, the researcher acknowledges such definition (Elder, 2007) and uses it as a benchmark to offer a novel contextual meaning. Thus, *critical thinking skills are the ability to discern and make sound decisions to find practical solutions to social issues.* As such, found to be effective in achieving innovation.

4.2.1.1.2.2 Resourcefulness (R). The second innovation competency under the creativity skills is resourcefulness. Recall that the technology of hydroponics out of recycled materials was improved. The example of hydroponics and discarded Styrofoam boxes to grow organic plants was detailed above in paragraph 4.2.1.1.1. The innovator transmitted indigenous resources and was imaginative in dealing with various situations. The innovator of iDetection kit could identify how different possible approaches would work, which supported making sound judgments and learning from failures. At times, she used these failures as stepping stones to success. As Innovator B narrates: *I encountered many failures when I validated the product. But I did not lose hope;* [although] *I almost cried. However, my colleagues told me that it is just normal to make mistakes. So, I tried again until I was able to master it. Yes, I do believe that my failures* [laughs] *brought me to success as long as you do not lose hope and turn insane* [laughs]. Pinpointing the actual nature and cause of problems, and the dynamics that underlie them, make the task easier and lighter.

As forwarded earlier in this section, innovators think 'outside the box, even if it may go against popular opinion—for instance, the technology on probiotic guava tea. Traditionally, guava fruits are known only to be an excellent source of vitamin C and the guava leaves are ignored and not given much attention. However, the innovator proved scientifically that guava leaves also have other essential nutrients for

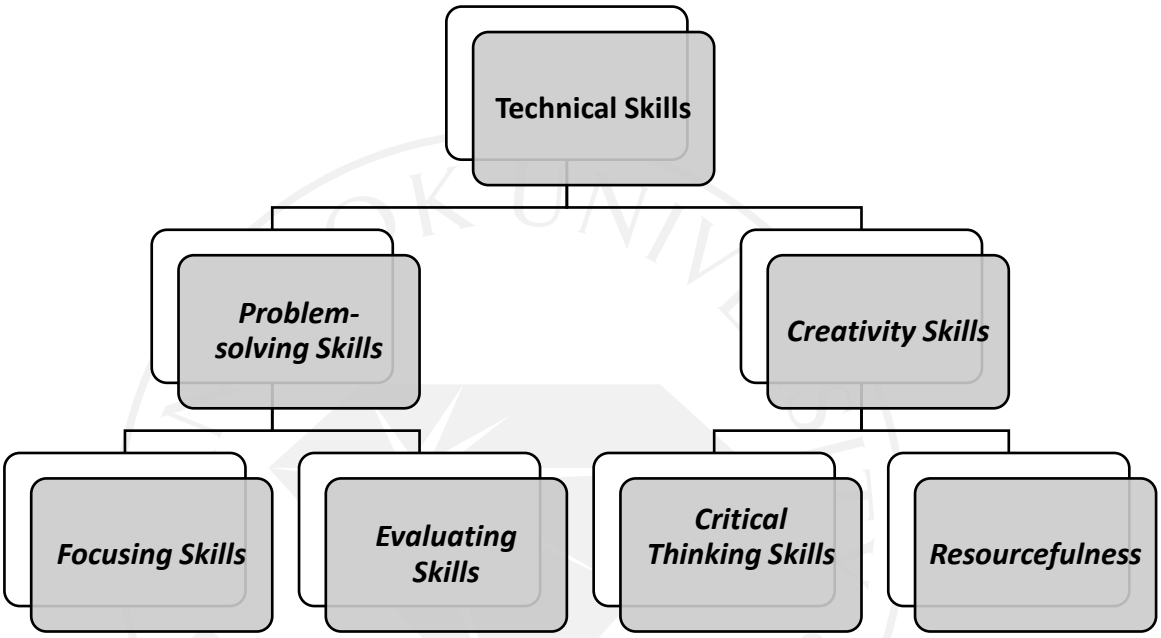
our bodies. As Innovator E says: *Why do guava leaves have? What is in there that pushed me to work on this technology? Probiotic Guava Tea is a probiotic drink that boosts the human immune system. It is a ready low-cost drink against radicals that weaken the body, which affects people's performance.* These findings agree with Okoye and Caleb (2019) that resourcefulness takes more than cognitive skills; it takes the ability to process information emotionally and intellectually. Seemingly, understanding resourcefulness, innovators exhibit the authentic skill of addressing the technology's complexities (see 4.2.1.1.1). For instance, when the technology fails, they immediately conduct an investigation or research as to why the technology failed. They look into the details and think outside the box. It means they are open to conventional and non-conventional ways of doing things. As a result, they widen their scope of understanding and put on their creative imagination, improving the technology. For instance, the guava leaf extract. As Innovator E adds: *Actually, it is the guava leaf. Yes, I extracted it, even before we tested the different isolates of probiotics in different plant extracts. Now, we have seen that probiotics can live in those extracts. Yes, bacteria are like that; they can kill other bacteria. Our probiotics are in local fermented food in plants. We share a laboratory. Cells are very concentrated; then, we freeze at 70 F temperature. The one we did before, that is why we came up with such, because we saw that it could survive in guava, so why not add in the probiotic bacteria in guava, because the guava is good for health.*

Based on the findings, *resourcefulness is considered the ability to source knowledge, think outside the box, and the maturity to deal with the complexities of the*

technology. In addition, innovators' resourcefulness was seen as the capacity to source knowledge and use available resources in achieving set goals.

Figure 4.7

The Technical Skills that Lead to Successful Innovation



4.2.1.2 Social Skills (SS). The second core competency is social skills. As introduced in Chapter 2, *social skills* are defined as the soft skills that individuals gain through their initiatives, such as engaging in reading materials, associating with various people, and self-reflection to perform a task accordingly. From the interview findings, social skills are *the ability of innovators to make extra efforts to learn on their own the rigors of developing the technology and negotiating for funds to run the project.* According to Han (2015), soft skills are usually self-taught and self-developed. It is consistent with the findings of this research, wherein innovators shared that from their personal desire to be of help to the society, they took extra

efforts to learn by themselves the rigors of developing the technology, in addition to their technical training, in order to improve the quality of the product innovation. Examples provided by interviewees included spending time reading, searching for deeper information, and socializing with teammates to gain more knowledge on the ups and downs of their projects. In addition, they get their inspiration from the legacy their forefathers passed on to them (see 4.3.1.1.1 and 4.3.1.2.1). This idea of "forefathers" emerges throughout this material, as it repeatedly did in the interviews.

Social skills describe the innovators' ability to make extra efforts to learn on their own and learn from others (the forefathers) the rigors of developing the technology and negotiating for funds to run the project**.** In addition, the findings agree with Gilley et al. (2008) claims that leadership effectiveness drives change and innovation along with the precursory skills necessary to do so. Precursory skills are for technical skills (see 4.2.1.1). As was introduced earlier, these skills are 'hard skills,' which refer to technical skills, and 'soft skills,' which refer to social skills. These skills stimulated innovators to perform their responsibilities effectively and efficiently.

4.2.1.2.1 Leadership Skills (LS). The sole innovation competency under the social skills is leadership skills. Findings revealed that the innovator's charge is to encourage teammates to perform their required tasks and be decisive in managing their responsibilities. These leaders exude charisma that inspires the team to do extraordinary things. When things go wrong, they deal with them through the heart and mediate them through the brain. According to Innovator B, there was an instance when her RAs failed to submit the requirements for the project. So, she called for

them and talked with them in a closed-door room, explaining the repercussions of not submitting the documents on time. After settling the issue with her RAs, she gave them another time to work on it and made a time plan. Taking advantage of the use of ICT available at the time, she created a google calendar for everyone to see. It meant that the RAs, together with Innovator B, could keep track of their daily activities. And then, they must tick the completed activities. Innovator E had a similar encounter with her teammates. The only difference is that she told her teammates that although they had gadgets to use, she preferred using the whiteboard marker parallel to their traditional pocket-size calendar where they write their activities, responsible individuals, and target goals. Every time the RAs have to cross out the accomplished tasks. These findings are consistent with Deschamps (2005) that leadership skills, charisma, and determination can lead to a significant innovation initiative and Abraham and Weisberg (2006) that self-leadership skills affect innovative behaviors at work.

Deschamps (2005) says that modern researchers are not interested in whether there is a specific and distinctive form of leadership for innovation since there is no concrete answer to this. However, in the context of this research, a number of the innovators interviewed believe the contrary. These innovators have a distinct leadership model in guiding their teammates in the pursuit of producing quality technology, meaning they can be both excellent leaders and a follower. For instance, when the chancellor shifted to food production, without a doubt, they subsumed themselves in creating innovative products related to food production and the health benefits accompanying those products. Take, for instance, the technologies on Rennet

Cheese, Bignay Wine, Guava Extract, and Dwarf Saba, which bring health benefits; and Wilcure, Mykovam, Hydroponics, and detection kits which are tools to produce products naturally and help prevent plants from insecticides, using biopesticides and a meat detection kit to secure 100 percent pork or beef content.

The conventional practice of leading scholars and researchers claim is the top-down leadership approach, the historic customary paradigm in the leadership field that emphasizes a vertical influence-related process; controlled subordinates, influenced, and managed by a single individual leader heading the team or organization, and her or his relationship with followers (Pearce & Conger, 2003). Conversely, the findings from this study postulate an informal leadership where team members perform their tasks with trust and confidence. Innovators manage the team with transparency and are accountable for all decisions and actions. However, when things do not go well, they remain composed and still believe in the capability of their teammates, that they will overcome the trial and stay with the team amidst challenges.

For instance, the technology on Dwarf Saba, which is very volatile to wind damage, caused the team frustrations when A typhoon hit dwarf Saba. After the calamity, they sat down as a team, discussed how to troubleshoot the dilemma, and delegated consequent tasks among themselves based on their expertise. As Innovator A describes: *My leadership technique was to delegate as much as I could to focus on the things that no one else could do. Of course, that was based on their capabilities. So, I delegated the technical aspect to the members who have an eye on the details of the product specification, with the other members on management of the product, checking what went wrong in growing Dwarf Saba. Then, my collaborator had to*

work on one aspect of the program. I looked for a suitable location where we could grow our technology. Later, I will ask my staff to tour you so you can see our technology. Finally, the innovators concluded that they needed to target shortening the height of the Dwarf Saba because the shorter the plant, the less prone to damage. They do not dwell on their weaknesses; instead, they move through frustration and move forward. They listened with a disposition to suggestions, sought the opinions of others, and were not afraid to try new ideas to reach a creative solution, having the faculty integrate multiple perspectives harmoniously. They seemed to know precisely the expertise required and optimized their teammate's potential. By doing so, they raised the value of the technology and honored both time and the team members. As Innovator A says: *We felt sad for what had happened because our plants died due to the inevitable typhoon. Although everyone felt sad, we did not lose hope. We looked for a location where the typhoon would not easily throw our plants. Then, we studied how strong the direction of the typhoon was, just in case. We asked: how do we grow the Dwarf Saba maintaining a certain standard height only? Yes, our technology is still Dwarf Saba because of the shortness of height. And because it is short, it cannot easily be thrown if there is a typhoon because we have a deadline, two in the making. If I convene a meeting, I feel happy because I know everyone is busy, yet everyone is present because each plays a significant role.* And Innovator D says: *One of my colleagues told us that we should try to look for dry soil and see if our plants survive using our technology. What does cactus have* [that allows them] *to thrive on dry land? We studied that so that even if it does not rain for so long, there will still be a*

bountiful harvest. With the help of the experts on our team, yes, farmers will be very proud of our technology. Thank you for the success!

Innovation is embedded throughout the team and is at the start of changing culture and mindsets. Innovators create a space for innovation to grow and thrive. Based on this practice, one can conclude that innovators are committed (see 4.2.1.3.1.2) to their technology. They look at things from fresh perspectives, and it takes various mindsets and ways of looking at problems and opportunities to reach a consensus. As Innovator C explained, our thrust changed when *we had a new chancellor. He said we need to focus on food production because that is what our growing population of the Philippines needs. For our part, we followed right away. It is just a matter of changing our mindset to accept new challenges. If our minds are closed to the new thrust of our chancy, nothing will happen to us. Hence, we are serious and committed to our products.*

Moreover, Innovator A says: *He said it informally, but we acted on it right away because we are open to new perspectives. Moreover, besides, the perspective of our chancy is good. So, hmmm…maybe that is informal leadership, as long as we understood his message and responded immediately. But, of course, what we are doing is related to food production.*

Finally, this line of thought is escalated by Pearce and Conger (2003), saying that informal leadership is an activity that can be shared or distributed among members of a group or organization. It opens up new lines of thinking about informal leadership in organizations (Fletcher & Kaufer, 2003), where people are empowered to make decisions concerning their tasks at work and implement them (Conger &

Kanungo, 1998). Further, the findings revealed that innovators display exemplar leadership skills, mainly informal leadership, in the sense that each one plays the key roles based on their expertise and talents within the team. Meaning, that innovators are versatile and possess various qualities that motivate and sustain the members' level of interest and enthusiasm. Just as Lombardi Jr. (2001) quoted from his father, "Leadership is not just one quality, but rather a blend of many qualities; and while no one individual possesses all of the needed talents that go into leadership, each man can develop a combination to make him a leader" (pp.2-3). Some of the innovators mentioned that this approach is just changing one's mindset to adapt to the changing culture. As Innovator E says: *As I have said earlier, it could be possible that what we know today may not be applicable in the future. That is why what we call changing the mindset is essential. If you do not have that perspective, if you are not close to change, you have no way to help.*

Indeed, whether formal or informal, leadership skills are a significant factor in successful product innovation.

4.2.1.2.1.1 Mentoring Skills (MS). The first innovation competency under the leadership skills is mentoring skills. Findings revealed that all innovators were once members of a research team headed by tenured and hard-core researchers called forefathers, who were introduced earlier in this chapter. Noticeably, during the interviews, the innovators kept mentioning these forefathers. They served as the first handlers of technologies like Mykovam, Rennet, and Hydroponics. Later, they carried with them these technologies. Thus, they are grateful to them (see 4.3.1.3.2). In addition, the forefathers were legendary inventors, scientists-innovators, renowned

leaders, much-sought national and international speakers, and advocates of peace, green living, and agri-business. In addition, grateful, kind, generous, humble, and God-fearing. Amid their being famous, they unselfishly shared their skills, talents, and time mentoring aspiring innovators, involving them fully in technology development. Blossoming innovators participating in these interviews went through a rigorous process of developing the technology from its inception to commercialization with the forefathers through conscientious mentoring. Some innovators described this as similar to cocoons nurtured by caring and altruistic organisms. When these forefathers retired, it was up to these innovators to take on the next responsibility of leading the projects.

Let us take, for example, the beginnings of Mykovam technology. Dr. Reynaldo E. Dela Cruz pioneered and served as the project leader and Innovator D, the study leader. Throughout the development of the product, the latter was part of it. She learned every step of the way from her forefather and has improved the technology, added features and commercialized it. Mykovam is a soil-based biological fertilizer with beneficial mycorrhizal fungi active ingredients called Arbuscular Mycorrhizal Fungi (AMF), comprised of 12 species collected from stressed environmental conditions. Mykovam is very effective in improving plant growth and increasing the yield and survival of several agricultural and fruit crops and forest trees. It can also increase plant tolerance against root pathogens (Aggangan et al., 2013). To date, Mykovam is used nationwide and across Asia.

Furthermore, Innovator D now has the responsibility of mentoring the next study leader. She has introduced the technology to all of her teammates, from the

research assistants to the technical staff. A significant response is that mentoring *is part of our job here, especially for most of us who are senior faculty members already.* She has shown them the process of mixing and combining fungi to master the technology and how to preserve or store it at the right temperature such that it will sustain its life span until it reaches the beneficiaries of technology. Mentoring is evident in all the innovators. To intensify the team's knowledge of the technology through hands-on involvement, the mentor also brings team members along with them to conferences, seminars, and other related activities. Innovator B keeps sharing throughout the interview that she was also a tag along by her former boss in conferences, training, and seminars. She was even encouraged to speak in fora.

Moreover, now that she is the project leader, she does the same with her colleagues as Innovator B says: *As I always say, I am happy with my former boss, my mentors in conferences, training, and seminars. It is a significant advantage that exposure to what I am doing now. In return, this is what I am also doing with my angels* [angels refer to her RAs]. *I think I have mentioned this to you already* [laughs]. *I feel happy if they meet other scientists so that they will be inspired more.*

Deriving from these findings, in the context of this study, *mentoring is the ability to mentor and guide the next generation of innovators.* As Innovator C describes: *I value those who did mentor me, and I thank everyone there for being at least a collegian follower. For this reason, it is also my responsibility to mentor my associates in the same way that I was mentored.* Therefore, mentoring is vital for product development to succeed, for it not only assists potential innovators but also sustains the legacy of passing on the technology from one generation to generation.

4.2.1.2.1.2 Collaborating Skills (CS). The second innovation competency under the leadership skills is collaborating skills. Collaborating is a competency tied to mentoring. In the context of this study, collaborating is *the ability to pool various resources and forge potential partnerships to fund the project.* For example, findings revealed that innovators went through the rigors of preparing proposals as an essential requirement in conducting research, part of which is preparing the budget proposal. Innovators conduct the research once the budget is approved (see 4.2.3.2.4.1) for almost a year. After getting successful results, they join exhibits or an expo to advertise the product and source funds to finance their projects, such as the bignay wine. Other means include actively collaborating on project proposals with a variety of entities such as non-profit organizations, local industry, and industry from outside the area and other different government agencies like the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD) of Department of Science and Technology (DOST).

When an entity is interested in a project, innovators establish a Memorandum of Agreement (MOA) between the two parties to proceed with the development of the technology. Examples of funding agencies with whom they partnered on specific projects are the Department of Agriculture (DA) Biotechnology Program Office, which funded the probiotic guava tea, and the DOST, which funded WiltCure. In addition, the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD), one of DOST's attached agencies, monitored these projects.

However, innovators note that this process is tedious (see 4.2.2.8). Here are other excerpts from the innovators' responses relative to the rigors of writing a proposal vis-à-vis collaborating skills: Innovator A says: *Like that, we did first a proposal, we submitted it, then it was approved. Then we worked on the technology. We conducted a trial. After that, we finalized the term report and the results... so that is it! Then the experimental stage. After this, we did further research to improve the quality of the technology. Then we looked for a sponsor to finance the production of the technology.* Innovator C says: *We joined an exhibitor expo. Then, if there was an exciting industry, we talked, then arranged the MOA. TTBDO will take charge of it.* Innovator H says: *The government is joining now in funding. We also collaborate with private industry. Like this* [shows papers]. *This is for PCAARRD to fund. We are going to propose. We have our collaborator. This will serve as a model.*

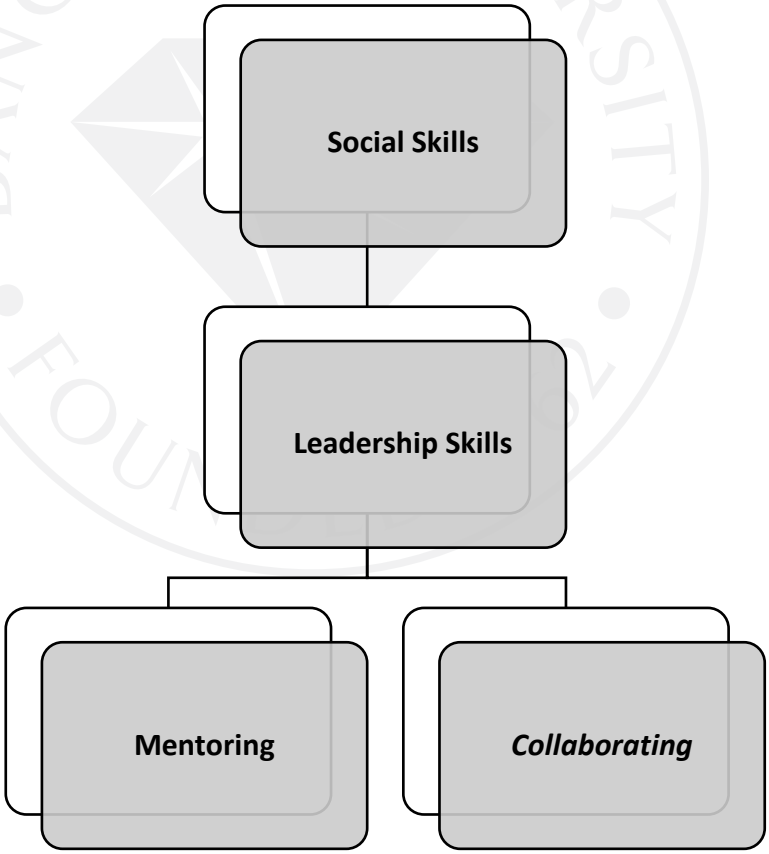
This finding is consistent with Reichlmayr (2006), who says that soliciting sponsorship, vetting proposals, and collaborating with various agencies is tedious. Nonetheless, innovators embrace the process as a challenge, considering that millions of people will benefit from their worthwhile projects. As Innovator E says: *Even if it is hard and tedious looking for funding agencies, we are still working because many of our fellowmen are waiting for our products.*

In conclusion, the growing interdisciplinary nature of collaborating skills of the innovators lends itself to building social relationships (see 4.2.1.2), where the work of innovators can deliver a high impact on society. For example, Innovator E says: *Sometimes, if a proposal is approved, we look for collaboration with different government agencies like* PCAARRD, *especially for funding. They will fund it if they*

see that the product potentially impacts society, as Innovator B says: *Collaborating with all people involved. To create the technology, we need funding agencies and other experts because not all are within the coverage of what we know. But, of course, I have to lead because I am the project leader).* And Innovator C says: *I talked to a potential collaborator from another college. I asked for his help; I developed a proposal. I sought his input; then, we submitted the proposal.*

Figure 4.8

The Social Skills that Lead to Successful Innovation.



4.2.1.3 Transcendence. The third core competency is transcendence. Maslow (1964, 1968) described self-transcendence as a person's ability to obtain a unitive consciousness with other humans. The transcended person can view the world—and his or her purpose in the world—concerning other human beings on a more global scale and is aware that they can have an impact, not just within their geographical boundaries or culture, but on the whole world (Ohnersorgen & Venter, 2012). Captivatingly, the innovators seem to agree with how Maslow (1964; 1968; 1973) and Ohnersorgen & Venter (2012), and McLeod (2020) regarded self-transcendence. These innovators are fully aware of their role in and responsibility to society and the country-their impact on technology-shared. As Innovator H shares: *You must know your role in society and be responsible, whatever your role is. I am old* [laughs] *already, and I know precisely my responsibility to our society. This technology that I am working on now is a trademark of my contribution to society. Every time you use this, you will remember me. Eat a lot so that you will gain weight* laughs. And Innovator C says: *I am very patriotic to my country and am faithful to my role as a scientist. Ever since I have wanted to create a product that does not only leave an impact on the small scale of individuals, but I want to bring into the national perspectives*.

Further, Maslow (1987) held that one reaches self-transcendence when a person seeks to further a cause beyond the self and experience a communion beyond the boundaries of the self. The transcended individuals who reach the top of Maslow's revised hierarchy seek a benefit beyond the merely personal, identifying with something more significant than the purely individual self, often engaging in selfless

service to others (Koltko-Rivera, 2006). Innovator D says: *I always think of my fellow citizens, most especially the farmers, and as I have said before, I did not dream to work abroad even if there were great opportunities. I wanted to come home immediately and help them. I want to create a technology that helps them in their farming.* Innovator C repeatedly shared: *I always think of the best interest of my country. I had all the opportunities to work abroad after my Ph.D. But I need to come back because I know my countrymen need me."*

According to Ohnersorgen & Venter (2012), humanity needs self-transcended people—leaders, innovators, and everyday citizens alike— advocating not only for their own needs but for the needs of others, not only in their immediate nation and culture but all over the world. To restore the environment and global health of the planet, people support peace and combat social crises such as poverty as a cause and personal responsibility. The innovators have exemplified similar findings. The innovators are needed to revive the luscious land to stabilize food production so that every Filipino has palatable food on their plates. Quoting once more from the chancellor's statement: *I told my team, with the presence of Dr. Glenn Baticados, Director of TTBDO, to shift our focus onto food production to serve the best interest of the people. Our scientist-innovators create technologies to respond to the problems of society.* These address poverty and malnutrition as personal responsibility and advocacy.

Finally, just as Ohnersorgen & Venter (2012) pointed out, Maslow's self-transcendence is the most accurate description of the type of person the world needs now: people taking responsibility not only for themselves but for others to experience

social justice whom the innovators were able to possess which leads to altruism. Considering the literature and the words and feelings shared by the innovators interviewed, the researcher postulates that in the context of this study, ***self-transcendence is the ability to respond to the community's needs through innovations without expecting anything in return.***

4.2.1.3.1 Altruism (Al). The sole competency under transcendence is altruism. It is *the ability to forget oneself in favor of the less fortunate who will benefit from the technology***.** The findings revealed that innovators do not think only of income-generating, awards, or benefits, neither promotion (see 4.2.2.5) nor title (see 4.2.2.6), but they enjoy and gain intrinsic rewards by innovating for the welfare of the common good. As Innovator G says*, I have grown old helping, but I have never thought of making a profit from this technology. I am happy that this one helps the farmers because I come from a family of farmers.* They tend to give selflessly, which pronounces them to be altruistic. Hence, altruism describes the essence of true sharing. This finding agrees with Flynn (2011) that altruism is commonly thought of as unselfish concern and actions for the welfare of others, which fosters personal psychological growth and increases an individual's ability to connect with others. An exact statement from the innovators reverberates the skill of altruism of the innovators. As Innovator C says: *I am apparent with my mission of helping the people regardless of their status in life, considering the local and national perspectives. I promised this to myself when I was still having my Ph.D. abroad because I knew I would only achieve fulfillment in my life when I did so.* And as Innovator D says: *If I had wanted to become wealthy because of my product, I should have done it a long*

time ago. According to our VP, doesn't it have high sales? [laughs] *But I did not. I am thinking of the welfare of my fellowmen.*

Throughout their journey to successful innovation products, the innovators assisted voluntarily, thus, giving joy to the weary farmers. As introduced previously, there were even times that they threshed pennies out of their pockets to meet both ends. They go the extra mile so their technologies can reach the target beneficiaries. These findings are consistent with Theurer and Wister (2010). Kahana et al. (2013) say that assisting others in the form of volunteer activities and informal support of neighbors are the key forms of helping behavior understood to be based on a sense of altruism and in the form of love (increasing joy in others) and compassion (relieving suffering in others) and one's happiness is the natural consequence of altruism (Harvey, 2000). Innovator F said: *Frequently, after my class, I visit the people because there is joy in them when they know someone guides them without cost."*

In the studies of Dunlin and Hill (2003); Warburton and McLaughlin (2005); Brown et al. (2005); Poortinga (2006); Parke and Chappell (2008); and Serrat et al. (2018), these authors found that older adults more often than not are helping others because it has a positive effect on their well-being and life satisfaction. In contrast, whatever their reasons are, the innovators, young and old, are at the core of really helping the people—regardless of status, age, and educational background—through their technologies. As Innovator B says: *I am the youngest scientist-innovator on our team. I am not yet in my 40s, but my heart is for helping. Do you know that feeling? You feel happy when you help. Here, when you get to see that your technology is being used and it helps. Entrepreneurship? I am still young. It is not yet entering my*

thoughts. What prevails more is doing something to help. I am not asking for something in return. Instead, I am happy that what I am doing will be used.) And as Innovator C expresses the same thoughts: *If entrepreneurship entered my thoughts, it's just a secondary. I would not say I like that because I am not good at business science. And besides, I am still young to think of profit* [laughs].

A recent study conceptualizes roles as resources for action and agency (Piliavin et al., 2002) in response to the needs of the society. Therefore, the roles played by the innovators through their remarkable product innovations are vital efforts in addressing the problems brought about by unavoidable calamities. In a nutshell, as the interview progressed, the value of altruism unfolds as one of the specific identified skills of the innovators since they were all consistent in their goal of helping the marginalized-that is, to uplift their living and improve their way of life through the technologies they produced without expecting anything in return.

4.2.1.3.1.1 Advocacy (Ad). Based on the interviews conducted, it was evident among all the respondents that the spirit of advocacy highly motivated them and contributed to their success. Innovators personally visit the sites and voluntarily assist the end-users. They are up-close and personal with the community (see 4.2.3.2.4.1). They establish innovator-adopter relationships through constant communication and feedback. Communication is a vital tool in expressing ideas and insights regarding their direct experiences with the product.

On the other hand, feedback is a tool to determine the strengths and weaknesses of the product (4.2.3.1.3.2). This connectivity practice continues until it becomes an automatic activity of the innovator and finally becomes their advocacy.

Innovators love to form advocacy out of their technology, meaning it is their joy to constantly get in touch with the beneficiaries of the technology, even if it costs them time and energy to be with them. An excerpt from Innovator G's response clearly states this: *We make technology respond to the thrust of the chancellor on food production, and it should be sustainable here in our country. Eventually, because we keep creating technologies, it will impact the community. It becomes our advocacy, and advocacy that would last long such that the next generation could even continue it.* Moreover, as Innovator H says, I *am happy that I am continuing what our forefathers have left us to help the farmers.*

In addition, based from the interviewees, innovation is not only pushing for competitive success, as Francis and Bessant (2005) found in their study, but that innovation provides a competitive life for the beneficiaries (see 4.1.1.2.1) and competitive society. Some similar testimony of the respondents includes represented by the words of Innovator C: *We love our community/society; that is why we help in its development. One way to do this is by creating technologies that we share with the citizens without asking for anything in return.*

Therefore, the principal Goal or agenda of the innovators in producing technologies is to improve the lives of people (see 4.2.3.2.4.1) and for sustainable development. As Innovator C says: *I would like to believe that our technologies are helping the people alleviate their daily sustenance issues. One more thing, our products are tools for helping the government achieve the SDGs.* The Sustainable Development Goals are the blueprint for achieving a better and more sustainable future. They address the global challenges we face, including poverty, inequality,

climate, environmental degradation, prosperity, and peace and justice. The Goals interconnect, and to leave no one behind, each Goal's target must be achieved by 2030 (United Nations Educational, Scientific and Cultural Organization-UNESCO, 2017).

To reach the goals, everyone needs to do their part. Therefore, it is a mandate that governments, the private sector, civil society, and every human being worldwide, in particular, state universities and colleges (SUCs), collaboratively work with various agencies in creating product innovations through their scientists-innovators in addressing the 17 goals for a peaceful, just and humane society. Etzkowitz et al. (2017) says that the university has been traditionally viewed as a support structure for innovation, providing trained persons, research results, and knowledge to industry.

This global concern is also the prime concern of innovators. Innovator G reinforces that his technology helps in mitigating climate change, which is one of the SDGs. As he says*: While I am working on the technology, I am thinking of climate change. It is by chance because I used Styrofoam, and if it is not recycled, it will become part of a landfill.* So, his technology is a straightforward way, a bold step in helping the government achieve the Sustainable Development Goals.

The study agrees with Ritu R. Sharma from the Academy for Educational Development; as Begloian (2017) quoted, advocacy is a tool for putting a problem on the agenda, providing a solution to that problem, and building support for acting on both the problem and the solution. This idyllic definition shares a vital idea and similar views to how the innovators express advocacy – bringing their technology to the people for a cause. As shared by six out of the eight innovators and shared here in the words of Innovator G: *You know it is because UPLB is for the people; that is why*

all that we are doing are for the people. We are happy that they are using our products. Over and above, it helps them improve their lifestyle. And as the chancellor himself affirmed: *We always care for the people's welfare, especially the marginalized people.*

In this context, advocacy *is the passion and ability to produce technologies for the local people to utilize and transform their lives.* In other words, it is the primary driving force to engage in knowledge sharing to produce technology. This study goes back to the origin of the meaning of advocacy, which, according to Anush Begloian, a communication and advocacy expert, comes from the Latin *advocate* and means to call out for support (Begloian, 2017). The origins of advocacy date back to ancient Rome and Greece, when well-established orators would perform as advocates or wrote orations specifically for pleading someone's cause.

Ultimately, innovators serve as heralds of activities that call for a cause – to uplift the lives of the marginalized and bring sufficient, nutritious, and affordable food to every Filipino family, and, foremost, refurbish and curate the damaged maltreated ecosystem of the country.

4.2.1.3.1.2 Commitment (Co). The second innovation competency under the altruistic skills is commitment coupled with advocacy. Findings revealed that the commitment of the innovators is towards maintaining the quality of knowledge transferred and captured geared towards maintaining the quality and impact of the utilization of technology. Innovators capture the knowledge, but they can translate the knowledge (knowledge put into action as defined in this study) into something valuable to society, which is the technology they produce.

It anchors the excellent argument from Bennet and Bennet (2007a) that knowledge, when not acted upon, leads to squandering; action with no knowledge is precarious. It means that knowledge is the capacity (potential or actual) to *take effective action* (Bennet & Bennet, 2004), and with thought, leaders have tied knowledge to action (Bennet & Bennet, 2005; Wiig, 2004).

During the interviews, the researcher observed that innovators give themselves to attain successful product innovations. Meaning they immersed themselves with the end-users to share the knowledge personally. As observed, while the researcher conducted interviews with them, the innovators attended to the call of their work, meaning they would excuse themselves for a while when immediate activities concerning the development of the technology called them for a time-out. It was appreciated because it allowed the researcher to visit the sites and laboratories (see 4.1.1.2.1) in developing the technologies. Furthermore, most of the venues of the interviews were on the sites. Therefore, there was no wasted time spent with them.

Reviewing one of the articles of Locke et al. (1988), the authors contradicted their previous definition of commitment, which concentrated on the self. According to them, commitment refers to one's attachment to or determination to reach a goal, regardless of the goal's origin. Thus, it can apply to *any* goal, whether self-set, participative or assigned. Results of this study prove that to be true. The innovators' commitment was not a self-service commitment but a commitment to a certain degree of responsibility outside of self, which, as previously discussed, is the result of advocacy. As Innovator H says: *What I am telling earlier?* [laughs] *Indeed, I am already old* [laughs]. *But then I continue to produce what will help society. It is*

already part of my life, being responsible for helping agriculture. I am destined to have this advocacy. If you say advocacy, do not wait for anything, something in return.

Allen and Meyer (1990) and Meyer et al. (2002) have extensively researched two types of commitment: affective commitment and continuance commitment. *Affective commitment* is defined as "an affective or emotional attachment to the organization such that the strongly committed individual identifies with, is involved in, and enjoys membership in, the organization" (Allen & Meyer, 1990, p. 2). On the other hand, continuance commitment is "a tendency to engage in consistent lines of activity" (Becker & Wilson, 2000; Powell & Meyer, 2004; Somers, 2009; Weibo et al., 2010). Which the innovators aptly possess. They are passionate about producing and transferring technology to end-users for a cause. Here is an excerpt from Innovator H: *It is a nice feeling to help without counting the cost, especially for us here in UPLB. Be of service to society. We have grown old thinking and creating technology for the community. Ordinary government employees are like that. So, I am not bitter* [laughs].

Beyond that, the innovators follow the impact of its utilization. Innovator D says, *oh, yes, I am more than willing to share my knowledge with anyone, most especially with my colleagues here. I do not own the knowledge per se. It has to be shared. But I see it is being captured well, like how I captured the knowledge passed on to me by my mentor. It is for the Filipino farmers. I owe my country, so I have to give back.*

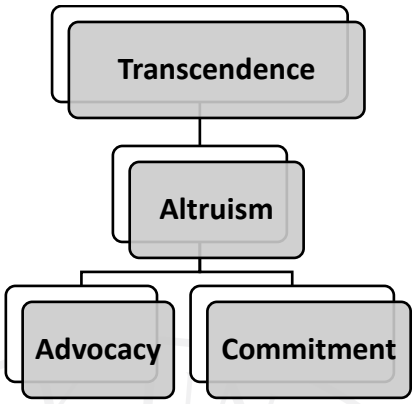
The innovators' technology is a tool to respond to corporate social responsibility (CSR), a commitment built within their system, thus, and becoming part of their advocacy to society. This study is quite intense in saying that advocacy is always tied to commitment. As Innovator D says: *What is the Tagalog term for advocacy?* [laughs] *We are committed. We are committed to our advocacy because, as you can see and if you notice, even if the technology is already with the community, we still visit it and ask if it is still effective. My technology is already mine because it has helped many farmers. For example, Mykovam, because we take care of it. Even if we turn it over to a younger scientist-innovator in the future, we will follow it up, like what my mentor did. Then, of course, I am thankful because I am given awards and recognition because of what I do.*

Based on the findings, *commitment is considered the ability to take charge and be responsible for the notable impact of technology in the community.* Hence, contrary to most researchers' view of commitment which is closely tied to goal setting (Locke et al., 1988), which is perceived as directed toward one's personal goal, innovators' commitment was not the result of their personal goal but the result of their advocacy the communal goal of serving the best interest of the farmers.

Figure 4.9 below shows transcendence's skill that leads to successful innovation.

Figure 4.9

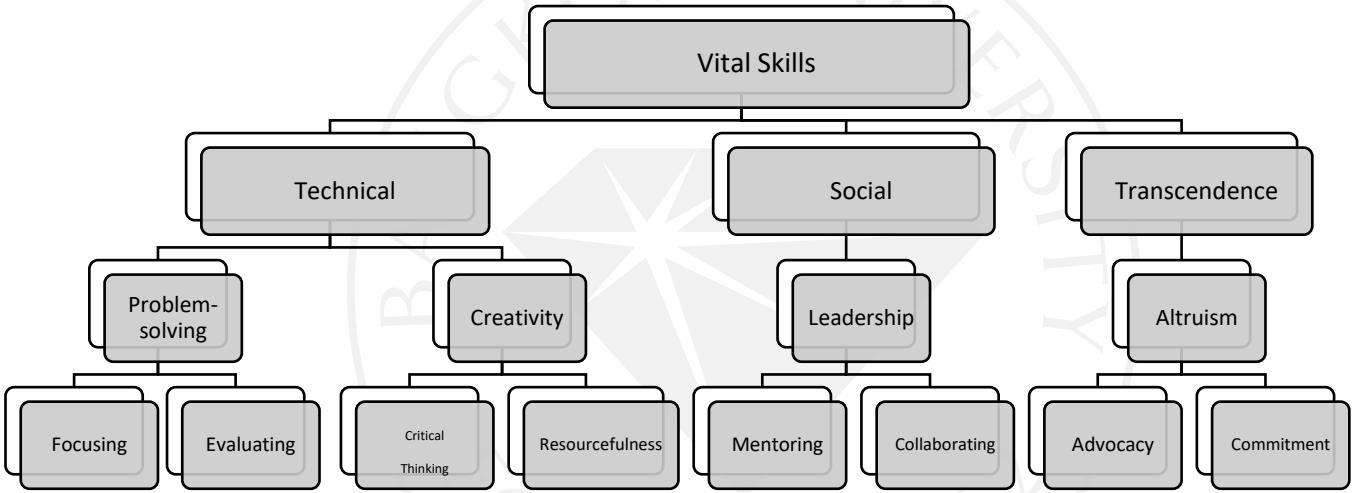
Transcendence that Leads to Successful Innovation



Overall, the innovators' competencies and attributes to achieve successful innovation at BIOTECH R & R&D are illustrated in Figure 4.10 below.

Figure 4.10

Innovator Competencies that Lead to Successful Innovation



4.2.2. Individual Influencers

Individual influencers and observations are those single ideas, pieces of words, or phrases not included in the discussion due to only one or two innovators having shared them. These are somehow attributed that enabling successful R&D BIOTECH innovation in HEIs. Hence, we cannot ignore them because they provide rich learning in the study context. The ideas shared in this category are: (1) family history; (2) concept of resonance**;** (3) trait of persistence; (4) tolerance; (5) contentment over royalty and promotion; (6) title does not matter; (7); innovation is self-initiated (skill of transcendence); (8) writing skills; and (9) prayers matter; (10) humility; (11) role of belief or religion; and (12) the joy of laughter.

4.2.2.1 Family History. It refers to a previous family episode that triggered innovators to share their knowledge to produce technologies. Two of the innovators come from a family of farmers, and they saw the adversities these farmers directly experienced (see 4.2.2.1). For instance, Innovator D had witnessed that farming is recurrent and thus the struggle to sustain it with a low investment return. She felt sorrowful and upset about these circumstances. As she shared: *I saw how my parents wrestled farming. They painstakingly bore the heat of the sun and stormed the unpredictable weather. So, I ventured into a technology that can alleviate their anxiety and agony in farming.]* For this disquieting concern, she developed technologies that have been tried and are successful and used nationwide. This noble action demonstrates the love and care for family, which the innovator has extended to the farthest end of the country and beyond. With this remarkable product on the market, the institution achieved national and international recognition as an innovator

(see 4.1.1.2.1). Innovator A said: *As a government employee, and my parents were farmers themselves, I know my responsibility to help the farmers. Then, maybe, eventually, I'd like the farmers to earn from the innovations I am doing; I want them to benefit from them.*

Another factor worth capturing is that due to his parents being farmers themselves, one innovator felt an additional personal motivation to share knowledge to produce the technology, which provides a close relationship with, and understanding of the needs of this segment of the population. As Innovator A shares: *As I have told you earlier, my parents are also farmers, so that became my motivation, why I want my technology to succeed.* Similarly, Innovator D says: *My parents are farmers, and I saw their hardship and the feeling of sadness when their plants die, and there is no harvest. So that is why I made this technology, and they tried it, and it was successful.*

4.2.2.2 Concept of Resonance. It refers to the zealous character of enriching and amplifying clear direction to be involved in knowledge sharing. Through the leadership of the chancellor (see 4.3.1.1 and 4.3.1.1.1), UPLB sets the direction of the university. Similar goals drive the innovators, that is, to respond to the needs of the less fortunate. Anchored on its vision and mission, the current administration even began benchmarking abroad to address societal issues (see 4.1.1.1.2), particularly in food production. As recalled by one of the innovators in this study, the chancellor said: *I told my team to shift our focus to food production so that we could serve the best interests of the people. The technologies they [these innovators] are doing respond to society's problems, most especially on sustainable food production.* The

innovators are fully aware of their strategic path to deliver quality technologies that can help produce sufficient and edible food for Filipinos, and they respond to this challenge without hesitation (see 4.1.1.1). The innovator's zealous character of conscientiously addressing the societal challenge manifests their desire to help the society in particular and the country in general. To achieve this notable goal, they work collaboratively with their teams and capacitate every member to contribute according to their expertise (see 4.3.1.1.2).

4.2.2.3 Trait of Persistence. It refers to the determination of the innovators to draw their attention to knowledge sharing to deliver the product to the end-users repeatedly and persistently demonstrating the skill. When end-users find it hard to absorb the knowledge about the technology, they repeatedly and persistently demonstrate the skill (see 4.2.3.2.4.1). It means they do not give up because it is their commitment to helping the people.

As introduced several times in earlier discussions and detailed in 4.2.3.2.4.1, innovators take their time to teach and demonstrate how to use the technology to the end-users. As Innovator F details: *Yes… so it is part of the process. I need to explain to them, and demonstrate how to use the product several times, then eventually discuss the benefits. Even if it entails consuming my time and energy, I am reminded constantly of our commitment to serving.* Similarly, Innovator H shared: *l introduced and shared my experience while at the same time explaining and demonstrating the product. I even gave a free seminar. In that way, people may fully understand the intent of the product.*

4.2.2.4 Tolerance. It refers to the recognition that innovators exercise understanding when mistakes occur. In other words, tolerance for making mistakes also plays a significant role in knowledge sharing (Tabrizi & Morgan, 2014). Similarly, innovators exercise a high level of tolerance in knowledge sharing, meaning that innovators do acknowledge they also commit mistakes as they share the knowledge. While they may have experienced some difficulties along the way, they are consistently assisted or helped by their teammates (see 4.3.1.2.2). Innovators are not hesitant to report errors, with their teammates knowing that they trust (see 4.2.3.1.1.2) each other since there is an established genuine relationship. When an organization creates an environment with tolerance for mistakes, professionals will be motivated to report errors and learn from them to improve quality services (Currie & Suhomlinova, 2006). There is leniency in compelling errors because that is where a large amount of learning occurs. However, this does not mean that mistakes overshadow the intended output. When one commits a mistake, they learn from it and see that others will not repeat it.

Rewards are also significant in motivating actors to participate in knowledge sharing. Knowledge-sharing participants need to see the benefit for themselves in the knowledge-sharing process. Otherwise, they might abandon the knowledge-sharing process when they face the first problem in sharing/receiving knowledge (Lin & Chang, 2009).

4.2.2.5 Contentment over Royalty and Promotion. It refers to the innovators' fulfillment in helping others rather than seeking external rewards. While benefits such as enjoyment and earning, respect are motivational factors for sharing

their knowledge freely to be able to create products, another reward that innovators could receive out of their technology is royalty. For the innovators receiving royalty (40% goes to the inventor and 60% goes to the institution), this is just a secondary reward. Innovators kept emphasizing that what counts most for them is the utilization of their products. Researchers would either publish their output or did not publish in the beginning. If you did not publish, you would not be successful and promoted. Regardless, the innovators are pleased with what they are doing; there is contentment because they see that what they are doing is worthwhile, even if it takes time for promotion. In short, their technologies are not in vain if they are helpful to the end-user and society. As Innovator F says: *When an inventor has a royalty, even the institution, UPLB, receives this. They divide it accordingly. Yes, because either you publish or perish here; you will not become successful if you do not have a publication* [laughs]. *You will not get promoted, although, for us, we are not promoted* [laughs]. *None, but then you are happy with what you are doing. You have contentment with what you are doing because it leads to something. You can already see that people are waiting to utilize it as if those who will be using it are just around* [laughs]. And, again, we are reminded by Innovator A: *To innovate is not only to earn points for promotion or to maintain our title as COE, but the most important reason is to help the farmers.*

4.2.2.6 Insignificance of Title. It refers to the titles [inventor, researcher, scientist instead of innovator], which are merely labels and do not define them or their work. Indeed, as the end goal of knowledge sharing is to produce technology for the people, they are not conscious of their title as innovators. They do not mind their

names-inventors, scientists, researchers, or innovators, seeing these as descriptive terms rather than titles. What matters most to them is that they could utilize the knowledge well. For example, one innovator is spontaneous with her work of creating products; thus, she is an inventor, yet does not think she is an innovator.

As Innovator F describes: Actually*, I am not aware that I am an innovator* [laughs]. *I am doing this because I want to do something with the product; it comes out spontaneously. I do not know that it is like that. Indeed, only now do I realize I am an innovator.* When asked why they call themselves inventors, the innovators responded that they are used to being addressed or called inventors instead of innovators. As Innovator D says: *We are called inventors or scientists; it is like we make something that is different. Inventor is when you can make something different. We are innovators because, according to TTBDO, when they called for us and we had a technology audit, we must be working on products that can be utilized as* Innovator C says: *Huh! Because your topic is very interesting, I was included as an innovator. All I know is invention; I am making something different, which is why I am an inventor. Now, there is such a thing as an innovation; what you have made should be used; it must be utilized. And it is not just stocked* [laughs].

Innovator B shares a similar experience. Whether they are called researchers or inventors or scientists or innovators, they remain faithful to their commitment to continuing the legacy of their forefathers in serving the marginalized. Innovator B shared this thought: *It is the same even if they call us researchers, inventors, or scientists. It does not matter* [laughs], *as long as we seriously do our commitment to helping the people.* Using these same descriptive terms, the PDO-TTBDO 1

confirmed this point, saying that: *Whether they are called researchers or inventors or scientists, or even innovators, their main goal is to have a productive technology transfer that springs out of their research, which is why we have now the technology transfer to avoid unproductive research outputs and products.*

4.2.2.7 Innovation is Self-initiated [Skill of Transcendence]. It refers to the innovators' self-impelled intention to produce innovation. After learning the condition of the society and the aftermath of natural calamities, which are the impetus for knowledge sharing (see 4.1.1.1, 4.1.1.1.1, and 4.1.1.1.2), the innovators lead projects that respond to the problems brought about by these catastrophes. However, it is self-initiated; still, they have the institution's support. Not all people have this mindset and can become innovators. According to this innovator, he explains that the institution is always there to help them out with those potential innovations. Hence, they are all the more encouraged to share and transfer technology. Reiss (1996) claims that typical features of Biotechnology are a solid science linkage, multidisciplinary, high innovation dynamics, and a modular production structure. These characteristics necessitate an appropriate innovation system to allow efficient diffusion of this key technology. Considering the significance and complexity of knowledge transfer in Biotechnology R & R&D, co-operations play an essential role in the Biotechnology industry. Innovator's eagerness to transfer knowledge is facilitated and mediated by the team along with some of the members of the university through knowledge absorption (see 4.2.3.2.4)

Eventually, there is a market for their products and see how these innovations will be utilized and reach the people, as the innovators say, from laboratory to table.

Innovator A shares: *Oh, my view on this is responding to the problems brought about by the calamities is self-initiated. But, of course, there must be the institution's support because not all people can become innovators, right? And we all know that capturing tacit and explicit knowledge is not easy. Not everyone has a mindset like that, but again, the critical thing there is the institution's support for those potential innovations. Eventually, we can market them; it is like the ultimatum, the end goal. And we will see how the innovations will be utilized and reach the people, as they say, from the laboratory to the table.* And as Innovator F says: *Self-initiated. Yes. Like that. We keep sharing and capturing things we know can help us create products. I did not expect the technology to reach that far; they tell me, okay, go there. You ride on so that you can prove that it is essential.*

4.2.2.8 Writing Skills. It refers to the innovators' ability to inscribe or write correctly. Writing skill here means the quickness and accuracy of jotting down ideas and information. These notes are helpful when verifying unclear messages. It is also a way to keep storing the shared knowledge. This skill enables innovators to write and prepare a concrete budget proposal. Before engaging in research, innovators go through the rigors of preparing proposals, part of which is preparing the budget proposal. No doubt, innovators are intelligible in this area. Innovators attend training concerning writing a proposal. As Innovator B says: *I think that should be one of those things we should be doing because there are a lot of those* [proposals] *here. Maybe you learn how to write a proposal because you are convinced that your project will be funded. I attended a training in PCAF. I was glad I was sent. Maybe PCAF has funds and knows that they need to train people how to write? So, I went,*

and [now] *I know how to write a proposal. Maybe that is the first skill that we should learn...yes, by attending training.*

4.2.2.9 Prayers Matter. It refers to the innovators' trust in a more significant source. On one occasion, two of the innovators beseeched the guidance of the Almighty. Despite all the knowledge they have, they admit that they do not know everything and, along the way, may commit errors, so they pray for enlightenment working on their technology and aspire to continue the legacy passed on to them, that is, to boost the economy of the country efficiently and make the life of every Filipino better. As Innovator D clearly says*, I think that is not enough despite all the knowledge I have. I beseech the guidance of the Almighty. He owns everything. Join us later in our bible sharing?* Together with Innovator F, they express the importance and necessity of prayer. In Innovator F's words: *It is still important to pray because if you know that you did everything and it looks like there is still something missing, then it will not work, and you have to meet the timeframe. So, pray… pray … pray …, and yes, prayer works!*

4.2.2.10 Humility. It refers to the innovators as individuals having an accurate view of themselves, knowing their strengths and weaknesses, and being other-focused rather than self-focused. Their modest attitude to integrating feedback and their desire to produce quality technologies delight the end-users. Innovators' humility boils down to their commitment to serving humanity.

Another influencer that is a tool for creativity is humility. Innovators are open to suggestions from the top-level management (see 4.3.1) and more than willing to shift according to the current thrust of the administration (see 4.3.1.1). Innovator H

says: *I have to abide by the instructions from above. I believe that the management's decision results from critical communal sharing of thoughts and ideas.* In addition, they also welcome feedback from their teammates and the end-users alike (see 4.3.1.3.1) to enhance or simplify the technology. Innovator F says: *I listen to the people's feedback when I demonstrate the technology in that way, I could improve the product. I am not saying that I know better than them; that is why I listen and take note of their comments.* Drawing from this thought, humility is tied with an ear to listen attentively and incorporate comments and suggestions without hesitation.

Over and above, they accept criticisms and use this as a tool to improve more on their craft. According to Bennet and Bennet (2005), "*The simple and profound conscious choice of humility provides an opportunity to ensure freedom of thought ...* it is clear that utilizing the tool of humility moves the individual beyond embedded mindsets, providing an opening for learning from others. It also benefits others. Openness to the thoughts of others allows them to be freer in their thinking, thus increasing their contribution to the diversity of thought and increasing the potential for bisociation." (p. 164)

There is a wide overlap in the concept of "selflessness" that contributes to the quality of altruism and the human quality of humility. As observed with these scientist-innovators, humility occurs at the individual and interpersonal (team) levels. As an individual, humility is having an accurate view of who you are, not too high or low, knowing your strengths and abilities, recognizing any weaknesses and limitations, and being honest about who you are and what you know about yourself and others. The interpersonal level of humility means being other-focused rather than

self-focused, which includes "empathy, knowing the needs and wants of others and taking those into consideration in your decisions and actions" (Bennet et al., 2018, p. 2). Each of the eight participants observed characteristics that reflect humility at both the individual and interpersonal levels. These characteristics included: willingness to listen, seeking and honoring truth, rewards not necessary for right actions, receptive to new ways of thinking, focus on others in service, seeking input and perspectives of others, not afraid to admit being wrong, openly addressing weaknesses, responsive to those in authority, grateful for their success and their ability to make a difference for the country, and recognition of a higher power. All these characteristics surfaced as qualities related to humility in the MQI Research Study (Bennet et al., 2018).

4.2.2.11 Role of Belief or Religion to Altruism. It refers to the innovators' conviction or creed, which led to being altruistic. As forwarded in 2.3.5, the word "altruism" is often used interchangeably with a host of others, including "aiding," "helping," "volunteering," and "prosocial behavior" (Midlarsky & Kahana, 2007). In altruism, a relatively rare behavior, the intention to help is other-oriented rather than egoistic. Altruism involves behavior with the apparent absence of external reinforcers without rewards or recognition. The innovators produce technologies for the target end-users without expecting anything from them. Innovators' sole intent to produce technologies is for the target end-users to improve their lifestyles. They are not after the profit gained, the awards, recognition, or even promotion but to uplift the present condition of the users (see 4.3.1.3.1**).** Innovator E gladly says, *"I do not intend to sell my products. I created this product so that people can maximize the guava leaves, which are everywhere. And they can make an income out of it."*

In his study, Etter (2019) suggested that an increase in religiosity correlates to increased altruistic intentions and altruistic behaviors. In some regard, there is an intertwining relationship between altruism and religion. Altruism—motivated by the desire to do good deeds or help others without the expectation of reward, reciprocation, or recognition—is significant for all religions (Neusner & Chilton, 2005). Religion is known for its tremendous influence on the behaviors of its followers, and, most prominently, these behaviors are often depicted as generous or selfless (Bennett & Einolf, 2017; Galen et al., 2015). The innovators' continuous commitment to the community through their innovations manifests their selfless service to the Filipino people. It is "selfless" because their bold and systemic action becomes advocacy and a legacy carried from generation to generation. Almost all innovators concluded the interview by being grateful to their forefathers who emboldened them to labor hard and have faith in God that everything will work well and that the welfare of the people will always be their top priority. An excerpt from Innovator H, *"You know our forefathers instilled in us to have a strong faith and always be true to our mission of delivering quality products to our countrymen."*

4.2.2.12 The Joy of Laughter. It refers to the jubilation of the innovators in sharing their insights, experiences, and knowledge in their journey towards product innovation. Generally, it has been observed and quite noticeable that innovators often replied with 'ahh'. For instance, Innovator H: *…Ahh, what I studied is directed to food production, which is why our focus now is on bio-pesticide.* The same is true with innovators D, F, C. *Innovator* D: *Ahh…Even if the soil is good, I do not understand why those plants I planted in Bukidnon died. Yes! Soil from Bukidnon. What I did was*

I collected the best soil in the country. As Innovator F: *It is a big help to identify what research you are going to do when you know the industry's need. Ahh…not the big industries. I mean here that I am thinking of our fellowmen engaged in small-time businesses. I am a food tech, bio–what, BS Food Tech Graduate, but I did not go to the industry.* Innovator C: *We have been capitalizing on this nationalistic outlook through research as we strive towards distinctive excellence, which enables us to know our place in the global arena. Ahh… it is my dream to my country that is why I was in a hurry to come back after I finished my Ph.D. abroad.*

Reading between the lines, innovators replied spontaneously with awe and firm conviction about their technologies. In fact, without realizing it, their actions towards developing product innovation are significant contributions to addressing the pressing issues of our agricultural sector. Their technologies also responded to one of the Sustainable Development Goals (SDGs). Over and above, in responding to the needs of the people, most especially the farmers.

Evans (2017) says there is a structure to humor that includes surprise, which is at the heart of comedy and creativity. "It is about producing something in a new way, a different way, a surprising way ... if you want to be creative in your life or work, it is important to be available to surprise. And the best way to surprise is to spend time immersed in humor, and turns on surprise" (p. 1). Evans goes so far as to recommend setting up a daily "laughter break" to move beyond the "freeways of habit." In the play of laughter, the emotions, and in turn peptides, flow through the body. Pert (2008) believes that "there is a free flow of information carried by the biochemicals of emotion, the neuropeptides, and their receptors" (p. 276), fully participating in the

creative process. In this study, the innovators appear to have incorporated laughter into their everyday conversations giving a lighter mood and getting the most out of the members' creative abilities (see 4.2.1.1.2). There is a balance between workload.

As confirmed through the interviews and observations, these attributes, which are inherent to the individual innovators, clearly contributed to the success of achieving desirable technologies that made an impact on the end-users and society in general.

4.2.3 Knowledge Sharing

Given the various definitions and classifications of knowledge—as well as techniques on how it can be transformed and exploited as reported in the literature (Feghali & El-Den, 2008; Awad & Ghaziri, 2004; Jarvenpa & Eerikki, 2004; Geyer, 2001; Scharmer, 2000; Vasconcelos et al., 2000; Nonaka & Takeuchi, 1995), how does biotechnology perceive, interpret and utilize knowledge? *Knowledge sharing is* "team members sharing task-relevant ideas, information, and suggestions" (Srivastava et al., 2006, p. 4). The availability of shared knowledge is necessary for adapting, extending, and creating new knowledge and innovation (Hislop, 2007).

Knowledge—a vital component for the economic development of modern economies—for the longest time, has been replaced by the concept of capital and labor as the key players in the economy (Eckl, 2012). However, the communities that flourish in the globalized and knowledge-based economy of the 21st century are those with essential knowledge assets (Goldstein and Glaser, 2012).

Since the beginning of the 19th century, universities have had the double role of performing both higher education and research activities. In the last decades of the

20th century, universities also started to be viewed as providers of valuable knowledge for exploitation in practical terms (Necoechea-Mondragón et al., 2017). The relation prevailing between knowledge production in universities, industrial innovation, and economic growth are of snowballing interest and has promoted significant changes in the traditional structure of many higher education institutions. The conversion of university research into a knowledge hub that facilitates knowledge sharing is vital for the future of many nations, especially in nations in the developing world (Warren et al., 2008). Universities play a unique role in society, providing an assembly of experts in experimentation and innovation. To retain national competitiveness in the global economy, leaders worldwide have had to push for the primacy of universities (Breznitz & Feldman, 2012).

Currently, the universities in some countries contribute to healthy and sustainable regional economies in numerous ways, such as the site of this study, UPLB BIOTECH. There is a so-called 'milieu,' or co-location effect because universities produce substantial positive economic development effects by attracting and encouraging scientists, engineers, and entrepreneurs to locate in specific geographical regions. These regions have a concentration of highly educated and creative people teaching and conducting research employed by the university (Goldstein & Glaser, 2012) and developing innovation products equally valuable for society and beyond.

On the other hand, tying knowledge to action allows it to have varying quality (or effectiveness) depending on how well a specific action achieves its anticipated outcome. Since the future is not certain to some extent, knowledge cannot be

considered as either true or false at all times, but rather is taken as having a probability between zero and one of effectiveness, and hence always open to some degree of uncertainty (Bennet & Bennet, 2007a). The knowledge advanced by organizations is frequently vastly tacit. Thus, it is difficult—if not impossible—to articulate and codify (Winter, 1987). The truth of the matter is that without key individuals who have the knowledge and the ability to communicate that knowledge to others, technology transfer is often difficult to transfer. It explains why the dispersion of new technology often depends on the mobility of engineers and scientists (Teece, 1997) and includes scientists-innovators.

In recent times, Biotechnology has introduced product innovations aimed at meeting the needs of industry, community, and national policy but failed to discuss knowledge sharing flow that influences innovation. In this context, *knowledge sharing* is "team members sharing task-relevant ideas, information and suggestions with each other" (Srivastava et al., 2006, p. 4) transferred by the forefather. It means acquiring knowledge through competent individuals for one purpose in one context (Minciullo & Pedrini, 2015) and Thorisson and Talbot (2018) to produce product innovation. The availability of shared knowledge is necessary for adapting, extending, and creating new knowledge and innovation (Hislop, 2007). In the case of the innovators interviewed, there is knowledge sharing among the group members with each having a special responsibility to play.

The move towards sustainable agriculture requires a more detailed understanding of farmers' knowledge(s) and knowledge practices. Increasingly, it is crucial to understand what farmers understand and how their knowledge practices

incorporate others – especially given the emerging call for environmentally-oriented policy measures to move beyond an individual farmer focus (Thomas et al., 2020). On the contrary, this research considers how innovators engage with, utilize, and share knowledge with the end-users, including farmers.

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Table 4.5

Knowledge Sharing Process as Experienced by the Innovators

Category	Sub-category	Themes	Verbal Description	F N=8
Prompting stage	Stimulating Elements	Passion	This refers to the driving force, commitment, and a sense of urgency to respond to pressing environmental issues, hence the need to share the knowledge and coach one another in the team.	8
		Trust	This refers to the team leaders showing trust and confidence towards the members and vice versa and never doubting their performance capacity.	6
		Enriched Environment	This refers to the working atmosphere of the innovators as they continuously share and transfer knowledge in the completion of their journey to successful product innovation.	7
	Matching Mate	Emphatic Nature	This refers to the innovators' identifying themselves with the situation of the beneficiaries of technology and the eagerness to share information in developing technologies.	6
		Well-grounded background	This refers to the technical adeptness and preparedness of the innovators.	8
		Appreciative Inquiry	This refers to the positive recognition and reinforcement received when sharing and expanding knowledge from the gurus to the innovators and understudies.	5

(Continued)

Table 4.5 (Continued)

Knowledge Sharing Process as Experienced by the Innovators

Category	Sub-category	Themes	Verbal Description	F N=8
Prompting stage	Viability Analysis	Foresight	This refers to looking beyond and becoming proactive in knowledge sharing to curate and design relevant product innovations.	8
		Feedback	This refers to the ability to clarify and point out missed things.	6
		Multiple Administrative Tasks	This refers to the increased workload that delays their duties to create technologies.	5
Expending stage	Knowledge Ground	Constant Search for Knowledge	This refers to the continuous exploration of traditional and scientific knowledge in creating remarkable technology	8
	Knowledge Transmission	Community of Practice	This refers to innovators who share a concern or a passion for creating technologies and learn how to do it better as they interact regularly.	6
	Knowledge Exposition	Research Skills	This refers to the ability to converting traditional knowledge into scientific knowledge to create sustainable product innovation.	8
	Knowledge Amalgamation	Demonstrating Skills	This refers to the ability to take their time out to teach and demonstrate how to use the technology to the end-users	8

4.2.3.1 Prompting Stage. This stage describes the knowledge source or receiver to create the KS process and how the innovator identifies the other members involved from its point of view. It is also in this stage that knowledge sharing comes into existence. Some factors stimulate innovators to participate in knowledge sharing actively. In other words, the innovators are motivated, affirmed, and supported to start EKS. This stage explains the motives for sharing knowledge in each sub-category and theme. The prompting stage has sub-categories: Stimulating elements, matching mate, and viability analysis.

4.2.3.1.1 Stimulating Elements. It was evident in the interviews that innovators are indeed motivated and supported to start KS. Seeing the plight of the farmers from their familial background and concern for the beneficiaries of the technology, innovators resolve to help them. It is why they are very eager and willing to participate and share their knowledge with their colleagues. Their commitment, dedication, and passion are the common stimulating elements to actively partake in knowledge sharing for successful innovation and eventually become their advocacy in life.

At BIOTECH, the forefathers or experts and project leaders, and other team members create an open communication wherein project leaders (innovators) and research assistants (understudies) are free to express themselves or share information. Through this stage, members of the team get to know each other and establish rapport. *For example, "I will be retiring soon, so I want to pass this information so that the technology will either be improved or terminated depending on the situation."* In addition, it is also their passion (see 4.2.3.1.1.1) to help the marginalized

farmers alleviate their lifestyle that ignites their desire to share and transfer knowledge. Stimulating elements means that innovators are precise with their objective of participating in the process of knowledge sharing. At the onset, the innovator's conviction to share the knowledge is evident. Meaning to say they are very supportive of the idea of knowledge sharing because of their commitment to producing technologies to be used to mitigate either manufactured or natural calamities (see 4.1.1.1.1). Innovator A aptly summarizes the thought of the innovators by saying, *"We are more than willing to share our knowledge and listen at the same. This process helps us refine our product. Yes, it is important to listen to the sharing of our colleagues for it will give us better information, and in that case, we will not lose in our commitment."*

Stimulating elements have the following components: passion, trust, and an enriched environment.

4.2.3.1.1.1 Passion. It refers to the driving force, commitment, and a sense of urgency to respond to pressing environmental issues, hence the need to share the knowledge and coach one another in the team. According to Frijda (2005), passion refers to urges of desires, behaviors, and thoughts with a considerable significant force to act upon them. Bennet and Bennet (2005) used this as an operational definition of passion in their 2005 study of thought leaders, which engaged in Knowledge Management Thought Leaders (KMTL study). In a similar tune, the present study adopts the exact definition. *Passion* is the driving force that urges scientists-innovators to respond to environmental issues. Innovator C says what *motivates me to share the knowledge is end-users' welfare. I am pretty*

passionate about responding to pressing environmental issues. You can only see me stressed out when I do not think end-users are getting the appropriate technologies. So, we want to make sure we teach the team as best as possible.

Many of the scientists-innovators—in their desire to help the farmers achieve sustainable lifestyle—zealously study the possibility of radical or incremental innovation (see 4.4.2.3). Either way, their creative minds led them to come up with technologies that address the concern of the beneficiaries of technology [farmers] and are carried on until it becomes their advocacy which is of the highest value, as mentioned by the innovators more than the rewards or benefits they get out of the created products. *Innovator G says: I have lots of those rewards already; passion motivates me to do this job given my age now still [I am retiring soon]. I love what I am doing.* Bennet and Bennet (2005, p. 237) stated, "Considering these characteristics, positive passion is used to indicate the value (something precious) and passion, whether positive or negative, is used as a determinant of what is of higher interest and excellent."

As forwarded in 2.3.4, passion 'is like the fire underneath the soup pot,' it heats everything up, blends the flavors, and makes those spices mix with the essential ingredients to produce something that tastes wonderful' (Goleman et al., 1992, p. 31). Innovator A says: *There is no stopping me from what I am doing because this is my passion; even if my group failed many times in finding the right solution in growing bananas amidst incremental weather, we kept going. My passion sustains my interest and strength. It is like fuel that keeps the fire burning.*

According to Csikszentmihalyi (1996, p. 72), there is a movement from passion to objectivity, from action to reflection, which respondents called out as what allowed them to keep learning and adjusting to new situations. The individual's creativity unfolded organically from idea to action, then through the evaluation of the outcomes of action back to ideas—a repeated cycle. Similarly, starting from the chancellor down to the innovators, they knew precisely their objective of developing the technology to respond to the current thrust of helping the agricultural sector [particularly the farmers] deliver organic and nutritious food to every Filipino family. The ideas built upon sharing forefathers [originator of knowledge] to innovators and collective objectives paved the way to creativity until successful product innovation is achieved.

Scientist-innovators in the study may not be gifted individuals, but their passion and commitment to serve the marginalized drove their creative instinct [creativity] to do something essential to the community [innovation], which they do out of service to the nation. Innovator D says: *I think passion is the key to becoming innovative. Because no matter how intelligent or creative you are, if you do not have passion for what you are doing, you will lose your grip on achievements are the primary reasons for initiating KSP.*

4.2.3.1.1.2 Trust. It refers to the team leaders showing belief and confidence towards the members and vice versa and never doubting their performance capacity. Literature shows that there are a variety of factors that influence knowledge sharing in teams. Some factors include personality traits, communication styles, trust, interpersonal attitudes, leadership, diversity of expertise, and team size. Research has

found that leadership and trust positively directly impact team knowledge sharing (Lee et al., 2010). It is an essential ingredient to successfully creating, sharing, and applying knowledge in teams. Innovators are aware and have trust that the knowledge shared is used to produce or improve the technology they are working on. Innovator C said: *I never hesitated to share my knowledge because I trust my colleagues to optimize the knowledge to benefit the people.* Research even indicates a strong positive relationship between trust and knowledge sharing for all types of teams (Staples & Webster, 2008). Similarly, the study showed that trust in teams becomes essential when a team process, like knowledge sharing, requires interdependence, information sharing, and collaboration.

When teams collaborate and share information openly, vulnerabilities often surface. Accordingly, the best teams understand why they have been brought together, what they are expected to accomplish as a whole, and what each individual is expected to do with trust Higgins et al. (2010), which is sharing their thoughts and ideas, and knowledge. In this case study, team leaders showed trust and confidence towards the members and vice versa. Never did they doubt the capacity of each one. They are open to checking and referring things to their data-based storage, storing explicit knowledge so that they have free access to it when they need it. While tacit knowledge is hard to capture, they see that they conduct demonstrations and constant feedback (see 4.2.3.1.3.2). As Innovator G says, *"I never doubted the knowledge shared by my colleagues. We function with trust and confidence. No, we do not hoard knowledge. We are accountable to our countrymen, and that is why we share and transfer our embedded knowledge just like our forefathers did.* "On the other hand,

Innovator C noted that *in my case, I developed new ideas based on the previous technology, and since this technology needs replacement, I need to learn more. After taking my Ph.D. abroad, I wanted to come back and start the journey. Oh yes, I am more than willing to share. I am mentoring my understudy now.* Hence, they meet regularly for mentoring and close monitoring of updates. Likewise, innovators were more than willing to listen and open to suggestions.

A trusting person will openly exchange valuable ideas, collaborate, accept influence, and impose relatively little control. On the other hand, when a teammate discovers evidence that leads them to believe they are not trusted, they conceal information, reject influence, and try to take control (Gillespie & Mann, 2005) and study the situation. Hence, trust needs to be present to enable knowledge sharing to happen. Conclusion: there is a belief that team members are honest, reliable, and trustworthy. More so, team members trust and look up to their leader [guru]; thus, innovators are more than willing to disclose even sensitive information. For example, innovator E said: *"Yeah, we are all willing to disclose sensitive information because we trust our leader and vice-versa. We have to share the knowledge because that is the best way to develop a production technology."*

4.2.3.1.1.3 Enriched Environment. It refers to the working atmosphere of the innovators as they continuously share and transfer knowledge in the completion of their journey to successful product innovation. There is a created organization's culture from the fundamental assumptions and beliefs shared by an organization's members; found to operate unconsciously, and it defines the organization's view of itself and its environment (Stylianou and Savva, 2016), where individuals are

encouraged to explore and share knowledge while working on their projects. It involves the values, principles, unwritten rules, norms, and procedures used within the organization (Stylianou & Savva, 2016).

Innovators are blessed to have an enriched environment that includes the use of space, its design, and plants [including outside fields, laboratories] (see 4.1.1.2.1). Innovator G shared that he designed a space intended for open discussion between and among team members (see 4.3.1.2.2). By doing so, the neurons in the brain start to recognize its various potentials, which brings out creativity among individual members. Experts and other team members are open to communication, and they attend to the concern of each one, even the most minor member of the team.

Begley (2007) pointed out that "exposure to an enriched environment leads to a striking increase in new neurons, along with a substantial improvement in behavioral performance" (p. 58). There is an achieved performance level of innovators, and positive and pleasant behavior is displayed. Innovator E said: *"We enjoy working because we have an accepting and understanding environment."*

In line with this, social interaction is built and established, and affective attunement is developed, which is a learning relationship with a trusted other; in the case of this research are the forefathers whom the innovators built their trust and confidence in sharing the knowledge pushing forward the radical or incremental innovation because they are in a welcoming and non-judgmental environment. Innovator H says: *We trust the abilities of each one in sharing our stored knowledge when we get to meet in our created space. More so, there is a provision for high-end*

laboratories where we store and nurture our technology while exchanging indigenous knowledge. And yes, we live in an environment free from judging.

Furthermore, end-users are welcome to share their knowledge to improve the technology. They are also encouraged to raise their questions and clarification regarding the use of the technology. As Innovator H continues to share: *I designed this simple room so that we have a space for collaborative work with my teammates as we share and exchange the knowledge we have. We also encourage end-users to come for further clarifications and share their personal experiences using technology.*

Bennet et al. (2018) explains that "An enriched environment can produce a personal internal reflective world of imagination and creativity... (p. 125). A rich environment entering the mind/brain/body through experience stimulates the mind to associate patterns and create new possibilities." Such a powerful statement echoes the conducive ambiance of the innovators, for they can release their creativity through the shared knowledge, which leads to successful innovation.

4.2.3.1.2 Matching Mate. This stage begins with an attempt to search for a suitable partner to share the information. On numerous practical junctures, we refer to knowledge as information, meaning that one has to have a handful of knowledge and informed decisions on how to execute things to serve the purpose of the current undertaking. Furthermore, Gurteen (1998, p. 6) stresses that "To make knowledge productive – you need information." It means that knowledge on its own is not enough. Good information comes with good knowledge; one needs both information and knowledge. Thus, we can conclude that knowledge requires information—which

is consistent with the literature—yet it is information connected to experience and related to action. Further, Feghali and El-Den (2008) bring in the element of sharing, saying, "Indeed, we can only accumulate knowledge through experience, but in its truest essence, knowledge can only have meaning if it is articulated and shared'' (p. 32) to those whom we can relate with and have access.

Innovator E says, *Ease of access [is paramount]. If somebody is there, it is excellent, I will ask. It does not matter if I have a good relationship with them. Just the quicker I get the information, the better.* Innovator F added: *I look for someone who will understand my perspective. In that way, I am confident that I get the correct information. For instance, if I am not sure about the amount of the mixture, I need to ask my boss [forefather], who can help me with the proper mixing. But unfortunately, we have a deadline to meet, so we cannot afford to play with our time.*

From the interviews, it was evident that innovators prefer to receive or share knowledge with those people who are more accessible, regardless of their status in the team or their relationship. Therefore, a matching mate is composed of emphatic nature, well-grounded-background, and appreciative inquiry.

4.2.3.1.2.1 Emphatic Nature. It refers to the innovators' identifying with the situation of the beneficiaries of technology and the eagerness to share information in developing technologies. Interviews also revealed that innovators tend to seek partners with similar characteristics. In this context at BIOTECH, knowledge sharing is at its best when the knowledge source and the knowledge receiver are from the same profession or have the same interest and intention. For example, agriculturists prefer to communicate with agriculturists, and nutritionists ask nutritionists. Innovator

D, a forester, enjoys working because her former boss [forefather] was also a forester. She says *I did not find any difficulty relating with my boss because we have the same field.* In addition, innovators further consider those colleagues with the same interests and goals. For instance, innovators working in the same field could relate well with one another, especially when working with the same overarching goal of helping the marginalized. As Innovator F says, *"Of course, I would prefer to work with someone who has the same interests and goals as mine. I can easily share knowledge with a person who could also identify with the clients' pressing needs. The sincerity to engage in knowledge sharing is because of the current condition of the end-users.*

In a co-evolving society, to understand an individual's (the end-users) needs, especially to stay ahead, it is necessary to understand the individual more deeply. The empathic nature of the innovators applies that way. For instance, we could feel how innovator A shows more profound concern for the farmers' situations. He says: *I come from a family of farmers, and I see many farmers struggling in their day-to-day life in the field. My heart cries for them. It* is a display of genuine empathy for the welfare of the end-users. Thus, continuing innovation success requires an empathetic understanding of the end users.

While innovation can undoubtedly equate to 'success,' however, innovators always equate innovation to service, that is, processes and products others will use to make or do something better, generally to make their lives better in some way and perhaps provide the opportunity for them to improve others' lives in some way. Innovation requires letting go of one's ideas, sharing them, applying them, taking

responsibility for them, and, as appropriate, expanding on them through an iterative process.

4.2.3.1.2.2 Well-grounded background. It refers to the technical adeptness and preparedness of the innovators. The partner's reliability serves as a determinant for successful matching. From the interviews, innovators prefer to receive knowledge from more experienced ones. As Innovator G confirms, *"I do not want to miss the coaching session with our forefathers because I firmly believe that they are reliable and more knowledgeable on the history of the product."*

Innovators are grounded in their technical adeptness and preparedness to address environmental problems, meaning that their activities in producing technologies depend on their in-depth educational background. For instance, Innovator D optimized her expertise as a forester to improve on the product she carried over from her forefathers. **S**he explained: *Since I am a forester and my boss was a forester, we targeted reforestation. I like to study the rhythm of the soil so that even if it is dry, plants will still grow healthy, and farmers will have something to look for even during the dry season. Oh, yeah, I need to finish within the time frame because I have to pay back my fellow citizens.*

Innovators' education played a significant role in fostering the skill sets required for each particular endeavor. As forwarded by Okoye and Caleb (2019), when people become more educated, their ability to engage, share, participate and understand increases. As Innovator C attested: *Not more on the years that matter, but the highest educational attainment]*. In addition, they have permission to pursue their passions and emerging ideas beyond specific tasks. It is significant to the innovators.

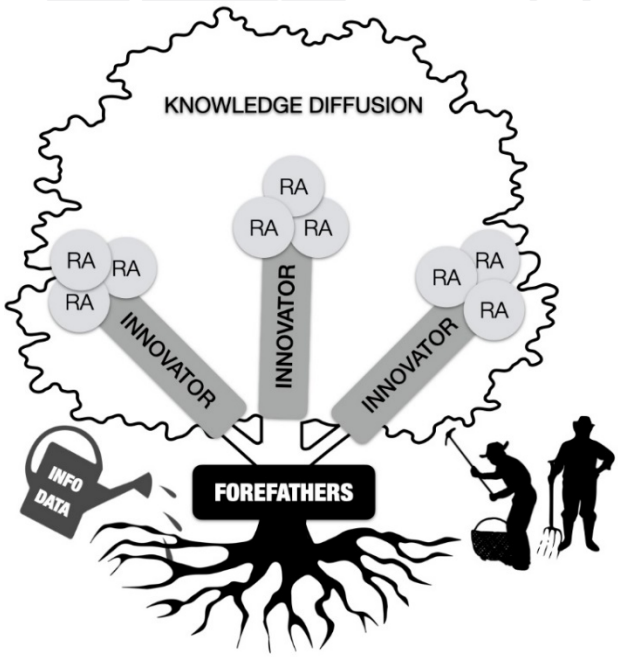
As Innovator G describes: *What is nice about us inventors, we are given by the top leaders the chance to do what we like the most. What I mean is … hmmm … I can go beyond.*

Indeed, as supported by their educational qualifications, training, and exposure, the innovator's intensive and massive education background made them adept at their current work, especially in sharing the essential information and taking action (knowledge) in producing sophisticated and contextual technologies.

4.2.3.1.2.3 Appreciative Inquiry. The simple diagram below refers to the positive recognition and reinforcement received when sharing and expanding knowledge from the gurus to the innovators and understudies.

Figure 4.11

The Diagram of Knowledge Diffusion.



There were certain gurus called forefathers (first handlers of technologies) who, upon seeing and appreciating the potentials of the aspirant innovators (who were called Research Assistants (RAs), conscientiously mentored them (see 4.2.1.2.1.1). It means the forefathers meticulously guided the rising innovators in product development. Hence, knowledge was passed on to them, emerging from the historical background of the technology (see 4.2.1.2.1.1). Thus, the young innovators were grateful to their forefathers (see 4.3.1.3.2). If not for the forefathers' self-effacing attitude, innovators would have difficulty starting anew. There is the highest degree of knowledge sharing among members of the group.

Being appreciative of the forefathers for sharing the information caused a ripple effect, meaning that the new breed of innovators is mentoring the young Research Assistants. As Innovator C described: *I value those who did mentor me, and I thank everyone there for being at least a collegian follower. For this reason, it is also my responsibility to mentor my associates in the same way that I was mentored.* Furthermore, according to Bennet and Bennet (2008), information results from association articulated by sets of patterns or any non-random pattern. Data (a form of information) is simple patterns, and data and information are both patterns and will only have meaning when an organism starts to recognize and interpret the patterns [to form new products]. Through the mentoring of the forefathers and the subsequent mentoring of the understudies by the innovators, there were various vital formed patterns and considered were the essential ones.

4.2.3.1.3 Viability Analysis. This stage allows the team leader to re-kindle the members' attention to be in full swing on knowledge sharing and affirm those

involved in the product development of their contribution. Findings confirmed that innovators are willing to help when needed in most cases. It is because there is mutual trust between and among the team members. This mutual trust establishes a positive attitude about participating in EKS. The innovators know that their colleagues will not negatively take advantage of their knowledge since the end-users' welfare is their topmost priority. Most innovators want their colleagues to know—and be able to apply—the best practices and thus provide the best help for the beneficiaries of technologies. The most interesting point here is that while end-users' welfare is their concern and motivates them to participate in KS, sometimes the innovators do not wait for calamities. They plan, and before these natural calamities attack, they can foresee (see 4.2.3.1.3.1) the situation. It is, of course, mainly because they constantly share and exchange information backed up by scientific research (see 4.2.3.2.3.1). Hence, they initially create a technology before it is critically needed.

This concept gives birth to the idea that as information is applied, knowledge enables creativity, and creativity enables innovation. Whatever is thought of as known [knowledge] and combined with a need or desire that something new emerges [creation], and when that something novel is produced and utilized by the market and impacts lives, it is considered [innovation]. Similarly, Hunter (2013) viewed innovation as applying something created that has realized value or significance to others. Given the literature review for this study, the following terms are affirmed: Information is the key to knowledge, and knowledge opens creative ideas, products, or processes. It serves as the backbone of creativity for potential and promising innovation output.

4.2.3.1.3.1 Foresight. It refers to the ability to look beyond and become proactive in knowledge sharing to curate and design relevant product innovations to address the community's needs. Findings revealed that innovators are copiously aware of existing and potentially social issues. These innovators look beyond voiced issues and become proactive; instead of grumbling over issues, they broaden their imagination and conduct extensive relevant research (see 4.2.3.2.3.1)., which supports applying the basic knowledge and expanding on that knowledge (see 4.2.3.2). In addition, innovators do scenario building when sharing knowledge in designing the technology in anticipation of its positive outcome. Based on an article released by Durham University Business School (1997), scenario building is a common theme in foresight. Scenarios move foresight beyond guidance into proactive consideration of desired futures, considering preferable (what you want to happen), probable (what will most likely happen), plausible (what could happen), all based on current knowledge, and possible (what might happen), based on future knowledge (Bennet et al., 2020). Scenarios can be considered pictures (mental representations) of future situations designed to help organizations make better decisions in the present. These innovators use scenarios to interpret knowledge fully and build patterns used in designing potential technology that will address social issues and positively affect the end-users through innovation, bringing the possible into the probable. As Innovator G forwards: *As a team, we do scenario building. For example, if there is no current, then there is no electric pump to circulate water to the plants, and they will die. Poor farmers with no income yet still short-changed. So, why don't we design affordable hydroponics wherein we can still plant even if there are no lands to till. Instead of*

using high-end materials, we use low-end materials like this one. Instead of upgrading, we opted for de-grading, meaning that instead of using an electric pump to operate the technology, we use the natural way of providing water to the plants; we use a hose instead. In that way, we help mitigate climate change. We lessen the cost of the materials, yet it has the same function and use. Innovator E says: *Innovative individuals should be futuristic. You should have the foresight to build what people or the community need so that the research and the technology you have developed are relevant.*

The skill of foresight is seen as a significant and relevant factor for EKS toward successful innovation, as confirmed by the technology transfer officer of UPLB during an interview to validate the data gathered. Innovators do not wait for the reverberation of manufactured and natural disasters before they create technologies. Even before these calamities enter the Philippine area of responsibility (PAR), innovators are already sharing knowledge, working, and developing product innovations so that when calamities do hit the Philippines, there are ready technologies to revive and sustain economic growth. The foresight exhibited by the innovators is consistent with Slaughter's (1995) description of foresight as an attribute or competence and, specifically, as a process that attempts to broaden the boundaries of perception and widen the scope of orientation. Innovators' foresight serves as their compass for a better direction and their ability to recognize the upheavals of the effect of man's relationship with the natural habitat and, as described by Innovator H, that we need to take care of our environment in the same way that we want to eat organic

foods to survive and to be healthy (see 4.2.1.1.1.1). Hereafter, forming advocacy of pro-environment and how to take charge of the vastness of nature's blessings.

Major et al. (2001) argues that foresight has mainly developed in isolation from the extensive literature on business strategy. In agreement, this study discovered that foresight is a gift to a few who have the heart to look into the potential pitfalls of the synergetic relationship between man and nature. The innovators were deeply engaged in discernment such that what they perceived as solutions to recurring problems would work out. Here are excerpts of responses from the innovators. Regarding the hydroponics example of Innovator G, he says: *An invention may be invented in other countries, but then can be an innovation. For instance, my hydroponics. Today the level is from high-end, which means to level up. But instead of leveling up, I opted to downgrade. It means I do not use a high-powered pump so that we will not be dependent on using current. In a way, we lessen the use of fuel that harms our climate. We are using those Styrofoam boxes, as you can see* [pointing to the hydroponics]. *It is economical, affordable even to ordinary people, and organic because there are no chemicals added to it.* As Innovator E sums up: *It is like this. We already know of an existing problem. We need to do something in response to it.*

Building on the definition above and considering findings from the researcher's observations and innovator interviews, *foresight*, as stated above, *is defined in this study as the ability to look beyond and become proactive in knowledge sharing in order to curate and design relevant product innovations to address needs of the community. The thing with us scientists-innovators is that we are responsible for society and the people. We cannot fool people around; many people,*

especially the less fortunate, will starve! So, we need small and careful steps… [therefore]. Instead of waiting for instructions from the higher up, we see beyond, and from there, we share and exchange relevant information before producing significant products.

Lastly, innovators were moved by their mantra; it *is not a question of how technology can be done but how it can be created and utilized by the end-users. Thus, knowledge sharing is a potent tool to start the journey.*

4.2.3.1.3.2 Feedback. It refers to the ability to clarify and point out missed things.

Feedback is a crucial tool to ensure the documented or decoded knowledge is shared (see 4.3.1.2.2). Innovator B shares: *"I always remind my colleagues to clarify things when in doubt because that is very crucial to the development of the product."*

In this case study, feedback from the members and end-users is vital to sharing knowledge. Innovator E said: *I listen attentively to the feedback from my teammates because that is where I get o to refine my technology. Yeah, more importantly to the feedback of the people. After all, they are the best persons to refine the imperfections of our products.*

Feedback usefulness is one factor associated with the feedback provided by each one that adds value to the knowledge-sharing aspect of the innovation process. For instance, factors such as feedback usefulness are an important aspect of the review process that initiates the process of knowledge sharing. In BIOTECH, knowledge sharing is an essential benefit for both innovators and end-users. This

research acknowledges that innovators and end-users share knowledge in insightful, constructive, and formative feedback.

4.2.3.1.3.3 Multiple Administrative Tasks. It refers to the increased workload that delays their duties to create technologies. Knowledge sharing is undoubtedly a fluid process at Biotech because the innovators' requirements are available and accessible. In addition, there are good training sessions that they can attend and participate in. There are appropriate training sessions available within their domain wherever innovators and other team members need training for a specific task or skill; however, when it comes to face-to-face communications, the challenge is that everybody is busy. It means that innovators have an increased workload, and sometimes they do not have enough time to allocate for KS. Interviews confirmed that in these situations, innovators postpone the sharing of knowledge. As Innovator C says, *"All the capacity is there; I think all the mechanisms are there. We need more people to do the KS more efficiently."*

It does not mean that KS is not implemented, but it does mean that the implementation stage occurs with delay. From the interviews, it was evident that increased workload slows down KS. It can cause delays in receiving the experience-based knowledge quickly: *It is more related to workload; it is not like they do not want to share their knowledge. I do not think they do not want to talk about it; it is just the working load that slows down the process* (Innovator C).

As voiced by the innovators, multiple administrative tasks are considered a block to KS. Nonetheless, though there are multifarious daily tasks, they take this as a challenge in carrying out their responsibilities and commitment to the people.

Innovator D enthusiastically shares: "*We cannot avoid and escape the various tasks here in the university. Though we have lots of things to do—and this does keep us from sharing—these are not the reasons for us not to share the information and knowledge."* In addition, activities at the university are not a hindrance to their desire to join KS. As Innovator C shares: *This was my commitment long before—when I was doing my doctorate abroad—I dream of sharing and creating products for my compatriots. So, any other activities that I do at the university are not a hindrance to my passion because I think of the welfare of my fellow citizens from a national and global perspective*.

Administrative tasks are responsibilities and duties attached to one's terms of reference (ToR) within a certain period, wherein innovators have no exemption from these multiple accountabilities. Aside from being a researcher (see 4.2.3.2.3.1), innovators perform all the peculiar tasks from writing a budget proposal, the tedious of looking for funding**,** to Procurement, to fieldwork, up until the submission of technical reports, which have been attested by the Technology Transfer Officer 3. As she says: *What I noticed as a problem in UPLB, is they are the ones experimenting. They are the ones overseeing the funding. Ah, they are the researchers who are at the same time doing the administration. For example, the research assistants are working on papers. And besides, it's a bit chaotic. I am not sure because I have never been part of the research team yet. And that is what also the funding agency has noticed. Usually, we have products like projects that need funding, for example, PCAARRD of DOST. So, there must be someone who monitors their budget. Our researchers also do admin at the same time. That became our concern; I mean, I cannot speak on*

behalf of everyone, but that is what I have noticed. Sometimes Procurement is a bit late because budget monitoring is slow. After all, our researchers have lots of things to do. As I have said earlier, they are the ones conducting the experiments; then they do admin work. Based on my observations from different universities, if you are a researcher, you are just a researcher. I mean, you can focus on your work as a researcher. You do not have other duties that are more administrative in general. It is not only about budget, monitoring the Procurement, but even internal activities in the university like getting signatories. That is one thing that makes it slow in terms of progress. Yes. So, in general, more on administrative policies or university policies. Yes, that is right. It is proper that there should be a designated admin so that, as I have earlier said, the researchers can focus on the development of the technology ... we can recommend that they would be free from administrative tasks.

The current role required of these researchers is unlike that of other universities, where if an individual is designated as a researcher, he or she performs the tasks of being a researcher with minimal other duties so that he or she can focus. In addition, the faculty researcher is more favored than the full-time researcher when it comes to funding.

Innovators look for their funding agency at the early stage of technology development (see 4.1.1.2.2). Along the way, innovators encounter difficult moments in this endeavor. But it has been emphasized that the Biotech is supportive in this challenging time. As Innovator F says: *The institution is supportive. What is not supportive at times is the funding agency* [laughs]. *Yes, like, for instance, when I was starting with that project. I was given money. My proposal is good for two years to*

improve on the process. To scale up the product, however, after a year, the DOST secretary then said, "We do not have milk; why would you still improve it? Why do you have to do that; why do we provide funding for that?" That is what I have heard on the news. I felt bad because here I was, working on something that had a good result, then suddenly, you were asked to stop. So that is it.

At times funding agencies would not want basic research, meaning they want to research with a tangible product because they want to own the finished product because of ownership, with which the innovators would disagree. As Innovator E says: *Because funding agencies like to have a product, when we propose, at the same time, we think of a product that we can do out of that research. So, that is how we do it. But at the start, it is fundamental research. Many get near Biotech as if to fish out information* [laughs]. *They say they need a proposal, so we made an accurate proposal, and there is no need to put in the details. Until now, the staff of San Miguel did not come back anymore. Yes, in private talking about protection, but then they do not like it. Of course, they want ownership to be theirs, but I do not know-how.*

Innovators are also responsible for monitoring their budget, and, as noted previously, at times, this causes delays in KS due to the timing around the funding agency's release of funds because of the preparation of required paperwork, which the researchers-innovators do themselves manually, and is further slowed down by the system of bureaucracy. As Innovator A says: *We have submitted it already to the funding agency. Then we need to make a follow-up. Since we cannot make that idea if there is no funding, first, we make an effort in funding. After that, of course, if there is already funding, then that is the time you can test your hypothesis to see if your ideas*

are correct. Of course, that had happened. We did test, and then, yeah! Innovator shares H: *Being lazy is not allowed. At times, they are contractual* [referring to the research assistants]. *I cannot ask them to do errands. That is what makes me at times; for example, they do not have a six-month salary. How would you ask them to do errands? It is good if I am rich so that I can give always. I have to shell out first. Although there is funding, the process is quite long because of the bureaucracy. It is already there; the money has been released for the contract, then many will have to sign, and then their appointment won't go down immediately. And once the appointment is available, you have to make a voucher. So, it takes six months that they will not have a salary.* Innovator C says: *There is lots of bureaucracy that sometimes delays the process of projects.*

And when the funding is available, another hurdle awaits, the procurement process vis-à-vis bidding procedure, since this is a state university where most of the funds come from government agencies. According to one innovator, at times, there is the possibility of getting no results just because they could not purchase materials. Some projects die naturally because, within a year, there are still no chemicals to use. As Innovator B shares: *So, the first year, you know Procurement, the government. It takes a while to start. So, I think that is one of the dilemmas of the researchers. Procurement?* [laughs] *Procurement means funding. But as I have said earlier to you, yes, I mentioned it already* [laughs]*, it is possible that you will not have a result just because you could not buy the materials. Some projects die naturally because they do not have chemicals for almost a year. Yes. My advantage is, before, I think I have shared with you earlier, I joined animal science, and my item at the start, I was a*

contractual researcher, so, not for bragging, I was exposed to the procurement process because it is part of TOR, but then Procurement is tedious because technical specifications are very detailed. It is pretty slow because it keeps coming back and forth. And, as Innovator H continues: *Then, for example, in purchasing our materials here, though the fund is already there, there is bidding because of the procurement process. Yes, sometimes that is a problem here in our government. Unlike in the private sector, they can buy right away what they need. For us, it cannot be. We have to count for months before we can get the resources, the chemicals, or the materials we like. Then, since it is government, you have to get the lowest price. Yes ... Bidding. At times, that is not good. In research, the materials you use are always of the best quality. But when it comes to bidding, no* [laughs]. *At the start, we are doing it a certain way so that we can buy the materials we want. Anyway, there is a way because they teach us how. But then, sometimes, the remedy that we do, for example, with branding, is not allowed; we cannot specify a brand. For example, we want sigma chemicals; we want sigma.*

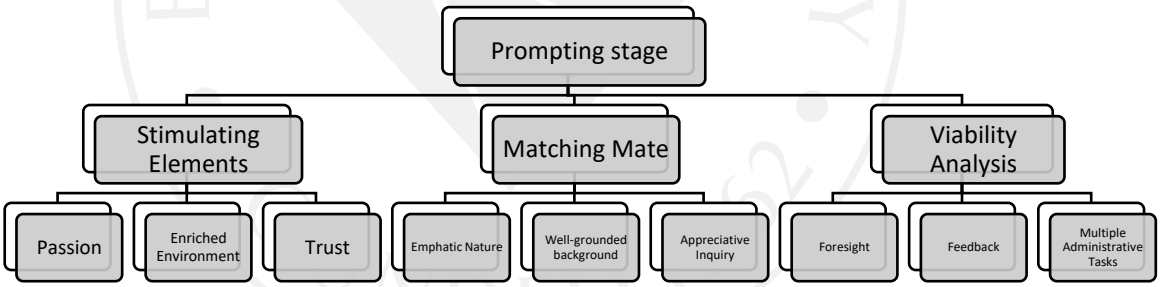
There are lots of competitors of sigma coming from India. They come from poor quality chemicals, so the purity is low. So, what do we do? We copy the label of sigma. Sometimes we say 99% purity, blah blah blah blah…like that. But still, there are some things that we cannot specify: sigma, which is the only thing that is not permissible. But then, the specs that are present in sigma, we copy. Sometimes this weak chemical or chemical company, we do not know how they go about it. So, when it comes to bidding, we get the same. There are cases like that. And Innovator A shares: *Funding of a project is one of our difficulties because of the procurement law,*

but then it is an excellent factor in the development and best results of the technology.

From the above discussion, it is clear that although some issues slow down the process of KS, the prompting stage is completed, and KS enters the requisite stage. The identified barriers are not perceived as a significant stumbling block to initiating the KS since innovators are committed to their mission of sharing and creating. Figure 4.12 below shows the prompting stage in KSP.

Figure 4.12

The Prompting Stage in KSP.



4.2.3.2 Expending Stage. The experience of knowledge sharing takes place at this stage, which consists of four stages: Knowledge Ground, Knowledge Transmission, Knowledge Exposition, and Knowledge Absorption, each of which has sub- stages. First, the team meets and discusses and agrees on the technology to work

on. After identifying the technology, the leader [servant leader] situates the members and gets the full approval to participate in the process. This task is challenging because they have to work within a timeframe. Taking part in knowledge sharing entails time, passion, effort, and commitment which the innovators embody. Batten (1998) explicitly describes servant leadership as a passion for serving. Such approaches to servant-leadership unswervingly inspire intense action, a sense of urgency and commitment (Lad & Luechauer, 1998, p. 60), and service, which is one of the features of servant leadership because the word "servant" is related to "service" (Asamoah, 2018, p. 107).

As Innovator C says, *"Even if I am busy in other functions, I have to deliberately involve myself through socialization because expertise is needed, and I need to share the knowledge with my colleagues.* Innovator B shared when she was still a RA: *I am even more than willing to go for an apprenticeship to capture the right knowledge to code and then decode. I do not hesitate to ask if I am not sure of what I am doing because I believe in my leaders, whom we consider servant leaders."*

In short, the expending stage is the last stage of the KSP. KSP is realized when innovators start using their experiential knowledge and check whether or not a satisfactory result is achieved. Knowledge captured and shared is rehearsed, offering innovators the opportunity to affirm their tacit and explicit knowledge to produce the desired product. When knowledge and information are adequately handled, optimized, and shared within and among knowledgeable individuals from top to bottom management levels, whether individual or group knowledge, maximized to the fullest, we are on our way to innovation. Some factors in achieving successful knowledge

sharing towards fruitful innovation are as follows: structural information and knowledge through creativity and skills; vast experiences and aptitude; and metacognitive and decision-making skills. In other words, they combine both types of knowledge before assuming the daunting task of producing incremental or radical innovation. At this point, the innovators go out of their way and test the technology with the community. Hence, product innovation is firmed up to ensure the optimization of knowledge to advance the utility of technology (see 4.3.1.2.1**),** thus, addressing the needs of society.

4.2.3.2.1 Knowledge Ground. The knowledge sources [forefathers] prepare the required experiential knowledge at this stage. The findings revealed that forefathers, bearing the entire technology background, unceasingly shared the information with the innovators. Indigenous knowledge is traced back from the first handlers of the technology, with the forefather orienting the innovator on the processes of creating the product. As Innovator G said, "*Before our forefathers retire, they see that we are ready and prepared to take on the challenge to carry on their advocacy. That is why they were hands-on in sharing the knowledge with us."* It is noteworthy that information comes directly to the proponents of the technology. She learned every step of the way from her forefather and has improved the technology, added features and commercialized it. Mykovam is a soil-based biological fertilizer with beneficial Mycorrhizal fungi active ingredients called Arbuscular Mycorrhizal Fungi (AMF), comprised of 12 species collected from stressed environmental conditions. Mykovam is very effective in improving plant growth and increasing the yield and survival of several agricultural and fruit crops and forest trees. It can also

increase plant tolerance against root pathogens (Aggangan et al., 2013). To date, Mykovam is used nationwide and across Asia. Under the knowledge ground is a constant search for knowledge.

4.2.3.2.1.1 Constant Search for Knowledge. It refers to the continuous exploration of traditional and scientific knowledge in creating remarkable technology. A very thought-provoking result of the study is the love for research, as discussed in 4.2.3.2.3.1.

What is striking in the participants' enthusiasm to conduct research is that it is not simply for science and arts per se but, as introduced earlier, for the wise use of the best of science and arts for nation-building. Innovator C continues to say: *We have been capitalizing on this nationalistic outlook through research as we strive towards distinctive excellence, which enables us to know our place in the global arena.* An example of accomplished research is 'Selection of Banana Cultivars with Tolerance to Strong Winds Damage in the Philippines', which became unbeatable technology.

Innovators are, first and foremost, research-oriented. Inherently, they were born to do research. As Innovator F says: *I started here. I did research right after graduation. I was hired as a research assistant. Because it's micro ... what I did is like wine. Then, my next boss, because before it was project-based, was the one who built up my research skills by engaging me in the research process.* Connecting research to the people, Innovator G says: *Some researches cannot be converted into technology like you wanted to know the effect, but they do not do anything. Not in our case. There must be something that people will use.*

In addition, as observed by the PDO-TTBDO 3, innovators even started their projects while they were still students in the graduate school through their theses. When hired in the university, they continuously work on it. That is why the TTBDO checks on each thesis so that when it has potential for intellectual property for innovation, individuals are advised to continue with it. PDO-TTBDO 3 shares: *The others, of course, also started as students. Then, they work on their theses ... That is why we start by checking on the graduate student's thesis to see if there is potential for intellectual property for innovation if ever, he or she can continue working on the project.*

Their research outputs are not like precious jewels placed in an exceptional box and used occasionally. In the respondents' case, research is targeted to bring output to the market and not just ornaments displayed on museums or shelves. Innovator H's words represent what most of the interviewees concluded: *We see that our technologies are out in the market and are utilized. But, most of the time, we are the ones bringing them to the people because we need to teach them how to use the technology.* Innovator D shared her passion by saying: *Yes, I was the one who personally brought my technology to the farmers, and I taught them how to use it in different kinds of soil.*

When indigenous or traditional knowledge is passed on to these innovators, they conduct scientific [where research is applied as explicated in the subsequent discussion] revision to back up the previous findings, and interpretation and utilization of data are conducted phase by phase because they still have to test the technology with the end-users until the technology works! As Innovator G

continues: *Then I asked myself if I could use creative materials. I have tried it. Instead of using high-end materials, I am using low-end materials so that the farmers can afford them. That is why I searched and searched until I could improve this technology.*

Significant findings reveal that feedback from the team members and the end-users is equally important in the constant search for knowledge because this is where ideas are enhanced and created, expanded, converted into action, and turned into a product (4.2.3.1.3.2). It takes almost 2-3 years before the technology is finally launched. As Innovator D says: *I tested first the biofertilizers together with the farmers, then we saw the effect of it on the plants. Others lived, the others' nganga'* [laughs]*, what I mean is, the other plants died. As a team, we talked and debated* [laughs] *... There you go, they realized that there is a certain amount of using the biofertilizer.*

Based on the identified needs and armed with their research skills (see 4.2.3.2.3.1), data are systematically collected, scientifically interpreted, and analyzed before producing the right technologies. They are not an overnight cooked meal; instead, their innovations result from careful planning, deliberately developed to ensure cost-effective and efficient products. Product innovation development involves a team or group of committed (see 4.2.1.3.1.2) and passionate (see 4.2.3.1.1.1) individuals like in the case of the current study. It is composed of committed and zealous individuals whose ultimate aim is to serve the marginalized in society.

Constantly searching for knowledge is vital because this is where ideas are built and created, expanded, converted into action, and turned into a product (see

4.2.3.2.1.1). To expand and triangulate the inherited knowledge, innovators conduct scientific revision and interpretation of data. Prior to bringing the innovation products out to the market, innovators collaborate with the end-users to acquire and incorporate feedback that enhances innovation. With this preparation, innovators redefine routines that facilitate the transfer and combination of knowledge existence, called transformation, according to Zahra and George (2002).

Innovators use these fractions of knowledge creation to produce technology. It is consistent with the work of Susen and Turner (2011) and García-Goñi et al. (2007), who argue that innovation depends mainly on the professionals who can create and apply new ideas and knowledge in daily work. Such emphasis on skills and innovation is reflected by several efforts to bridge and narrow the current skills and productivity gap (Audretsch et al., 2012; Nakamura et al., 2010).

Hence, there is a strong manifestation of *a constant search for knowledge* (indigenous or traditional and scientific knowledge)**.** It *refers to the continuous exploration of traditional and academic knowledge in creating remarkable technology.* Scientists-innovators collaborate with the end-users to be able to enhance further or even scale up the technology. They do not lose hope in improving the technology until they get the desired product. They get the feedback from the end-users (whoever that is) and incorporate it before bringing the products to the market. In particular, Innovator F shares: *In the meantime, I wanted to prove my production could be scaled up. With the tiny amount of money given, finally, I was able to produce plenty.*

4.2.3.2.2 Knowledge Transmission. At this point, knowledge is transferred via face-to-face communications or training. Innovators are humbled and elated in this process of KS because if they encounter any problem or do not understand something and need clarifications, they have the opportunity to raise them in the team and make sure nothing is missing. Thus, there is accuracy in transferring reliable knowledge.

Another factor that seems to work in this stage is to speak up one's mind. Innovators are notably conversationalists, not to undermine their inputs and sharing. One innovator describes herself as shy, but her acquaintances do not see her as such. She says that one thing that she needed to learn was how to speak up. So, she learned it, and it is one of the skills that helped her a lot. If she does not speak up, nothing will happen; she will not be able to express her thoughts and deliver the knowledge expected of her. In addition, she says she will not be able to leverage the technology she wishes to develop and make a good negotiation for funding if she does not speak. She wishes that many more researchers would be encouraged to speak up. As Innovator B shares: *I considered myself shy, but those who know me said I am not shy. But then I felt I was shy but had to learn to speak up. Speaking skills. Public. Because it seems I have developed it anyway. Yes. So, I learned it. And it helped me a lot to express what I want about my technology and to negotiate with funding agencies. I hope many will be encouraged to speak up. I have realized that this is very important so that we can be understood well and that knowledge transfer becomes easy and manageable.*

In addition, innovators formed a community where they could continuously gather and exchange and share their knowledge to enhance their understanding of the technology, similar to what Wenger et al. (2002) call a community of practice.

4.2.3.2.2.1 Community of Practice. It refers to innovators who share a concern or a passion for creating technologies and learn how to do it better as they interact regularly. Wenger et al. (2002) define communities of practice as groups of people who share a concern or passion for something they do and where learning begins with individuals and then spreads through teams (Lane et al., 2006). In knowledge sharing, innovators make it a point that they frequently meet in their created space to intermingle and relate. They share their newfound learning and existing knowledge among the group. One thing that they have in common is passion. Passion is considered those desires, behaviors, and thoughts that suggest urge with considerable force (Bennet & Scott, 2019). The innovator's passion for their projects drives them to get involved in sharing knowledge. No one is superior to the other; they treat each one equally, and each has something to contribute and share.

The concept of a CoP has been adopted most readily by people in business because of the recognition that there is a need to manage knowledge strategically since it is a critical asset in KSP. Communities of practice provide an approach that focuses on people and the social structures that enable them to learn with and from each other Wenger et al. (2002). In Biotech, it is the team's foremost responsibility to manage its knowledge and know exactly when and how to share it among team members. In cases where innovators need deeper clarification on the knowledge shared, they seek the assistance of experts to validate their understanding of the

information. As Innovator E says, *"I do not hesitate to ask experts if I am not too sure of the information at hand. Our task is daunting. Therefore, I need someone to validate things for me."*

Moreover, Innovator G added, *"I am glad we have this great community where we can discuss our thoughts and ideas without hesitation. It is fulfilling when the information shared is validated. You see, we are dealing with technologies that will sustain many lives. That is why we cannot afford to delay our projects. And with the* assistance *of [other] experts, we can accomplish our task on time.*

There is intense open communication to share the necessary knowledge among the team. Innovators spend much time communicating with their teams. Part of this communication includes listening closely to those around them and humbly remaining receptive to others' ideas, considering all ideas as they make crucial decisions. They have to ponder the transferred knowledge before putting premium interpretation to it. Thus, they do this to collect the necessary experiential knowledge required to produce the product. As Innovator F says: *Most of the time, I need to stop what I am doing to listen attentively to the instructions or sharing of our forefathers. Otherwise, I may not be able to capture the indigenous knowledge shared with us well. And this is an excellent opportunity to listen to gurus of technology, the first handlers of the technology.*

4.2.3.2.3 Knowledge Exposition. At this stage, the innovators absorb and filter the professional knowledge passed on to them, meaning that innovators remove the barriers to the shared knowledge to obtain the valuable part. Information that appears not related to the product development is set aside. Moreover, this assessment is done

scientifically through their research skills (see 4.2.3.2.3.1); hence, knowledge is consistent with scientific bases. Pragmatically speaking, innovators are all engaged in research capabilities.

4.2.3.2.3.1 Research Skills. It refers to converting traditional knowledge into scientific knowledge to create sustainable product innovation. The study revealed that research substantiates the knowledge acquired by the innovators, which is the tipping point to successful innovation, and the innovators unanimously agree (all 8 out of 8) that technology development starts with simple research. Therefore, in all areas of undertakings in biotechnology, research and development (R&D) is the primary step towards successful activities knowledge sharing, including innovation.

University is both a research and development laboratory and a mechanism through which the nation builds its human capital to enable it to actively participate in the global economy (Angeles, 2017). Moreover, Etzkowitz and Zhou (2017) say that recently the university has increasingly become involved in the formation of firms, often based on new technologies originating in academic research. It is quite faithful to the finding of the study.

Based on the one-on-one interview in terms of its innovation scheme and a bridge towards a brighter future, as forwarded in its vision statement: "UPLB, a great university, taking a leadership role in developing a globally competitive Philippines. Driven by academic excellence and operational excellence; strong research and creative capability, supported by an expanded graduate program and geared to addressing the country's problems" (see 2.8.2.1). Research serves as a doorway for substantial product innovation. All the innovators interviewed (A through H) are

researchers themselves. For example, as Innovator C said, each *of us is focused on our respective research because we have an item as a university researcher.* As Innovator E further details: *Because the funding agencies like that there is a product when we propose, we also think of a product that we can do out of our research, but basically, it all starts with research.* From another viewpoint, Innovator B says: *Hmmm … maybe the new thing that I brought here is they have seen a researcher can be very indeed productive. As a researcher, technically, I am equipped.*

Research is a formal part of the UPLB educative community. In an interview, the University Extension Research Specialist II unit explained: *We have a structured research organizational chart headed by our Vice Chancellor for Research, who talked a while ago at the conference room where you have been. He was the one who told me to let you attend the assembly earlier. We had visitors from another university who wanted to benchmark in our research unit. Yes, they were also the ones who were in the conference room. We encouraged all to do research and collaborative research during our annual research capacity building, which is reflected in what we call the Individual Performance Commitment and Review. Every faculty and staff member has one, each guided by their output for the year. One of the* [elements] *is doing research. Our scientists have this item as a researcher, which is why they are required to conduct, need to do, research in order for them to make a technology. But then, the full-time faculty and you* [as a Ph.D. student] *like to do research, so you will be given non-teaching to reduce your time for teaching to do your research. Oh, yes, you will still teach as long as you put in the IPCR your accomplishments.*

In other words, there is a structured organizational chart of the research center, which the Vice Chancellor for Research governs. Research capacity building is conducted annually to ensure and imbibe a culture of research among all community members. All faculty and staff members are encouraged to do collaborative research during the program planning since this is also part of their IPCR. Their IPCR guides their output for the year. The resident scientists must research since their item is university researcher, and they need to engage in research to develop the technology. For full-time faculty who want to do research, he or she is given a non-teaching (NT) load to lessen his or her teaching hours to be able to finish the research.

The thrust is interdisciplinary research, which means that all experts are involved in the team and collaborate with different colleges and units through their created two spaces, physical and virtual. The physical space is an office space (cubicle type), a technology incubator building, and conference training rooms where they exchange views and opinions and share their best practices. The virtual space is where different university units work together, communicating through the use of information communication technology (ICT). Hence, the office runs even without the presence of warm bodies. As the University Extension Research Specialist II continues, *there is coordination among colleges or institutes in conducting research. For example, the College of Animal Science coordinated or collaborated with the Institute of Plant Breeding, meaning each department expert is helping to enhance the research output. There is an office, a style cubicle where the research assistants stay most of the time, anyone as long you are doing research. There is the technology incubator building (repository for the technology until it reaches the end-users and a*

conference room where we hold training, with the exchange of views or opinions, not only the scientist-research assistants but all those who are doing research. Furthermore, we have what we call virtual space, where every university unit is working together using information communication technology.

In every research proposal there is a project leader in which the innovators assume being the leader of the group or the team and exhibit teamwork (see 4.1.1.2.3) since it is the first step to successful product innovation. Extension Research Specialist II continues to say: *While leading the team in conducting the research, there is an exercise of a mentor-mentee relationship, as experienced with their forefathers*, *meaning the tenured researcher guides and assists young and neophyte members (otherwise called the Research Assistants or termed as RA who are understudy) on the rigors and intricacies of conducting research.* Hence, teamwork (see 4.1.1.2.3) is highly evident where more profound ideas and knowledge (traditional knowledge which is mainly passed on by the forefathers [see 4.1.1.3.1]) are built, enhanced, and shared within and among the group. As previously noted, traditional knowledge is knowledge directly coming from their forefathers through simulation, direct experience and actual observation, and which are not written in books or manuals. Drawing further from the University Extension Research Specialist II: *This is where ideas and knowledge are intensively built. We have tenured researchers, and they mentor the neophyte members.* And Innovator G says: *While I am observing or watching what the forefathers are doing, I am learning.*

In addition, the forefathers stirred the passion for research. A legacy that is at the heart of understanding the vital importance of research about the technology. They

underwent a rigorous process of research. Innovator H: *Before we can produce technology, we have undergone … hmmm…rigorous research to* produce technologies that must result from the community's needs based on a needs assessment and interpret with hardcore facts supported by scientific explanations. By doing so, innovators, through their product innovations, boost the economic growth of the society and enhance the lifestyle of the farmers. As Innovator G says: Ah hmmm … *Yes. The culture of research, especially here in the Los Banos campus, that is why, and then our forefathers who kept on, you know, reminding us. It started like that, doing research was inculcated within us, and doing something that will help the community. It was like that even before we came. That is why our research must impact the community through our technology. I started with a low rank until it went up, just like that.* Innovator H says "that *we have to undergo rigorous research before producing technology.*

As an example of the value of research, a respondent whose parents are farmers had observed that farming is seasonal and thus the difficulty of maintaining it with a low return of investment. She felt sad and disappointed about these circumstances. So, she developed a program and taught about how to do farming amidst differing types of weather and still yield excellent results. As she mentioned in the previous discussion, she comes from a family of farmers, and she saw herself in the hardships these farmers experience. Furthermore, she established a technology that they have tried, and it works and is successful. As Innovator D recalls, the existing technology was started by a senior colleague, and during her prime years at the university she was exposed to it. Since the first initiator of the technology has

already retired (and is now called a forefather), Innovator D has revived (with improvements) the product called Mykovam. Mykovam is a soil-based biofertilizer for fruit trees, crops, reforestation species and ornamentals. This example of technology clearly explains the idea of incremental innovation, where existing technology is enhanced and improved and, when launched into the market, creates comparable works to farmers and yields good outcomes. This product is currently widely used nationwide. With this remarkable product on the market, the institution achieved both national and international recognition along with the innovator.

Research outputs are commendably incentivized and encouraged for publication. Innovator E shares: *We are pushed to publish. Outputs that are published are given incentives. But then we are looking into it first because they said if once published, it can no longer be patented. I don't know* [laughs]. Innovator H says: *good thing, when you publish, you get incentives.*

Furthermore, innovators pointed out that younger faculty and researchers are provided with impressive opportunities to get advanced degrees and hone their expertise. Innovator B says: *Even if I am the youngest scientist, I am given opportunities to take up my Ph.D. I am sent to various training. I feel grateful because I like very much to attend training.* Moreover, the robust research culture in UPLB is boosted with a good incentive and reward system that encourages not only strong disciplinal research pursuits but also inter-disciplinal and trans-disciplinal undertakings connected to food production, which is being advocated by the chancellor (see 2.10.1.1.1.1). As Innovator G describes: *Our institute, the Institute of Plant Breeding, prioritizes research that is more on the breeding aspect. Since our laboratory here is into*

physiology, most of our work supports the research of plant breeders to develop new varieties of seeds. Yes, it is still connected to food production, which the chancellor advocates. Yes, that is why, aside from our discipline, we cross over to other disciplines.

In other words, innovators disclosed that research embodies their existence as an institution. For them, research is a way of life. For example, here is an excerpt from Innovator H: *It is already part of our system, our life, to research so that we could produce technologies that bring goodness and lighten the lives of the people because that is our mandate as scientists-innovators, and it is also the mission of the university.* As Innovator E says: *That is how I see it because it seems though the university aims to become a graduate research university. So, then the component of research is to come up with knowledge to make a product, which is what the university likes.* Innovator B says: *My position is University Researcher 1, and what I like about it is I have 100% research. It means I am a full-time researcher. So, my work is 100% research instead of faculty who has full-time instruction.*

From these observations and the interviews, it is evident that research is the university's lifeblood, a gateway to innovation. All the innovators used these words at some point in their interviews: *Research is the university's lifeblood.* The Vice Chancellor for Research also affirmed this statement. As he shared: *The concept of doing something different is the result of in-depth research. That is why as students, they are fully immersed in research so that when they are already in the field, they become experts.* In other words, the concept of innovation in UPLB springs from research, which is an essential source of competitive advantage for the organization's

success. These findings are supported by Roper & Love (2002) and Geroski (1995) that innovation is acknowledged as a key factor of a firm's success and provides long-term growth in coping with the demands of the changing time.

A published article by the European Commission (2014) states that research and innovation improve Europe's competitiveness, boost growth, and create jobs. At the same time, innovation helps make people's lives better by improving healthcare, transport, and digital services and by offering countless new products and services. True enough, the remarkable technologies produced by the interviewed innovators improve the lives of every farmer and reach out to future farmers nationwide to revive the usefulness of barren lands and seas. This vision, lived by these innovators, is a vision that any developing country—including the Philippines and its concerned citizens—dreams of.

Describing research in a general context, which could be applied to multiple disciplines, American sociologist Earl Robert Babbie (2010) says research is a systematic inquiry to describe, explain, predict and control the observed phenomenon. However, the interview findings reveal that the research in this study is unique because it is more than the conceptual definitions given by previous researches. Instead, it is about analyzing, utilizing, and maximizing the systematic collection of information that is either timeworn or combined with the latest learnings such that it becomes helpful in the community.

4.2.3.2.4 Knowledge Absorption. At this stage, the innovators integrate the valuable part of experiential knowledge into their existing knowledge and apply it to fulfill their responsibility of creating innovation products. Knowledge is already free

from unnecessary points in this stage, focusing on their specific product. Hence, they can now utilize the knowledge to craft the technology. Moreover, since they are hands-on with the knowledge-sharing practices, they are confident in demonstrating the technology to the end-users.

As forwarded in 2.2.4.3, Cohen and Levinthal (1989; 1990) introduced knowledge absorption. Cohen and Levinthal (1994) define knowledge absorption as the ability to recognize new values of external information/knowledge, assimilate, apply, and be able to predict future technological advancements for commercial purposes. On the contrary, innovators conform to the knowledge handed down by their forefathers, apply it as needed, and forecast technologies not for commercialization (the gain of economic profit) but for the end-users to optimize to improve their lifestyle.

Zahra and George (2002) claim four dimensions of the capacity to absorb knowledge: acquisition, assimilation, transformation, and exploitation. They define *acquisitions* as the ability to recognize the value and acquire critical external knowledge for the company. As mentioned in the above discussion, generally, innovators acquire knowledge through their forefathers. Innovator F said, "*I am indebted to my forefather [mentor]. Had he not shared the knowledge about this technology with me, I would not have done anything." Assimilation* is routines and processes that enable a company to understand, analyze, interpret and include information from external sources. TTBDO (see 4.4.2.5 helps the innovators achieve the level of assimilation, Knowledge absorption is essential for a company to achieve success since it can facilitate decision-making capabilities, build learning

organizations (through a learning routine), and, finally, stimulate cultural change and innovation (Edwards, 2000). Still, overall performance in a company improves just when people do things differently. Routines and procedures are steps innovators systematically follow to reach the finish line for the technology to be received and utilized by the market. Standard operating procedures are equally important since missing one procedure might impede knowledge transfer.

To grow, develop, and be innovative, companies and organizations—including Biotechnology in higher education institutions—need knowledge, an intangible resource (Barney & Clark, 2007) attached to an individual or company. In comparison, other experts incorporate the concept of intellectual capital (Mar 2006; Pierre et al., 2011) and even economic gain. In the case of the present study, it is committed to the individual innovators by which the forefathers honed their personal knowledge and, when shared among team members, create more excellent value that can respond to the growing needs of the society. Knowledge is a critical factor for anyone as a source of innovation, the growth of entrepreneurial values (Drucker, 1985), competitive advantage (Teece, 2009), and an essential source of value creation (Poston & Speier, 2005). This type of knowledge has two classifications: tacit knowledge and explicit knowledge (Nonaka & Takeuchi, 1995). Knowledge characteristics can be measured, transferred, and cumulative (Kerste et al., 2002).

The acclaimed statement above reverberates in Biotechnology, where individual knowledge of the innovators combined with the knowledge absorbed by all the team members through teamwork (see 4.3.1.2.2). Expressions of this innovators' explicit knowledge are in the form of numbers, graphs, and actions. It is reflected in

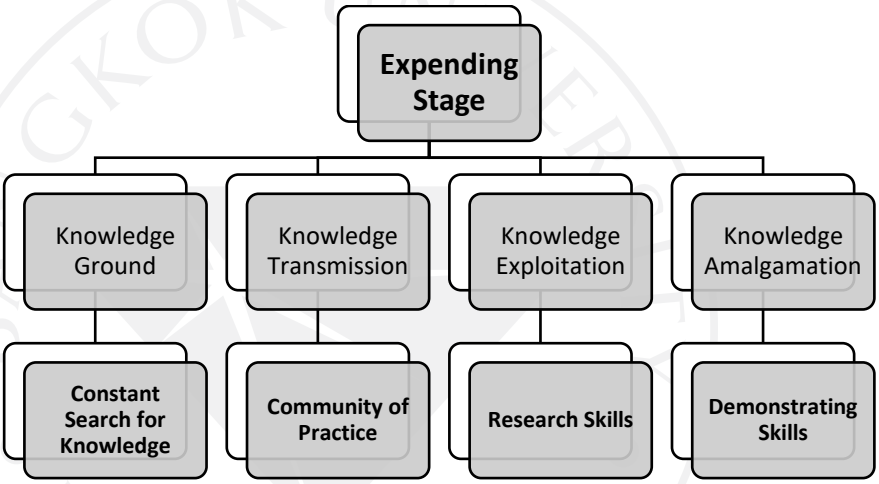
their agility in conducting research (see 4.2.3.2.3.1). Such are visibly shared formally and systematically in their created space (see 4.1.1.2.1) in data, specifications, manuals, drawings, videotapes, and demonstrations. While it is true that tacit knowledge is difficult to transfer, innovators come together in their formed community (see 4.2.3.2.2.1) to dialogue and listen and simulate the knowledge before maximizing it. It means that mobilization of knowledge and information to their fullness, innovations in BIOTECH bloom into desirable and valued by the community. It could attract more consumers to patronize their products and, more importantly, for the intended target users to utilize and appreciate them.

4.2.3.2.4.1 Demonstrating Skills. It refers to the ability to take their time out to teach and demonstrate how to use the technology to the end-users. As introduced several times in earlier discussions, innovators take their time to teach and demonstrate how to use the technology to the end-users. Knowledge sharing becomes fruitful with the culmination of innovation products. Just as how they have shared, absorbed, retained, and applied knowledge, on their end, they now have the responsibility to bring out their products and demonstrate them to the beneficiaries of technology. Innovators are buoyant and patient in dealing with people. Demonstrating is not an overnight ability to acquire. It comes from repeated practice until the recipients come to understand the dynamics of the technology. As Innovator F details: *Yes… so it is part of the process. First, you need to explain to them and demonstrate how to use the product. Yes, like that. Okay. Then eventually, you also discuss the benefits. It would help if you had many people to become a bridge to reach out to your client. You cannot just tell them; here, use it and force them. It is not like*

that. Some are adaptive, but then the old ones are not receptive to it. So, we do not lose hope. And, as Innovator D says: *There is no overdose. Friendly, you have to explain, introduce yourself only, and share your experience. Then, there are the qualities of the product. I was the one who gave the seminar. Del helped, only the two of us. Yes, not a joke; it is hands-on because we care.*

Figure 4.13

The Expending Stage in KSP.



4.3 How Innovator Success is Supported and Encouraged

Despite the crucial importance of being innovative (Ottenbacher & Harrington, 2014), the knowledge about how to achieve success is limited (Johne & Storey, 1998). As a result, managers in the industry—including directors of units and services—often rely on gut feeling, speculation, and limited experience about the keys to innovation success (Ottenbacher & Harrington, 2014; Godarth et al., 2015). Biotechnology in higher education institutions (HEIs) is no exception to this crucial reality for achieving success. In recent times, higher education institutions have

introduced product innovations to meet the needs of industry, community, and national policy but failed to discuss its process and influence on success.

Findings revealed that success in R&D BIOTECH is supported through organizational elements as presented in Table 4.6 and discussed below.

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Table 4.6

Organizational Elements that Lead to Successful Innovation as Experienced by the Innovators

Category	Sub-category	Themes	Verbal Description	F N=8
Organizational Elements	Organizational Context	Management Style	Refers to the interplay of the institution, administration, and innovators in responding to the vision-mission to be a globally competitive graduate and research university contributing to national development through the produced technologies.	*8*
		Know-hows of Innovators	Refers to the technical and soft skills acquired through various exposures to produce the technologies responsibly for the people.	*6*
	Organizational Culture	Process of Technology Utilization	It refers to the systematic function of gatekeepers who put a premium on the technology to serve its purpose to the fullest.	*8*
		Cohesive Teamwork	Refers to the teamwork demonstrated by the individuals in sharing their expertise to create substantial technology	*7*
	Organizational Values	Concern for Beneficiaries of Technology	Refers to the driving force to produce technology and leaves an extraordinary impact on people's lives.	*8*
		Consistent Appreciation of Mentors	Refers to the behavior exhibited towards their mentors, such as appreciation and credit for the insights/ideas shared in starting the technology through community immersion, consultations, and formal training abroad	*8*

4.3.1 Organizational Elements

There are elements in the organizational system in BIOTECH that are essential to subsist successful innovation. Thus, organizational elements represent the central innovation path to success. As part of UPLB and declared a Center of Excellence (COE) in Agriculture by the Commission on Higher Education, the Institute of Biotechnology continues to outgrow its innovation platform and value chain (see 2.6) to sustain its designation significantly influence its community and the country. Specifically, Bessant et al. (2005, p. 136) emphasized that "innovation represents the core renewal process in any organization" where the organizational system—including its elements—is paramount.

The innovation platform lies at the university, whose focus is on agriculture, and researcher-innovators, farmers, university officials, government entities, and significant others join forces in coming up with viable technologies or product innovations in response to their current thrust on food production as one of the societal concerns of Philippine government. Each of the entities plays a crucial role in the governance of knowledge, and with their contributions, knowledge sharing comes to fruition. For instance, the innovators used feedback from the farmers to tighten and affirm their knowledge of farming. In addition, University officials supported advanced training in this context and other related activities (see 4.2.3.1.3.2 and 4.3.1.1.1).

The unparalleled interplay of these entities made knowledge-sharing governance a smooth vehicle for innovation needed in this time of uncertainty. Indeed, as presented in chapter 2, innovation is crucial for all firms to survive and grow, especially in natural disasters such as unpredictable pandemics.

Value chains in the study include various members of the institution – top to bottom officials, the organizational system – established framework, management style, innovators, experts, and beneficiaries of the technology. In addition, chain supporters such as government and private funding agencies, procurement law officers, and organizations provide various services to the chain and enable it to function.

Further, as Turban and Aronson (2002) say, knowledge resides within the organization in an unstructured manner through their organizational memory. With the help of KM, organizations can identify, select, organize, disseminate, and transfer important information and expertise as needed. Wiig (2004) contends that this practice will enable the organization to have organizational knowledge-related effectiveness and prosperity. Nonetheless, as was observed and validated in the interviews, personal knowledge is located within and shared among the members through the leader's initiative [forefather].

Biotechnology's organizational performance in terms of product innovations improved and advanced, and they even became exemplars, with knowledge located within and shared among the team members. As observed and validated in the interviews, indigenous knowledge (elaborated in the ensuing discussions) resides within the organization and with individuals whom the innovators call 'forefathers.'

Forefathers are the first handlers of technology which passed knowledge emerging from the historical background of the technology on to the innovators. Then, when the forefathers retire, it is up to the current inventors to decide whether to continue (see 4.2.1.2.1.1 and 4.3.1.3.2). Whether to continue a product depends on its usefulness, which is discussed in more depth later when discussing incremental and

radical innovation. Thus, indigenous knowledge (elaborated in the model) is rooted in cultural values and transferred or passed on to innovators from generation to generation. In the words of PDO-TTBDO 1: *The other technologies here are already old and have been taken care of for generations. When the forefathers retire, passing on the technology, the following young inventor, such as Mykovam, is still helpful to the community. The young inventor will be the one to enhance it.* This observation is consistent with the literature, which is, according to Davenport et al. (1998), an underlying principle of knowledge management (KM). Further, as Turban and Aronson (2002) say, knowledge resides within the organization in an unstructured manner through their organizational memory. With the help of KM, organizations can identify, select, organize, disseminate, and transfer important information and expertise as needed. Wiig (2004) contends that this practice will enable the organization to have organizational knowledge-related effectiveness and prosperity

4.3.1.1 Organizational Context. The first element is organizational context. Organizational context plays a significant role in supporting knowledge-sharing practices (Hislop, 2007). Leadership support, time and resources, and human resource management are the main factors of organizational context in the literature. Leaders set the example for others; they directly impact the organizational culture and how the organization approaches and deals with knowledge-sharing practices (Sensky, 2002). It is also essential that BIOTECH offer enough time and resources to allow innovators to share their knowledge (Currie & Suhomlinova, 2006) apart from innovation. Furthermore, people are the core of creating organizational knowledge because it is people who create and share knowledge. Therefore, it is critical to managing those willing to create and share knowledge (Sensky, 2002).

UPLB finds ways and strategies to incorporate innovation in their organization. All the organization sectors create and observe formal and informal structures in delivering their respective responsibilities, especially the innovators. Formal structure refers to following the line of authority in observance of their function as innovators. As Innovator C says: *We observe the line of authorities in the discharge of our responsibilities, but we directly report to our directors of units.*

Nonetheless, in their teams (elaborated in the subsequent discussions on Cohesive Teamwork), they observe informal ways of delineating individual and group tasks and swiftly adapt to conditions in developing their innovation capacities. All participants attest that they are flexible in their functions, regardless of their position in the team or group. For instance, it was observed during the interviews that the project leaders (innovators) assume the responsibility of another team member if he or she is absent or out in the field. As Innovator H enthusiastically shared: *One time, one of our members was absent, and we needed to guard the temperature of the specimen because we needed to record it every half an hour; that is why I did the work [laughs]. It is all right. Here, we are all the same, no boss* [laugh]. Innovator A had a similar experience: *I went to the site and checked on the technology when our field officer could not come because he had to do a report. I even drove myself to the site* [laughs].

In addition, capacitated members perform according to their respective expertise, especially those understudies, so that even in the absence of the project leader, the work continues. On the other hand, Innovator F said she had to wait for her member because of her member's expertise. *I waited for our Dietician to come back, who attended a 3-day conference because she knows the amount of sugar to be added*

to our product since we also consider those cases with diabetes [laugh] *who wanted to eat cheese.*

Hence, the findings support the argument of Teece (1996) that the formal and informal structures of firms and their external linkages have an important bearing on the rate and direction of innovation. The increasing shift of responsibilities of organizations requires their effective adaptation to those new conditions. These changes mean they must be willing to adapt, which requires innovations in organizational structure (Cohen, 1999) (see 2.9.3.1). UPLB redesigned its structure and shifted its thrust to food production, as directed by the university chancellor, which allowed them to respond to the needs of the external and internal environment, to have control over their environment, and, according to Cohen (1999) and Damanpour (1996), respond more rapidly to changing demographics.

An excerpt from the interview with the chancellor: *I told my team, with Dr. Glenn Baticados, Director of TTBDO, to shift our focus to food production so that we could serve the best interest of the people. The technologies they are doing respond to problems in society. Dr. Baticados give Madam what she needs in her study. We need the result of her study.* Innovator H added insightfully: *... it is just but fitting that we focus on food production because, in the Philippines, our country needs to have stable food production. Yes, besides, UPLB is identified for agriculture. Because of what we did before, we programmed on natural products ... we always think first of health or well-being.* Similar to this account, the organizational structure is significant to delivering quality product innovation to its intended clientele. More importantly, the created technology is for UPLB to remain economically stable and for the end-users to have a quality, healthy, and sustainable lifestyle. It was made clear by remarks

from Innovator B: *This technology that I am doing is not only for generating income for the university but to help the farmers to have a stable income so that they will have a flourishing lifestyle.* Innovator F made the vital point: *I like to help people have a good income and good life with the use of rennet in making cheese. There is a secret to making cheese not taste sour and will not be easily contaminated with molds.*

The findings revealed unique perspectives on the concept of organizational context in the attainment of innovation. Findings reveal that innovators' management style and know-how are elements of organizational context that contribute to successful product innovation. We find the discussion of these findings below.

4.3.1.1.1 Management Style (MS). As related by several innovators, the current administration embarked on benchmarking abroad to help the National Institute of Molecular Biology and Biotechnology (BIOTECH), the home base of the innovators, achieve its vision-mission (see Appendix A) and, because of their multifarious patents, to meet the demands and expectations posed on them as a Center of Excellence in agriculture among higher education institutions. An excerpt from an interview with the chancellor shows this expectation: *Actually, I just came from another country where I attended a meeting on the topic of innovation. I immediately shared with my constituents, most especially with the scientists … I will have a special meeting later with all my directors.*

As the highest governing body, the chancellor gathered all university sectors and discussed how to respond to the communities' needs in agriculture vis-à-vis successful innovation products. He then chose the best experts for his team to deliver the tasks effectively and sufficiently. Similarly, the chancellor wanted to ensure that

the researcher understood the importance of innovation to the university. As was communicated: *Hmmm…actually, I will have a meeting after my interview with you. That is why I already asked Dr. Glenn Baticados, the director of TTBDO—and where the Dr—to join us here because they are the best persons to assist you in your research. They are the best on my team when it comes to innovation. Sir Glenn, please assist Ms. Aggarao.* The creation of the Technology Transfer and Business Development Office (TTBDO) is to facilitate technology creation to commercialization (discussion of the office details in the model located in section 4.4.2), thus contributing to the country's economic growth. This finding is consistent with Conchada and Tiongco (2015) when they say that higher education institutions (HEIs) play a pivotal role in concocting a country to be globally competitive through the skilled human capital resources it produces and putting the country on the world map through unique and commercialized innovation products.

As introduced in the literature review at 2.9.2.1, Naughton (2004) argues that change agents – including scientists-innovators – are transforming today's workplaces, allowing people in innovation leadership positions to take their seats at the table along with top managers to deliberate on how to go about innovation. As attested by the director of TTBDO, the university chancellor is solid and aggressive in establishing linkages and networks, both local and national, and even international, to achieve comparable and effective technologies. As he shares: *Our chancellor is strong and aggressive in establishing linkages and networks, both local and national, and even international, in order to advocate the technologies made by our inventors. You have heard him say he has just arrived from abroad, right? And he likes that technologies are focused on food production because it is what the Filipinos need."*

Then, the director added: " and his mother, I think, is in food technology." This resilient practice of linking and networking worldwide, which the able chancellor is doing, supports innovation. This finding is consistent with Doyle and Bridgewater (1988). They aptly describe innovation as the result of a complex set of processes which also depends on the organization's marketing ability, strategy, the resources, networks, and processes it builds, together with the culture and leadership in the firm and the management style of the existing leadership.

Furthermore, the majority of innovators maintain that the management style of the institution's highest governing body sets the university's strategic direction in adherence to its mandate leading to successful innovation. For example, Innovator E says, echoing an earlier quote from the director of TTBDO: *Our chancellor, together with the Vice Presidents, sets the university's strategic direction towards successful innovation. Hmmm…and our chancellor likes that our products are focused on food production.* This management style is *the interplay of the institution, administration, and innovators in responding to the vision-mission of being a globally competitive graduate and research university contributing to national development through the produced technologies.*

Thus, he urged everyone in the team to continuously share and transfer knowledge in the best way they could. Extended various support mechanisms to the innovators are encouraged to update their expertise by attending seminars or training frequently, seeking exposure to expos or exhibits, participating in workshops, and, the most common, socializing among themselves in the team. 95% of the innovators value their attendance and exposure to workshops and training. Innovator B says: *We attend seminars and training and frequently participate in workshops related to our*

field to encapsulate their sharing. And yes, we get support from management. I am happy because I enjoyed all these activities while still young.

Innovator C says: *I join various exhibits and expos, and that is an excellent opportunity to introduce our product to interested individuals or companies who will sponsor the production of the technology.*

As demonstrated above, top management views innovation as something that does not only put them ahead of the competitors and stay in the dome of excellence but, through product innovations, helps in the solution of problems besetting Philippine society, particularly in the glitches of agriculture. As explained by PDO-TTBDO 1: *It is pretty clear to our resident scientists-innovators that what they are working on is to respond to the calamities that destroy agriculture. Therefore, this office* [TTBDO] *is the one helping them to apply for patents so that their technologies will be protected and even the university in that particular field.*

Further, Innovator H points out: *All medicinal … since we are into agriculture, we study medicinal plants. That is why I work on tissue culture because I propagate medicinal plants. But then, our new chancellor came along with a new thrust on food production; it's like, yeah, medicinal, it's like drugs but not on food. So, it's a bit related. What I studied could be directed to food production, so our focus now is on bio-pesticide.* The excitement of top management carries over to the innovators. As Innovator F says: *I was able to produce plenty. But then… I knew there was already a problem in Visayas and Mindanao because the one used in making cheese is vinegar … as long as there is something to taste sour … then it turned out that there was a meager yield cheese. As far as I know, the one who evaluated the project was the National Dairy Authority. But they cannot connect* [laughs] *my project to… the one*

with Dr. F … so, they said, use the rennet of Dr. F and, hopefully, the problem in making cheese in Visayas and Mindanao will be addressed. Like Luzon, many end-users were happy when they learned the secret of making a good cheese at an affordable price.

The university chancellor's management style pushes everyone in the community to go out of the box, leaving their comfort zones once in a while and encouraging them to become sensitive to the needs of the society, to do something that contributes to the welfare of their fellow citizens. In this regard, the chancellor's message is clear and strong: *I urge everyone to get out of our usual practices and do something better for society. Let us not stay complacent with our usual output. It is when our fellow citizens need the most from our technologies.*

Findings reveal that the goal of the leader to produce technologies that can increase food production to provide staple food in every family is rooted in cultural values. Innovators consistently expressed their desire to think of the people's best interest, exceptionally the less fortunate. Such action is a challenge for the administration. For example, innovator B says: *The product that I am doing is very timely… and it is related to… food production because… this device…detects if it is pure beef or pork or there is a mix of* [laughs] *beef and …pork… So, our brothers and sisters looking for… halal food will feel happy.* And, as Innovator H says: *Oh…yes…this will be used primarily for our poor fellowmen. We are thinking of them when we are doing this product…that is the challenge from the administration. It* agrees with Uche and Timinepere's (2012) claim that there is no one best management style but that the selected style should be in tandem with achieving set goals, cultural values, and organizational peculiarities.

As expressed by the innovators, UPLB BIOTECH management aims to serve the marginalized, and the corresponding responsibilities attached to it are significant factors in their direction to innovate. Dubey et al. (2017) support this frame of understanding, saying that the effective management style is how a leader continually and progressively leads and directs followers to a predetermined destination agreed upon by the whole group. The innovators abide by the thrust of the leader in response to the country's pressing issues. They enjoy working on their projects because they are driven by similar goals, that is, to respond to the needs of the less fortunate. For example, below are some significant responses from the innovators.

Innovator A acknowledged a common direction: *The thrust of the chancellor changed. It is because every three years we change chancellor. The current chancellor pushed for food production. Food for Filipinos should be stable. So, we support this thrust because this is what we also like.* Innovator E linked the focus on food and her technology: *I feel happy that our focus is on food now. That is why I made sure that my technology has good health benefits. There are lots of health benefits from probiotic guava tea.* Innovator G was concerned with a primary issue at hand: *If you go to Europe … and especially to Israel, space is minimal, land space, that is why we need to think of a way to produce food or vegetables with limited space or land. This snap hydroponics is appropriate.*

Another significant finding regarding management style is the attitude of various leaders towards innovators. Leaders and heads of various offices, institutes, and units support the innovators' projects. Innovators are encouraged to attend further studies, training, conferences, and seminars, both national and international, to benchmark and hone their craft. In this area, an example response from innovator G

was: *my boss asked us to do hydroponics here when he was still alive. However, it was not then the priority project of the Institute on Plant Breeding (IPB) because we are for breeding. It was like hydroponics was just side research only. Then, when we had research on solidity tolerance, I was one of those who were sent to Israel to work on solidity of tomato using hydroponics. From there, I started to think, then I thought of hydroponics. When I had the chance to be sent to Australia for my Ph.D., I studied Plant Nutrition using the tool of hydroponics.*

Another example response from Innovator D was: *Since I am a forester and my boss was a forester, we targeted reforestation. I continued doing my research on organisms, even when I did my Ph.D. in the USA. Oh, yes, I was a scholar there. It was nice, but a bit hard to study abroad … I needed to finish within the time frame because I had to pay back my fellow citizens.* As can be seen, there is the support given to innovators in expanding their education and following their areas of passion, including a diversity of international experiences. For example, Innovator H said: *I was trained in Japan because it was there where I earned my Ph.D.* This is similar to the statement of New Zealand Management (2001) that individuals operate better if they consider themselves to be part of a well-functioning, supportive organization to which all are happy to belong. As committed participants in the group, the innovators feel that they are more productive, communicative, trusting, motivated, and loyal.

Moreover, management urges innovators to take up broader exploration and deeply investigate the field of agriculture, especially in addressing the persistent problems besetting the Philippine society. Therefore, driven-innovators conduct studies focused on agriculture and food production. As Innovator D shared: *I do not understand why those plants I planted in Bukidnon died, even if the soil is good. Yes!*

Soil from Bukidnon. What I did was I collected the best soil in the country, in Bislig, Surigao, and from Luzon in Pangasinan. So, I did different soil analyses. The plants in Bukidnon always die. I asked myself, what happened? How do we have enough harvest if plants die? Do we lack food? Good enough, management supported me in this endeavor. What solutions can they offer to address these societal problems? Innovators are prodded to look into, and commended for looking into, what the people, especially the farmers, need to alleviate their long-day labor with a meager income. Innovator H says: *We know that there are many problems when it comes to our vegetable crops … sickness that affects their growth and development. And besides, it will be a pity for our poor farmers when they do not have income because plants are useless. So, I proposed the sickness of plants and how to avoid that without combining chemicals.*

Once a proposal is approved, though it takes quite a long for it to be approved, the project leader convenes the group for discussion and allows everyone to share their thoughts to achieve their common goal of serving the marginalized. As Innovator E describes, it *took quite a long time to approve the project proposal because we needed to meet all the technical specifications. When it was approved, I called for a meeting in order for us to work on materializing our projects. We hear every opinion.*

The approval is quite long, and writing project proposals (see 4.2.2.8) is tedious because attached to it is the budget proposal that calls for funding (see 4.1.1.2.2). Funding is challenging; however, they are motivated to proceed with their proposals and do not lose hope (for similar patterns) as Innovator H says: *That long. Just like this one, phase 1, we finished in 2015. Then, submission of proposal again,*

and we started in 2017. In addition, you have to make the budget proposal tied to funding. I am not losing hope. It is approved with God's grace because this is what the farmers need.

In addition, leaders of UPLB allow innovators to explore beyond their ordinary tasks to think of ways to improve the lifestyle of the people. They have permission to pursue their passions and emerging ideas beyond specific tasks. It is significant to the innovators. As Innovator G describes: *What is nice about us inventors, we are given by the top leaders the chance to do what we like the most. Like me. I am limited to what I see; what I mean is that I can go beyond that…it does not mean I will do what is complicated.* Innovator D talks about this in terms of freedom and happiness, and that happiness is reflected in her words and tone as she shares: *I am happy because I am on my own* [laughs]. *I mean that I am free to do what I want as long as I come home to the university with an output for society. I was once an understudy; that is why I am adept at what I am doing now. There is our laboratory. It is only Del who can enter inside because it is restricted. Just take a photo of it* [laughs]. *While we hold here* [laughs] *our meeting, lunch [laughs] and bible sharing after eating lunch. You can join us later.*

It is consistent with how Uche and Timinepere (2012) talk about management style, which is a way of life operating throughout the enterprise, permitting an executive to rely on the initiative of the personnel of an entity. As described by the innovators, they work independently in their respective niches, with facilities (see 4.1.1.2.1) and space to hold their experiments, seeing to it that they have an initial output at the end of the day efficiently with a limited staff because the nature of their work is project-based where most of the staff are contractual. There is an understudy

(as mentioned by the research assistant of the university in section 4.2.3.2.1.1, among their research assistants (RAs) only if the technology has the potential for a longer lifespan. As Innovator C says: *We have our own spaces like this one, our office, and over there is our laboratory to do our business with our limited staff, though we have our research assistants. Because this is project-based, we can manage with an output at the end of the day.*

The respondents-innovators themselves serve as project leaders, and as such, they take the lead in creating a positive, team-oriented environment. From their descriptions, this requires much more than just pulling a group of members together and labeling them as a 'team.' These innovator leaders turn individuals' talents, knowledge, and efforts into a collective force to arrive at successful product innovations. It was described by Innovator B as follows: *My boss brought me to scientific conferences when I was a Research Assistant* [RA]. *When he gave me the leadership to become the project leader, I had two RAs (two RAs, then my boss; so, including me, we are four on the team). I brought the RAs to attend a scientific conference because they are scientists in training. Attending the conference, it is very inspiring. They feel happy because I gave them the opportunity. In fact, for the RAs to stay long, I invest in them. I train them on doing the Deoxyribonucleic Acid* [DNA] *test for animals. For instance, one RA I hired is a BS graduate in animal science, so he does not have DNA exposure. I thought one month or two months of training would be enough; it is not* [laughs]. *It took one year. So that is a one-year investment—a significant impact on them. In a way, they appreciate what they are doing. So, we are developing technology, which is essential to us (me and my boss) having the same focus on animal science.* We *want to develop the workforce at the*

same time. The significant products produced through this process are recognized and bestowed awards and incentives for exemplar output.

For instance, the Best Scientist of the Year was Innovator D, while the youngest scientist was Innovator B. Management encourages them to aim high, to qualify for the Nobel Prize, even if just as nominees. In the chancellor's words: *I feel delighted that our scientists received various awards. Next time, we aim for the Nobel Prize, even if just as nominees.* Management style is not limited to the procedure on *how to do* but is the management framework for *doing* (Uche & Timinepere, 2012) *with a cause*. [Note the concept of *cause*, which the innovators instinctively and notably achieved through their technologies, which led to a fuller definition of innovation and expanded beyond what is commonly understood in the industry]. The innovators contend that all of the technologies are shared and utilized with a cause until it becomes an advocacy (see 4.2.1.3.1.1). It means that technologies are not only utilized for a certain period but make significant sustainable changes in the lives of the marginalized.

4.3.1.1.2 Know-how of Innovators. The scientists-innovators interviewed are hardworking and patient and perform multi-tasks. Though interviews were pre-scheduled, the innovators all attended to tasks that needed immediate attention. For instance, signatures needed for a purchase request, staff asking for approval of some technical specifications of equipment, and potential buyers' queries. This particular behavior is consistent with Noe, Hollenbeck, and Gerhart's (2015) discussion on skills, which refers to the level of performance of an individual on a particular task or the capability to perform a job well. In addition, innovators were mindful of the tasks at hand while the interview was going on. An example is an encounter with Innovator

D: *Hmmm ... excuse me for a while, kindly pause first your recorder* [laughs] *because I need to sign this so that farmers can bring these fertilizers to the farmers.* While the interview was going on, somebody came in and asked Innovator D if she could come for a while and check the site. Innovator D turned to me and said: *Ahhh ..., please wait for a minute. I will go there to the site* [off-site is just across the interview venue] *to see whether the farmers put the fertilizers correctly. I will be back right away. Meantime, you may attend our prayer meeting* [checking her watch]. *Anyway, it is lunch break now. See you!* Innovator D was so pleasant and accommodating. Innovator C showed a similar experience. *Please give me a few minutes. I will meet for a while my potential partner in our project. Do not worry, and I will entertain you later since you are already here.* He then asked his student assistant (SA) to accompany me to the lobby of his office. Innovators did not lose track of the conversation while touring the researcher around the location of the technology. This is an interview segment from Innovator G: *Come here. While you are going to interview me, I will show you, our technology.* [We went to the other side of the building.] *That room is our laboratory. Outside is our hydroponics made up of discarded materials; hence, it is easy to work.*

According to Noe, Hollenbeck, and Gerhart (2015), technical and behavioral elements are two skills related to this situation (see 2.9.4.3). Daud et al. (2012) says that technical elements measure "hard" technical skills while the behavioral elements measure "soft" skills, which include the attitudes and approaches applicants take to their work, such as the ability to collaborate on team projects including forging partnerships to fund such projects (see 4.2.1.2.1.2).

Moreover, to be competent, it is necessary to have knowledge and skills and the right motivation and attitude (Gurteen, 1998), which, as introduced above, are referred to as soft skills. The interviews revealed that an innovator's soft skills include the right attitude, intrinsically motivated, and high intrapersonal and interpersonal skills. The right attitude is because they eagerly and earnestly respond to the needs of society, even if they do not get benefits or rewards from doing so. Innovator H posed a dilemma: *I do not have … in my position as a scientist … we have a performance contract. Maybe that is why I have to think constantly, and I need to, ah, there is none I need to write a paper. But, on the other hand, I am obligated as a scientist. If I do not write a paper, that is it. Moreover, we cannot write in international publications or lose our benefits. Nonetheless, even if we do not receive benefits, we still respond to the needs of society.*

The researcher's desire to help is their sole motivation to keep going. Further, based on behaviors observed during the interviews and site visits, innovators know how to conduct themselves and get along well with their colleagues and other people concerning the development of the product (see 4.2.1.2). They know precisely when one needs help or assistance and performs their duties without being told. There are several clear examples of this. As Innovator B said*, two of us with the research assistant are working most of the time. Alternatively, if I have a little knowledge, a bird's eye view of everything, that is where I go for a consultation with our senior consultant.*

Innovator C shared: *I always tell my team, as their project leader, if they know that what they are doing is right, then they must do it. They need not wait for my approval, especially when it comes to the specimen of wine. Time is of the essence*

since we also study the life span of wine. It has a bearing since it has something to do with health, most especially to those who will drink it. And as a final example the researcher witnessed how Innovator H demonstrated to his laboratory assistant how to handle the equipment inside the laboratory. *If you get inside, you need to remove your shoes, and just wear only the slippers provided inside. Don't forget to use gloves, and this how to use the gloves and lab gown properly.* [Shows to the laboratory assistant]. *When you get out of the laboratory, you check if the laboratory is at the right temperature. Then, take care when you get home later. I will just finish this interview.*

Dewey (1938), states that the educational process has no end beyond itself; it is its own end (see 2.8.5.1). Meaning, copious education as an end justified in itself, an innate good emancipating the possessor's judgment. Through education and genre of technique and social institution, man is liberated socially. This means that what he considers to be significant about an educated person is not the amount of information that the person has acquired, nor even the 'kind' of knowledge, but the ability to act intelligently on that information and knowledge, constantly cultivating the ability to proceed for himself in a changing world through exemplar outputs, which abilities are referred to as soft skills. Such observation of Dewey is manifested by the respondents, and can be related to the soft skills these innovators carry with them. They appear to have a kind of unique leadership (which will be elaborated in teamwork at 4.3.1.2, probably because they have been trained under the baton of their forefathers, referring to the mentors, who first started the technology or product innovation and were actually innovators themselves (see related discussion on forefathers in 4.3.1), and they have the communication skills (see 4.2.2), to connect with various people in relation to the development of technology.

Innovators acquired hard skills during their education and training in UPLB and other reputable national and international institutions. Half of the interviewees mentioned that they were trained in UPLB, while the rest were outside the universities. As Innovator G shares: *I started from this university, learned how to socialize, and most of all, do research, be proactive with the problems of the country, think, and do something to help those in need. I felt the support from the start, and it is nice.* Innovator A said: *I learned from my training outside, even abroad.* Indeed, irrespective of the institution where they were trained, the innovators know how to socialize, do research pro-active with the problems of the country, and think and do something to help those in need. Innovator C makes this point clearly: *So, when I came back, after getting my Ph.D., that's when I thought of developing a product that could not just be an endpoint application of a technique that I learned abroad but something that could improve the lifestyle, the health of many Filipinos.* And as Innovator H emphasizes: *I used all that I have learned from my professors in Japan.*

As supported by their education qualifications, training, and exposures, the innovator's intensive and massive education background made them adept at their current work, especially in producing sophisticated and contextual technologies. Their education played a significant role in fostering the skill sets required for each particular endeavor. As forwarded by Okoye and Caleb (2019), when people become more educated, their ability to engage, participate and understand increases. As affirmed by the innovators interviewed, skills development is primarily through education and training, with these skills serving as drivers for innovation. This finding is consistent with the understanding of MacLeod and Clarke (2009) that hard skills are an important driver and focus on the quality of labor inputs.

Moreover, findings concur that innovators have received their highest degrees and trained in well-renowned universities in reputable international universities, primarily on scholarship grants. Representative excerpts from three innovator responses support this finding. Innovator G says: *Then when I had the chance to be sent to Australia for my Ph.D., as a scholar, I studied Plant Nutrition and studied nutrition using the tool on hydroponics.* Innovator D says: *I continued doing my research* [laughs] *on organisms, even if I did my Ph.D. in the USA. I love so much the* [laughs] *microbes. I have grown old studying them* [laughs]. *Yes, I was a scholar.* Innovator H says: *Ahhh… I was trained in Japan because it was there where I earned my Ph.D. as a scholar.*

The innovators were also given opportunities by the university to further hone their learnings by attending international conferences, training, and seminars, and most of them were given recognition as exemplary scientists-innovators—for instance, the technology on Meat Detection Kit. Even when Innovator B was still a research assistant, her boss used to bring her to conferences. Now that she is the project leader of the new technology, she has attended many conferences, training, and seminars and has presented her technology to various fora. As Innovator B shares: *My boss brought me to scientific conferences when I was a Research Assistant. That is why I know the value of attending conferences. I learned many things and met some the scientists. I also talked in fora. I was blessed; I received an award.* The same thing was experienced by Innovator D. Additionally, at times, Innovator D was more than willing to shell out money out of her pocket to be able to attend because, in her words, she was investing in her learnings. As Innovator D shared: *I did attend conferences, seminars, and training on my own, most especially*

when I was abroad studying. I shelled out money on my own because I was investing in my learnings. I go where I know it is related to my project.

This impressive academic track appears vital in the organizational structure and, from the interviews, contributes to achieving innovation. Thus, this supports some research accounts that educational attainment concerns the completed highest education program, typically certified by a recognized qualification. It certainly makes sense within the venue of this study. As Innovator C says: *It is not more on the years that matter, but the highest educational attainment.*

However, over and above, educational background is not limited to the highest degrees these innovators have obtained. It was evident that innovators are not only experts in their fields but, equally important, have encyclopedic experiences in learning first from their forefathers, as introduced earlier, to back up the theories they learned. Their outside exposures also allowed them to apply the concepts and theories learned in the Philippines directly. For example, take the technology on Mykovam. While in training, Innovator D had to bring various kinds of soil abroad to test which type best fits the technology used in the Philippines. From there, this innovator further enhanced the potential of the technology and was able to determine which technology was most effective considering the weather, soil, and water conditions. As Innovator D explains: *I took extra effort to pursue a higher degree because I like to add more to the variety of the technology that our forefathers* [leaders] *have made. Therefore, when the opportunity came to experiment, I needed to come back here to the Philippines to get various soil types* [laughs] *and test them.* In addition, Innovator D got commended for her technology for getting the highest sales all over the country as she describes: *Huh! I was shocked. The Vice-Chancellor for Academic Affairs, UP*

Diliman, told me, it is your product all over the Philippines that got the highest sales!'

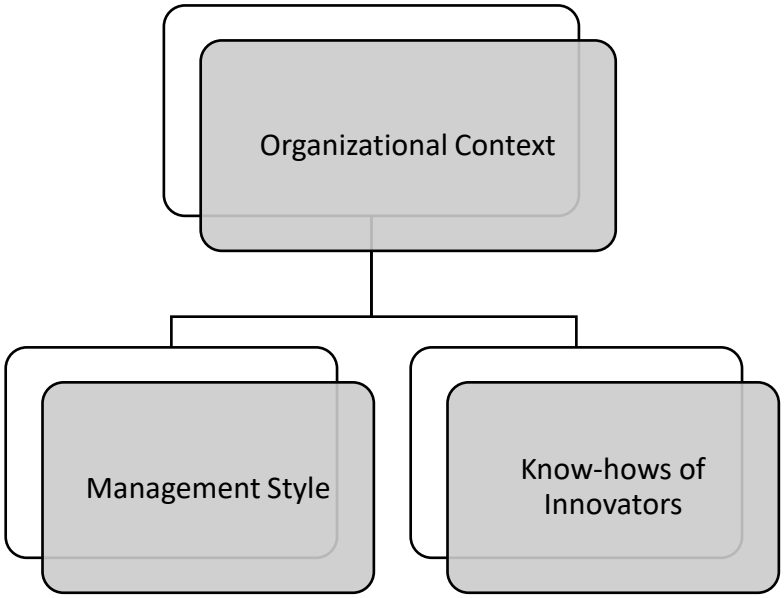
It can be described as a hand-me-down opportunity to explore further the technology passed on to them, as stated in the discussion in (4.1.1.2.1**,** 4.2.3.2.1.1, and 4.3.1.3.2). Innovators' exposure to the considerable state of the technology, and because these were hands-on experiences, is an add-on to their qualifications to produce the technology. Innovator G says: *This technology was already here together with the forefathers before I came, and that is why more or less I am a bit exposed to it. However, I did not use expensive materials when I improved it. When I came back from Australia to the Philippines, it was at the height of the brownout, which was very, very frequent, right? Back then, it was almost a whole day. From there, I experienced using hydroponics in a supposedly electrically powered system. So, that means when there is a brownout, the plants die. So, this* [experience] *was a blessing in disguise. Because when I was young, I noticed I lived without electricity, and plants need water through a pump powered by electricity to oxygenate the system, the plant nutrients solution. The oxygen dissolved in water is limited for the nutrient solution. If it is limited, the roots of the plants may succumb to the water due to a lack of oxygen. The brownout that I experienced and observed the seedlings being affected when not oxygenated was the basis for developing this technology using low-end materials.*

Remarkably, through the interviews, respondents possess both skills to successfully perform their roles as scientists-innovators, which the study termed as know-hows of innovators. In other words, hard skills are related to specific technical knowledge, training, and exposure, while soft skills are personality traits such as leadership, communication, time management, collaboration, and teamwork.

Hence, *the know-how of innovators refers to the technical and soft skills through various exposures to responsibly produce technologies for the people.*

Figure 4.14

The Organizational Context that Leads to Successful Innovation



4.3.1.2 Organizational Culture. The second element is organizational culture. The recent revival of academic focus on organizational culture may result from myriad contextual factors, the legitimization of corporate social responsibility, and growing consumer idealism (versus materialism) due to the economic recession (Bell, 2013). Kotler et al. (2010) and Gorenak and Košir (2012) postulate that organizations' values and cultures are increasingly a competitive differentiator because of collaboration [exchanging and transferring knowledge], with consumers demanding a more significant role in co-creation, including determining what constitutes product value. In the case of the current study, officials of the university and innovators do collaborate in knowledge sharing (see 4.2.1.2.1.2 and 4.2.3), and

funding agencies (see 4.1.1.2.2) play significant roles (in funding the project). In addition, end-users' feedback (see 4.2.3.1.3.2) is considered equally important in knowledge sharing for successful product development.

Biotechnology is constant with its organizational culture incapacitating its human resources towards the goal of producing technologies for the community. Innovators were operating within a well-established set of principles, guidelines, and practices embedded in the organizational culture. They have the same goal of helping the people and protocols to follow. The statement of the two prospective respondents who were not part of the final ten (10) participants because of prior appointments that could not be re-scheduled affirmed this claim. Prospective Innovator Respondent 1 said: *Sorry, I cannot be one of your respondents because I have a prior commitment. Anyway, whatever the result of your study, I agree with it since we almost have the same protocols to follow. We only differ in technologies.* Prospective Innovator Respondent 2 reiterated this point: *Pardon me, I have an unavoidable commitment abroad You have a good study, and whatever the result is, it is all right with me, since we almost have the same guidelines and principles,* [our] *goal is to help the people through our work.*

In light of the interviewed innovators, UPLB Biotechnology stays attuned to its culture of constantly producing technologies for the marginalized. Several example responses from the innovators include below. The researcher was personally impressed with the similar responses of Innovators D and G. As Innovator D shared: *Since we studied and started working here in the university, it was already imprinted in our system to help the marginalized. Therefore, even if there was an opportunity and the offer was lucrative abroad, we decided to stay.* One innovator

shared his personal experience with a test of his integrity in developing the product. As he relates, one time, he was offered sizeable financial support for the project, and then, in the end, the sponsor would buy it with a considerable amount of money. This innovator declined the offer because it might defeat the purpose of helping the farmers. As Innovator H shares: *I have a personal experience, and I share only through this. In this experience, it was a test of integrity as a trademark of a UPLB scientist. Moreover, I thank the officials because I owe the university my training, and it is just right that I give back to those in need. One time, a man offered to support my project, but in the end, he would buy my technology for a significant amount. Of course, I did not agree. And because I disagreed, he did not support me anymore. From then on, he did not show up until today. I declined because it might defeat the fundamental goal of helping the farmers.* These findings agree with Bate and Johnston (2005), saying that the capacity for strategizing innovation is within the capabilities of any organization.

Furthermore, BIOTECH considers its technical preparations in all university units, including indigenous materials, financial, and all areas of human resources, including external stakeholders, to fulfill its vision-mission to the fullest. As recounted by the innovators, before planning to work on a project, they conduct a feasibility study, meaning they consider all the technical issues and human resources, including the recipients of the technology. As Innovator C shares: *I talked to a potential collaborator from another college, asked for his help, developed a proposal, and sought his input; then, we submitted the proposal and presented the proposal within the different levels of DOST. It was approved. Then we hired a program manager, and my leadership technique was to delegate as much as I could so that I*

could focus on the things that no one else could do. So, we delegated the management aspect to someone else, and then my collaborator had to work on one aspect of the program or work on the other aspect. We hired a research associate to do most of the [hands-on] *work. We were a small program team. At some point, our RA left to pursue another job, and that was a minor setback, but we were able to finish the project. The RA did most of the experiments, and I supervised him throughout.*

The study agrees with Claver et al.'s (1998) observation that innovation requires a technical preparation in material, financial, and human resources. Without a transparent corporate culture, the technical side of innovation will hardly develop satisfactorily, which will delay the development of product innovation. As Innovator C continued to share: *We need to get in touch with the everyday problems of people in our locality to think of the problems besetting them in the regions, the nation, and how our problems stack up with those of our neighbors, say in Asia. Then, from a global perspective, we can at least get in touch with the kind of innovation happening overseas and then try to see its applicability to the Philippine setting.* As can be seen throughout the quotes provided from the responses, there is a consistent culture very much focused on benefiting the farmers, the people, and the country. As Innovator A says: *As a government employee, I know my responsibility to help the farmers. Then, maybe, eventually, I would like the farmers to earn-out from the innovations I am doing. I want them to benefit from these innovations.*

BIOTECH's unique organizational culture in terms of innovation endeavor persuades innovators to involve and create productive technologies that will elucidate societal issues and be helpful to the industry and the people in general. As Innovator F examples: *You know it is already a culture. Of course, I think of helping the industry*

and people. So then, what I did, was I took a course on dairy. I met my professor, but now he has retired, Dr. Davide. He taught us how to make rennet, in making cheese, which comes from a cow's stomach. Then, I saw the problems – lots of mosquitoes, dirty, stinky. How is that? How is our industry [influential] *if this goes on and on, and how about those patronizing the product? What is the quality of health?* While Innovator F exampled the thinking necessary to serve the people best, Innovator H said quite directly: *Then, just the same, my technology helps the farmers, like that.*

It is consistent with the literature that suggests that organizational culture is the primary source of motivated and coordinated organizational activity that can serve

1. as a coping mechanism for solving problems and interpreting daily organizational events,
2. as a substitute for structure and as a complement to leadership, and
3. as a social glue that keeps employees together and increases the system's stability (Hauser, 1998 and Pervaiz, 1998); to be enthralled in the world of innovation.

Likewise, with the study of Jaskyte and Dressler (2005), who forward that organizational culture and values are significant predictors of organizational innovativeness and clairvoyants for successful product innovativeness. Product innovativeness, as defined by Olson et al. (1995), is the degree to which the developed product is new to the company and the market. In the real work of Kessler and Bierly (2002); Langerak and Hultink (2006), the gradation of product innovativeness is a broadly used and classically acknowledged exigency factor. According to Griffin (1997), different management processes, activities, and outcomes are involved in radical and incremental innovations. Radical product innovation departs from the

usual and existing routines and practices, requiring new conceptual models in the firm. Contrariwise, incremental product innovation variation in existing customs and practices that rely on existing conceptual models.

Indeed, organizational culture plays a significant role in innovators' success. As observed and throughout the interviews with the innovators, they are consistent in continuing the culture rooted in their organizational history of helping the farmers, just as their former mentors [forefathers] did. Their technologies are testimonies of their passion for really serving the beneficiaries of technology. As Innovator D says of her technology: *The farmers will apply this to their plants so that they will grow healthy and there will be an abundant harvest. They will have a good income* [laughs]. *It is already my passion that I will grow old with* [laughs]. From a unique point of view, Innovator H says: *I do not believe in organic because once the plants are exposed to the air, we are aware that the air is no longer clean. What I mean is that the air is already contaminated with different chemicals. That is why I call it natural. We do it naturally, and there are no added chemicals in the pesticides.* Some former mentors started Mykovam, rennet, and snap hydroponics technologies geared toward assisting the less privileged in their lives.

Cummings (2008) suggests that old values can be changed through a new vision or mission statement. Leaders can do that by empowering their employees to implement the new vision into reality and increasing employees' motivation. Similarly, based on the researcher's interview with the chancellor, acting as the chief leader of the organization together with the director of TTBDO challenged the whole members of the research community to focus their vision on food production in response to the crucial need of the society. As the chancellor stated, I deemed

it *necessary to shift our vision to food production, and our goal is for every Filipino to have sufficient food on their table. I am challenging all the scientists-innovators through the assistance of the TTBDO to bring their expertise to this worthwhile endeavor."* The director of TTBDO supported the chancellor's challenge, saying: *The primary task of innovators is to shape and influence the work environment of our organizations to make it conducive to the efficient delivery of product innovation to target clients.*

Prioritized organizational values are competing; firms probably vary in the values they choose to emphasize (Bell, 2013). For the innovators interviewed in this study, knowledge sharing begins with showing gratitude to forefathers for mentoring (see 4.2.1.2.1.1), exhibiting exemplar leadership, and being open to sharing indigenous knowledge. Innovator G, who feels very grateful to his forefathers, shares: *I owe so much and am very grateful to our forefathers who started the technology and passed on to us the indigenous knowledge behind this technology. Now it is my turn to share and transfer the knowledge by training our RAs. Some established people have already done the same thing, which means that what you can do to make it unique is that no one has done yet. And that is when I was coming from my Ph.D. There were not many who worked on this. So, it was ancient technology, but then, it was not yet really used for commercial production of food or vegetables during that time.*

Undeniably, knowledge sharing—as a built-in value in the organization [BIOTECH]—is not difficult for innovators to practice because of their training when they were still RAs. For instance, Innovator A says: *I did not find any difficulty sharing my knowledge because it has been part already of our values as an*

organization in biotech. Moreover, this is what I admire most in biotech, where everyone is more than willing to share what we know. We do not hoard knowledge, you know. I was trained when I was starting as an RA. And when I finally got into the post, I was a bit well versed already. And the same thing happens to our understudy. We replicate, adjust, revise and add to our indigenous knowledge.

On one occasion, one innovator shared that she beseeches the guidance of the Almighty (see 4.2.2.9) as she aspires to carry on the legacy passed on to her, that is, to boost the country's economy efficiently and make the life of every Filipino better. As Innovator D shares: *I always pray that our plants will grow with the technology. Likewise, I pray fervently for the success of using the technology for the less fortunate farmers and increasing the country's economy.*

The themes related to an organizational culture that emerged from participants' responses were the procedural process of technology utilization and cohesive teamwork.

4.3.1.2.1 Procedural Process of Technology Utilization (PPTU). The first element under the organizational culture is the procedural process of technology utilization. Knowledge sharing is essential for a company to achieve success since it can facilitate decision-making capabilities, build learning organizations (through a learning routine), and stimulate cultural change and innovation (Edwards, 2000). Still, overall performance in a company improves just when people do things differently. Routines and procedures are steps innovators systematically follow to reach the finish line for the technology to be received and utilized by the market. Standard operating procedures are equally crucial in KMS since missing one procedure might impede knowledge transfer.

Constantly searching for knowledge is vital because this is where ideas are built and created, expanded, converted into action, and turned into a product (see 4.2.3.2.1.1). To substantiate the inherited knowledge, innovators conduct scientific revision and interpretation of data. Prior to bringing the innovation products out to the market, innovators also collaborate with the end-users to acquire and incorporate feedback which enhances KMS.

Innovators' comments divulge that there is an established framework within the organization that guides the innovators on how to apply for patent, utilization, and commercialization of the technology following an organized and systematic procedure. Built on this scenario, *the procedural process of technology utilization refers to the systematic function of the gatekeeper, referred to as the technology transfer and business development office, who puts premiums on the technology to serve its purpose to the fullest.* Putting premiums on the technology is the act of monitoring the process of technology development until it reaches commercialization (see 4.4.2). *Procedures* are steps that are systematically followed to reach the finish line for the technology to be received and utilized by the market, not just displayed on the shelves or in museums.

Using gatekeeper in a specific context; from multiple innovators' descriptions, gatekeeper refers to the established framework (see 4.4.2.5), handled by the Technology Transfer and Business Development Office (TTBDO) to ensure that all technologies pass through quality control before reaching end-users. The office has a structured system protocol that guides the innovators on how to commercialize their technologies. In addition, the office conducts technology audits to identify the number of technologies that have a potential market value that would undergo the process set

by the established framework. Here is an excerpt from TTBDO- PDO 2: *Regularly, we conduct an audit, meaning we gather all the scientists and audit them on the strength of their projects. We determine the status and direction to know how to guide them to avoid projects dying naturally because some scientists do not have passion. Right now, we are conducting an audit on our scientists.*

Despite the aggressive approach taken by the gatekeeper, all innovators interviewed mentioned that one of the difficulties they encounter is commercialization (technology transfer) because of their lack of awareness, specifically in patenting. The value of patents has never been given much attention by these innovators because, according to them, applying for a patent is a tedious task and not their top priority. Their only concern is to create technology that will be utilized by the people, especially those who are in most need of their products. Therefore, they aggressively created technology and did not begin to appreciate the benefits of patenting until the establishment of the system. If not for the Technology Transfer and Business Development Office (TTBDO), the innovators would have no chance to patent and commercialize their output (see 4.4.2.4). As most of them say: *Thanks to the administration, for there is already an established system that helps us commercialize our technology.* In this regard, Innovator F shared: *For me* [laughs]*, it takes so long if I go for the patent. Applying alone is quite long. What is more important, what I did is being utilized.* Similarly, Innovator E said: *The only thing is that processing for a patent is too long. It took some time for our technology to pass; a very rigid process, and then you need money. We have other finances to attend to. Now our university is laying down offers, including the needed finances. It is an excellent thing that the office helps us out.*

One common downside of traditional practice from the past was that university research outputs, after they had been completed and presented (and lucky enough to be published) were kept and stored on the dusty shelves of libraries. After some time, due to the pile-up of copies, they were placed in the archives. The innovators expressed sadness that many of these have never been used or utilized by the community. As described by Innovator E: *Well, our goal [back] was just to present and publish. We did not know that the publication was no longer possible after publishing. It is the reason why our technology got stocked. Do you know the saying, publish or perish* [laughs]*? It was the reason why I presented in Vietnam. It is only now that I realize that the research was kept at the library after being published, and it stayed there.* However, the current administration sees the need to convert these research outputs into viable products that will help the farmers in their way of life and living. As Innovator E continued to say, the *chancellor challenged us that our research outputs be converted into something that citizens can use because that is the right thing to do.* Moreover, from the viewpoint of PDO-TTBDO 2, our scientists must utilize their research output*, meaning it is not only a document that one can read, but there is a concrete output that helps agriculture.*

These findings from the interviews are consistent with the view of Nelson and Winter (1982), as forwarded in 2.9.3.1**,** that an organization's technology is not ought not to reside in some hypothetical book of blueprints or with some hypothetical chief engineer but in an organization's system and habits of coordinating and managing tasks for fuller optimization of the products in the market referred to as organizational routines (Nelson & Winder, 1982). The performance of these routines is at the essence of an organization's technological capacity (Teece, 2009).

Similarly, TTBDO's framework, the so-called system, works collaboratively with various offices in the university, particularly with the innovators, to facilitate the progress of technology from its incubation stage until it reaches consumers. This routine activity constantly monitors the technology until it reaches the community, which otherwise might die a natural death. As PDO-TTBDO 2 describes, we *in the office monitor the technologies from the proposal until commercialization because it would be a waste if they did not reach the masses. What is worse, it will just die a natural death if there is no follow-up. At times, it will only be the results of data with no tangible thing our farmers need. That is our task here. We conduct regular reviews called auditing.*

In other words, through the utmost care of the gatekeeper [TTBDO] religiously monitors the implied organizational routine to safeguard the integrity of the technology before finally launching to the market.

4.3.1.2.2 Cohesive Teamwork

> "Not finance. Not strategy. Not technology. It is teamwork that
> remains the ultimate competitive advantage,
> both because it is so powerful and so rare."
>
> -Patrick Lencioni

The findings revealed that cohesive teamwork is a vital factor for successful innovation. As Innovator C explained: *I was with a team. I was the program leader. I am very thankful because I am blessed with well-versed and kind team members. All of those that I got, the program manager, management officer, research assistants, and experts, are all good and reliable. For instance, our project turned out to be successful because we were united in the team. We performed our respective tasks*

accordingly. Innovator A shared a personal anecdote: *Of course, since this is a team effort, we have the support of each other; I do not claim that I did it alone. If we are tired, we tell each other. 'Go team, Banana'* [laughs]. *There is a saying, 'Together, we achieve success for the Motherland.'*

This study maintains Pramlal's (2004) claim on cohesive teamwork that teams need to be cohesive and practical to be successful in any undertakings. In UPLB, the research team is composed of diverse individuals, each with his / her field of expertise, and each plays an essential role in achieving congruent product innovation in the solution of societal problems. Each team has a project leader (roles played by the innovators), as shared earlier by the research assistant, with supportive and aggressive members. Aggressive means that even without the physical presence of the team leader, members still work without qualms and have practical decision-making skills. For example, while the project leader was out for fieldwork, members diligently performed their tasks. As the researcher was waiting for the respondent to arrive, team members were seriously working in their space. One team member approached the researcher and said: *What can I do for you, Madam? I think you came early for the appointment. But unfortunately, our boss is still in the meeting.* So then, the researcher asked the team member if she could give a tour of the site while waiting for the innovator. The team member enthusiastically accompanied the researcher to the site without hesitation. When he arrived, the innovator was glad for the reception his team member rendered while he was still in the meeting.

Moreover, as project leaders, innovators have the full responsibility to guide the team members in just the way they have been steered by their former mentors, as mentioned in section 4.2.3.2.1.1. The team is described as a cohesive family because

it is related to a familial relationship where the leader acts as the family's father and gathers all the family members to discuss and work on a common goal. The leader sees that each expertise is shared and optimized (as exampled by Innovator F in 4.3.1.1). Further, each team mentors the understudy scrupulously to carry on what the forefathers have started. Innovator D eagerly shared her unique experience on this: *You know, I began as hmmm … an understudy* [as mentioned earlier by the University Extension Research Specialist II] *of our forefather in the technology that we do. I have already mastered how to make the fertilizer. So, even if he has frequent trips abroad, we continue with our work.* Innovator B shared: *I always tell my members, especially those who are technical and research assistants, to study their tasks well so that if their contract ends and they decide to go, they can use the skills they learned here. Or, those who choose to stay will learn the routine of technology.* Innovator G says: *And that is what I tell my understudy because I am nearing retirement age. What my forefathers did for us, yes, they were my mentors, is what I am sharing with them. I teach and guide them. They call me Daddy here* [laughs] *because I keep on sharing. I always tell them to listen to their opinion of each other, regardless of their position.*

Moreover, to trust the abilities of each other. It is crucial in the team. We call it a multidisciplinary approach, meaning various experts contribute insights/ideas to one another, delineating tasks and consulting based on each one to arrive at a substantial technology.

Their response was similar when asked, "What was the secret of staying cohesive as a team?" their response was similar. Everyone observes open communication, and trust is evident. It agrees with Messmer (2003), who forwards

that the increase in using project teams requires members to communicate effectively and work well together to yield more excellent value to product innovation. This study revealed that innovators prefer to work with a group because it is a confessed reality that they cannot do it alone. They need experts in the team to confirm their established patterns of information and double-check their knowledge acquisition. As mentioned earlier in the organizational context (see 4.3.1.1.), one innovator noted that she had to wait for her team member because of her expertise.

While it is true that innovators can be influential when working alone, research indicates that teamwork with various personalities can dramatically achieve and attain classic results by the same number of individuals working in isolation (Bunderson & Sutcliffe, 2002). The interviews confirm that innovators feel they cannot do it alone; thus, there is a need for the expertise contribution of the team. Innovator E recognized her limitations, so she needed experts in her group. As she related: *That ph level* [laughs]. *I need the proper calculation; we have a chemist on our team. Indeed, it is better if we have members to work with. True, I was the one who taught them about the technology, even conceptualized it, but I cannot do it all alone. I need someone. Wait, I have mentioned earlier that we also have a dietician to take charge of the sugar component to be diabetic friendly.*

It is similar to the findings of Bunderson and Sutcliffe (2002), saying that by broadening the range of experience and expertise available to a team, functional diversity can promote team effectiveness resulting in a sound and productive output. In this vein, findings reveal that when innovators are with their teammates, they can be more creative and innovative, develop more precise strategies, and respond more aggressively to competitive threats and environmental concerns. For instance, when

they address the question of how can they enhance agriculture to interpret the issue of food production? Having this in mind, they converge and corroborate, sharing their ideas according to their field of expertise, and knowledge creation occurs as Innovator A narrates: *Of course… the higher the plants, the more vulnerable to wind damage. Right? Of course, if plants are taller, they can't resist strong wind; they can easily be blown away, like tall bananas.* [And then] *there is no harvest, no income for the farmers, and people will have no food to eat. So, what we did as a team, we tried to … develop a dwarf saba through two means: first is through radiation, second is that there might be some short ones farmers may find in the fields. So that's what we did. Although we did the radiation, we found few that were good. And although there were a few, the process was quite long. So, we separated ways and went to different regions of the Philippines to look for a shorter banana variety. But the target was not only short ones. It should also have quality and be relative to saba. So, we conducted taste tests and sensory evaluations, and the yield should be competitive in the market. Oh, yes, we have experts on the team. So, there was a good turnout. But, of course, if there is an earlier harvest, the investment return to the farmers is faster, right? Aside from that, there should be resistance to strong wind, especially to typhoons.*

The SECI model, known as the Knowledge Creation model (Nonaka & Takeuchi, 1995), describes how knowledge types can be combined and converted, showing how knowledge is shared and created in the organization as shown in 2.6.4. Nonaka's (1994) view of knowledge creation involves transforming knowledge types between tacit and explicit. He argues that to create new knowledge, individuals in organizations take existing knowledge and change it into a new form of knowledge. There are four means of knowledge conversion: tacit to tacit (Socialization), tacit to

explicit (Externalization), explicit to explicit (Combination), and explicit to tacit (Internalization).

Converting tacit to explicit knowledge, innovators demonstrate (see 4.2.3.2.4.1) the process, and sometimes, through a non-formal dialogue, they document it by taking down notes—with their writing skills (see 4.2.2.8***),*** helping them in this stage [brochures, kit]—and then these documents are shared for everyone to read. For instance, Innovator D was proud to share the brochures and even showed a portion of how to prepare the mixture of the technology. *This is how to mix the product. For this fertilizer to be effective, you have to measure the correct amount; come and see our laboratory, and I will show you the live bacteria that we need to propagate for the mixture. You cannot just do the mixing. You have to consider some preparations. Yes, you need to measure it to avoid spoiling your crops.*

On the one hand, by converting explicit to tacit knowledge, innovators learn from the lectures and demonstrations of their forefathers (gurus). Or, at times, they read the manuals or brochures. They relate or connect what they are learning to their prior knowledge. Then, they put into practice or apply what they have read or learned from their mentors (with the guidance of their mentors) (see 4.2.1.2.1.1). After which, they come to their created space (see 4.1.1.2.1), meet their teammates (see 4.3.1.2.2***)*** and hear feedback from each other. They even have dialogues with the end-users and work collaboratively (see 4.2.1.2.1.2) in addressing and incorporating that feedback. They are also critical (see 4.2.1.1.2.1) when it comes to decision-making and looking into what best serves the people's interest. They are true to their commitment (see 4.2.1.3.1.2) and are altruistic (see 4.2.1.3.1) innovators. As

Innovator A narrates: *I started learning by watching the demonstration and listening to the lectures of our gurus. That is how I gained my basic knowledge.*
Then, of course, we have our schema. But you know, it feels good when you can relate or connect your experiences with what you already know… the higher the plants, the more vulnerable to wind damage. Right? Of course, if plants are taller, they can't resist strong wind; they can easily be blown away, like tall bananas. [And then] *there is no harvest, no income for the farmers, and people will have no food to eat.*

There was one innovator who said that he was alone in the project in the beginning. That project was under the Bureau of Agricultural Research (BAR), under the Department of Agriculture (DA), when the project was limited to having only one project leader from the originator to the next successor of leadership. Then he has to voluntarily share his idea (inspired by his forefathers) with one of his colleagues because he had to go to Australia for his doctorate. But when he came back, that's when he formed his team. As Innovator G recalls: *technically, I was alone. However, there was a time that under the Bureau of Agricultural Research … the project was limited to having one project leader. It started from the former project leader, leadership from Maximo to Langata, so eventually, I was compelled to convey it to my colleague. So, he took over the project's leadership, although the idea came from me. Of course, when I came back from Australia to the Philippines, we continued working on this technology with my teammates.*

Weiss (2002) forwards that one of the emerging trends in management strategy was reorganizing the company into teams, notably to boost productivity. This study found that innovators are not only after an increase in the organization's productivity but also work collectively for common task goals and objectives to help

the beneficiaries of the technology earn dignified, sustainable living. Similar to the team's tasks, Spector (2000) says a work team has three specific properties:

(1) Individuals must be interdependent and cooperative;

(2) Each has a, specified role; and

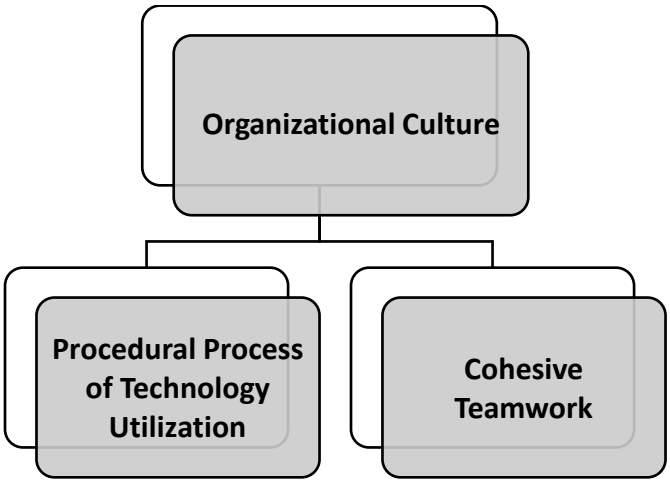
(3) There are common task goals and objectives.

As stated by Innovator H: *All of us function according to our strengths.* Innovator A says: *This is a team effort; the support of each one contributed to the success of this technology, and I don't claim it alone.*

Such practice is evident in UPLB Biotechnology since all individuals from top to bottom are involved, including partners and the beneficiaries of the technology, in mobilizing knowledge to achieve its full relevance to the community. Figure 4.15 shows the the organizational culture that leads to successful innovation.

Figure 4.15

The Organizational Culture that Leads to Successful Innovation.



4.3.1.3 Organizational Values. The third element under the organizational element is organizational values. The recent revival of academic focus on organizational values may result from myriad contextual factors, the legitimization of corporate social responsibility, and growing consumer idealism (versus materialism) due to the economic recession (Bell, 2013). Kotler et al. (2010) and Gorenak and Košir (2012) postulate that organizations' values are increasingly a competitive differentiator because of collaboration, with consumers demanding a more significant role in co-creation, including determining what constitutes product value. In the case of the current study, officials of the university and innovators do collaborate (see 4.2.1.2.1.2), and funding agencies (see 4.1.1.2.2) play significant roles (in funding the project). In addition, end-users' feedback is considered equally crucial in product development (see 4.3.1.3.1).

Similarly, organizational values play a significant role in the academe context in attaining product innovation. As observed and throughout the interviews with the

innovators, they are consistent in continuing the values rooted in their organizational history of helping the farmers, just as their former mentors (forefathers) did. Their technologies are testimonies of their passion for really serving the beneficiaries of technology. As Innovator D says of her technology: *The farmers will apply this to their plants so that they will grow healthy and there will be an abundant harvest. They will have a good income* [laughs]. *This is already my passion that I will grow old with* [laughs]. From a unique point of view, Innovator H says: *I don't believe in organic because once the plants are exposed to the air, we are aware that the air is no longer clean. What I mean is that the air is already contaminated with different chemicals. That is why I call it natural. We do it naturally, and there are no added chemicals in the pesticides.* Examples of technologies mentors started are Mykovam, Rennet, and Snap Hydroponics, geared towards assisting the less privileged in their lives.

Cummings (2008) suggests that old values can be changed through a new vision or mission statement. Leaders can empower their employees to implement the new idea into reality and increase employees' motivation. Similarly, based on the researcher's interview with the chancellor, acting as the chief leader of the organization together with the director of TTBDO challenged the whole members of the research community to focus their vision on food production in response to the crucial need of the society. As the chancellor stated, I deemed it *necessary to shift our vision to food production, and our goal is for every Filipino to have sufficient food on their table. Hence, I challenged all the scientists-innovators through the assistance of the TTBDO to bring their expertise to this worthwhile endeavor.* The director of TTBDO supported the challenge of the chancellor, saying: *The primary task of*

innovators is to shape and influence the work environment of our organizations to make it conducive to the efficient delivery of product innovation to target clients.

Prioritized organizational values and competing, firms probably vary in the values they choose to emphasize (Bell, 2013). For the innovators interviewed in this study, innovation begins with showing gratitude to forefathers for mentoring (see 4.2.1.2.1.1), exhibiting exemplar leadership and being open to change such that they can withstand the test of time. Innovator G, who feels very grateful to his forefathers, shares: *I owe so much and am very thankful to our forefathers who started the technology. Now it is my turn to train our RAs. Some established people did the same thing, which means that what you can do to make it unique is that no one has done yet. And that's when I was coming from my Ph.D. There were not many who worked on this. So, it was ancient technology, but then, it was not yet really used for commercial production of food or vegetables during that time.*

On one occasion, one innovator shared that she beseeches the guidance of the Almighty as she aspires to continue with the legacy that has been passed on to her, that is, to boost the country's economy efficiently and make the life of every Filipino better. As Innovator D shares: *I always pray that our plants will grow with the technology. I pray fervently for the success of using the technology for the less fortunate farmers and to increase the economy of the country.*

Doyle and Bridgewater (1988) say culture and leadership are essential elements to consider in the process of innovation. This study found that while this is undoubtedly true, there are considered essential elements. Organizational values, which include consistently showing appreciation for mentors, and concern for beneficiaries of the technology, are elements that mean a lot to these innovators. For

example, Innovator D describes: *I won't forget how my mentors helped me develop my skills. I was like their right hand* [laughs]. *But then I felt happy anyway. Do this…bring this…compute this…read this…Until today, I keep on reading, which led me to multiply this technology. There were only about six microorganisms. I was able to add more; now, it's already up to eleven. Because of them* [the forefathers], *I learned this technique. That is why when I did my doctorate, this became my focus.* As Innovator H says: *I grew up and witnessed the teachings of those who were ahead of us, their care for the farmers. That is why it was already imprinted in my thoughts to do what is best for our fellowmen. That is why I thought of natural farming. It is a good legacy. Prestige? There is or not; it does not matter. More important is the legacy because it is how people remember us the most.* Innovation can, therefore, also be described as the result of a complex set of organizational values built with the philosophical and sociological view of legacy since the innovator's motivation is to continue the legacy of their forefathers, and a primary goal is to build advocacy (see 4.2.1.3.1.1), rather than prestige or getting awards.

4.3.1.3.1 Concern for Beneficiaries of Technology. Based on the interviews, generally, innovators produce affordable technologies, improve lifestyles, sustain economic growth, and provide a lucrative return of investment to the end-users. As Innovator H says: *We are doing technologies not to earn an income* [but] *those that can help the farmers because that is our primary goal, our answer to the problems of the farmers, and* [it is] *affordable. Of course, they will ask about our income will be asked. But that is just secondary to us.* Similarly, Innovator E says: *It did not dawn on me to earn. My target is to produce something that will enhance people's health, like this probiotic guava tea. We all know that the fruit is nutritious; we did not realize*

that even the leaves are healthy. The end-users will earn from this because there are lots of guava trees.

In other words, findings reveal that innovators create technologies not for their prestige or lucrative income but for the prime beneficiaries of technology that remarkably affect their lives. Anchoring on this discovery**,** concern for beneficiaries of the technology, which refers to the extraordinary impact on or usability of technology in people's lives, is the topmost element. It is a distinct element of the organizational culture, which one innovator calls the *habitual culture of* passing on from generation to generation, which is why they always have an understudy. As Innovator G, the oldest of the innovators participating in this study, says: *We have already done this since time immemorial, and we pass this habitual culture from one generation to another. That is why we always have an understudy.*

In another lens, however, innovation, as defined by Fadaee and Alzharh (2014), "Is the process of converting products or ideas into merchantable merchandise or service" (p.1) and usability. The conceptual definition of usability by ISO (International Organization for Standardization) 9241-11 is when a product helps achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use (Agarwal & Venkatesh, 2002; Sauro & Kindlund, 2005; Whitehead, 2006; Peevers et al., 2007). Adding to ISO's conceptual definition of usability in the context of UPLB Biotechnology means utilizing the product innovation to improve the lives of the user and address solutions to society's prevailing environmental problems.

As can be seen, these findings disclose that, indeed, usability is a critical element of innovation. From a pragmatic viewpoint, usability or impact denotes the

beneficiaries of the technology, which brings those beneficiaries comfort and ease once they navigate the essentiality of the product, meaning the clients are comfortable accessing and using the product. Consumed Less time, yet the productivity is high. For instance, consider iDetect, a meat detection kit used to identify the kind of consumed animal meat. According to its developer, they lead with the iDetect Pork variant to tap into the Halal market. She explained that certifying bodies in the government and private sector are looking for affordable and effective ways to verify meat in the food industry in adherence to the Food Safety Act and address food fraud. Usability of the technology is a factor that is given considerable attention to providing an affordable and durable product. Hence, the interview findings agree with the conclusions from Selden and Orenstein (2011) that usability is a doorway for navigating the technology to find its purpose.

Apart from the beneficiaries of technologies or the end-users as the ultimate goal why innovators produce technologies, one innovator said her technology is industry-driven, meaning it was the industry that requested the innovator to come up with technology as a response to the demand of the sector in eradicating animal fraud in food, that is, verifying animal content of the food like halal food. As Innovator B describes*, it's industry-driven because that's what PCAARRD does. It's like they get the needs of the industry. PCAARRD identified the problem. They had an interest in traceability in response to the industry's demand. And the problem is, we cannot export pork, pork meat to like Japan. I think they target Japan, an export market because Japan requires traceability. But then, we don't have a DNA test kit for animals. So, I am working on it.* However, Innovator F identified the need of the industry where most of the potential clients are small-time business people trying to

make something of what is available in the community. As Innovator F says: *It is a big help to identify what research you will do when you know the industry's needs. Not the big industries. I mean here that I am thinking of our fellow men engaged in small-time businesses. I am a food tech, bio – BS Food Tech Graduate, but I did not go to the industry.*

One of the most striking findings in this study is; Contrary to the corporate world, which keeps trade secrets to sustain the economic growth of the company, UPLB BIOTECH does not keep trade secrets. Most respondents are not thinking of entrepreneurship but are willing to share their technology. If and when they do so, this is just a secondary motivation. As Innovator C says: *I am not so sure about the marketing aspect. I had no training on that. And I am not very good at the business side of science. I am just thinking of sharing my technology with the end-users.* Innovator B narrated that she only captures the chancellor's message to create a technology that the end-users will use (and not the business side of it, if ever), which is what motivates her to work. There is no secret to her technology because she is more than willing to share it with people, and she feels happy doing this. Regarding the marketing side, it's not her interest. In her words: *So, as a scientist with a technology I am making for them, I like them to use it, and I feel happy if they use it. Why would I keep a trade secret? I am doing a technology that helps the end-users. And how will they be enabled if I keep the secret? They will always be our top priority. Hmmm…the aspect of the business is not my interest.* And as Innovator F affirms: *I don't keep the trade secret (like what the others did before, they don't share how to do it, as if they are afraid* [laughs]*, because we produce technology to help people.* Once end-users have utilized the innovation, innovators describe a feeling of

happiness and self-fulfillment, which is an element of achieving altruistic skills (see 4.2.1.3.1). As Innovator H shares: *I like that farmers will earn from the technology that I am doing; they will utilize it to sustain a bountiful life. That alone makes me happy.*

In a nutshell, innovators create technologies to appease the lifestyle of the farmers, and BIOTECH is more than willing to share its trade secret of their products. After all, innovation is not about one's economic security but the financial sustainability of the end-users and society in general.

4.3.1.3.2 Consistent Appreciation of Mentors (CAM). Findings revealed that technologies still relevant to the community are resurrected and enhanced by the innovators, who aim to improve those technologies and leave an impact on the community. As Innovator G says: *Most of the time, forefathers started it. Then we continue so that the citizens will utilize it.* And then this technology is handed down to the younger generation, a new set of innovators, to continue. As Innovator F says: *I am passing this already to my students so that they are knowledgeable already when they would like to continue with it and enhance and increase the value. It's like they have on-the-job training*. This chain of dispensing over information continues to the next generation without cost (see 4.2.1.3.1). Thus, innovators are grateful to their forefathers, who were very generous and prudent in sharing their indigenous knowledge.

As introduced above, there is an individual or group of individuals whom all the innovators address as 'forefathers' (see 4.3.1). These forefathers, who were innovators themselves, mentored and guided the new breed of innovators, impressively indebted (to the forefathers). Innovators show consistent appreciation to

their former mentors (forefathers). It refers to the behaviors such as gratitude and credit for the insights/ideas shared in starting the technology that innovators toward mentors' exhibit. These mentors shared knowledge with the innovators without hesitation, and that is why the innovators are very grateful. If this had not occurred, they would have found it challenging to start. As Innovator D shares: *Mentorship is critical to us. Sometimes, seniors leave us, and there's no one to replace him/good enough to transfer the knowledge persistently; it's complicated if they do not* [laughs]. *So, I tell my research assistants that I need to train them. I teach them to be better than me so that their work becomes excellent. And when I have visitors, I tell them that my RAs are better than me.*

McCullough et al. (2002) and several other researchers conceptualize gratitude as a directed emotion towards appreciating the practical actions of other people such that they can emulate those actions to benefit the people, which this study supports. For instance, scientist Innovator D is indebted to her former mentors. She says that she is what she has now because of her mentors. She owes her successes to their forefathers. As she shares: *I owe this to my former boss. Ayyy, yes, he told me I could change the name* [laughs]. *Anyway, I improved it. But then I would say I want him to be remembered with this technology.* Wood et al. (2008), Watkins et al. (2006), and Armenta et al. (2017) view gratitude as an emotion that occurs after people receive aid, perceived as valuable and altruistic.

Gratitude, in this case, is similar to the work of Wood et al. (2010) and may have arisen from sources such as appreciation of one's abilities or a climate in which such successful work was possible. Similarly, the innovators in this study are very grateful. In addition, they are very appreciative of the advantages of technology;

hence, they look up to their forefathers who initiated the technology. Gratitude, then, is one of the virtues exemplified by innovators. Based on this context, it is appropriate to define gratitude as an emotional state that serves as the first driving force for the innovators in their quest to innovate and make a difference. Over and above, it is a remarkable value to which they adhere. It resonates with Gabriel Tarde's statement in his theory on 'The Laws of Imitation' when he says: "Meanwhile, let us not forget that every invention and every discovery consist of the interference in somebody's mind of certain old pieces of information that others have generally handed down" (Tarde, 1890 (1993), p. 3). 'Others' are those individuals who are first and foremost the starters of inventions which create a social change within societies or cultures (Kinnunen, 1996), and 'who' is referred to as the forefathers who have self-expertise (embodied knowledge). Correspondingly, this study elevates Tarde's ideas, whereby the innovators continue with what their forefathers have taught them and pass them on to the next generation until it becomes a cyclic habit, forming a commitment (see 4.2.1.3.1.2), to serve the people until it becomes an advocacy (see 4.2.1.3.1.1). The words of Innovator F are appropriate to conclude this discussion: *I am happy to continue with what our ancestors started, and this is what I am also sharing with my students. For this reason, I am grateful to them.*

Innovators show consistent appreciation for their mentors for the knowledge shared and even among the minor member of the group. Whenever one participates and contributes to the success of knowledge sharing, they feel their significance to the knowledge sharing process. Findings revealed that consistently showing appreciation of mentors is an essential element of knowledge sharing, which built up organizational values that means a lot to these innovators. For example, Innovator D

describes: *I won't forget how my mentors helped me access knowledge so I could develop my skills. I was like their right hand* [laughs]. *But then I felt happy anyway. Do this…bring this…compute this…read this…That is Until today, I keep on reading, which led me to multiply this technology. There were only about six microorganisms. I was able to add more; now, it's already up to eleven. Because of them* [the forefathers], *I learned the technology. That is why when I did my doctorate, this became my focus.* As Innovator H says: *I grew up and witnessed the teachings of those who were ahead of us, their care for the farmers. That is why it was already imprinted in my thoughts to do what is best for our fellowmen. That is why I thought of natural farming. This is a good legacy. Prestige? There is or not; it does not matter. What is more important is that people remember you through your legacy.* Innovation can, therefore, also be described as the result of a complex set of organizational values built with the philosophical and sociological view of legacy since the innovator's motivation is to continue the legacy of their forefathers, and a primary goal is to create an advocacy (see 4.2.1.3.1.1), rather than prestige or getting awards.

Figure 4.16

Organizational Values that Lead to Successful Innovation.

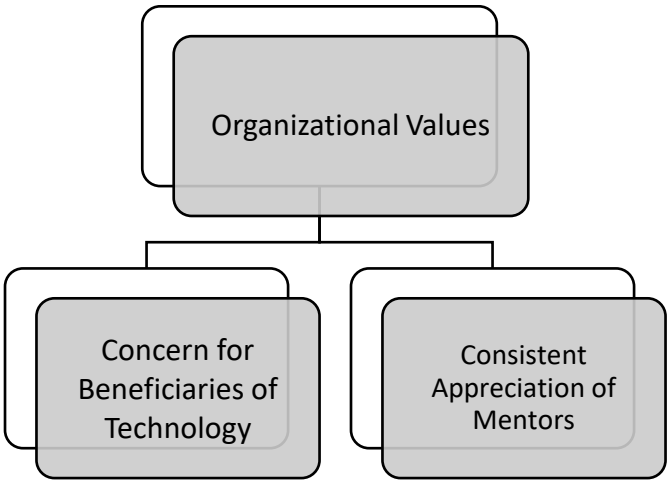
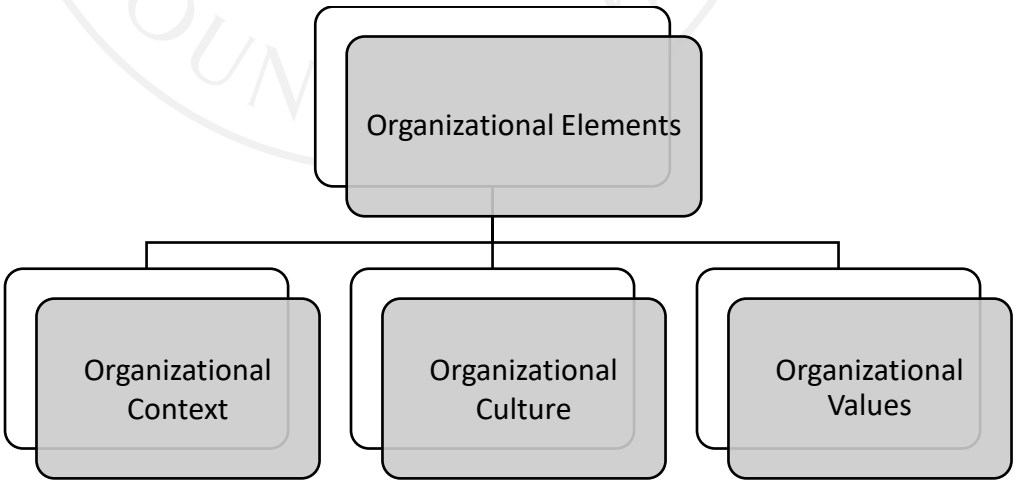


Figure 4.17

The Organizational Elements to Successful Innovation



4.4 Why and how R&D BIOTECH innovators in higher education institutes achieve success.

This study is conceived based on the framework in section 3.15 in Chapter 3, drivers along with influencers, attributes, organizational elements, and innovation push BIOTECH in higher education institutions to pursue successful innovation. Innovation in universities could either be undertaken using context-responsive or transformative approaches. In the first approach, the innovation path is heavily influenced by the need to respond appropriately to external drivers. In contrast, in the transformative approach, certain factors exclusive to the institution like its vision-mission-goals and objectives and institutional culture dominate the path of innovation.

This study pursues an innovation path model for higher education institutions. As one of the prime producers of human resources, UPLB BIOTECH attributes its success in innovation to its resources. Self-initiated innovation with support from the university is also evident (see 4.2.2.7). People perceive innovators as leaders in significant pioneering products that help them handle problems. As Innovator E says: *The university's resources are the first and foremost tool to realize smooth sailing and successful product innovation. Probably, we are the first, and people always say that we bring into action the result of our research to the community. We are being invited to share our knowledge in doing things that help the people.*

In addition, BIOTECH continuously seeks to improve its performance, products, processes, and systems through collaborative research (see 4.2.3.2.1.1) to produce technology. As Innovator H says: *We get in touch with private industry, like this* [shows papers]. *This one is PCCARRD; we will propose, and we have a collaborator. This one will serve as a model of a funding agency, the government agencies like DOST. We have collaborative research to identify technology that we*

need to do. In particular, the innovators seek to find solutions to industry's or society's problems through their product innovations and won't do things that are not useful. Innovator H says: *We propose with a partner, our private partner. This is our thrust, for example, on food production, because that is the identified problem of the industry, the sickness that affects the vegetables. Which one are we going to work on? For which one are we going to make a solution?* Innovator C adds: *You have to know the science like at the back of your head, and you have to think about the problems of familiar people, ordinary people. Then, you have to compare the problems with the solutions offered and try to discern their thinking and the solutions offered or proposed. You do that several times—I am not sure what core competencies* [are being used when I am] *doing the same process several times until I come up with an innovation.* And Innovator F says: *People here in the Philippines already have this kind of technology, although we do not have milk. Many overseas Filipino workers were interested in how to do it because they like the quality. They like it because it is locally made. So, instead of buying abroad, which is expensive, they expressed their interest in the product. Yes, yes, I made this. So, they have another choice in making the cheese that they prefer. A lot of them have already bought it. Some use it as a hobby, others for a trial like the students, others own a restaurant, a bakery, and the other as an authentic cheesemaker. Then, later on, I received various calls already. More calls are coming.*

The findings in this study are consistent with Kalanje (2003), who stresses that in a knowledge-driven, globally competitive setting, technology-based innovation, called 'innovation,' is a central element for fruitful firm performance, including in higher education institutions. As a result, scholars give considerable attention to

creating and developing innovation models, and higher education institutions are starting to take this trend seriously, embracing innovation to their advantage. This study, however, shows that the successful innovation products UPLB Biotechnology has produced are focused on the benefit of the community, particularly the farmers (see 4.3.1.3.1) as Innovator H says: *As if there is a pressure on us to produce technology. Nevertheless, of course, my only goal is to help the farmers.* Based on these findings, what model could be derived for successful innovation? Two compelling schools of thought on what drive innovation in UPLB BIOTECH significantly relate to this study: the market-based and resource-based views (see 2.8.3.1).

In contrast, innovators are not only concerned with the conditions of the market but are more concerned with the farmers' conditions and are conscious and responsive to the existing social, and environmental problems (see 4.1.1.1) that led to their innovation activity. Innovator H says: *No, not yet, that cradle program of DOST. That is why we are giving solutions to solanaceous plants, eggplants, tomatoes, and chili in my technology. We are giving a solution on wilting, derived from fusarium, a pathogen. The dying and withering of your bitter have a more significant problem than the problem on tomatoes. So that is why they want me to be involved, or we partner to find a solution to this kind of problem.* They can scan their demanding environment and study the immediate issues (see 4.2.3.1.3.1) and problems that confront the townspeople. The environment (see 4.1.1.1) is the impetus for innovators to aggressively involve themselves in innovation endeavors to address the aftermath of natural and manufactured calamities (see 4.1.1.1.1). These findings agree with Cohen and Levinthal (1990) and Trott (1998) that few firms—including higher

education institutions—can scan and search their environments effectively, and only those who do have the ability will thrive and survive to create an impact. As Innovator H says: *We have used core competencies, even if it is simple, but we can reach the product, that is what we thought of something to do. What are our tools? We are thinking of something, but we need to fit our tools with our environment? We might be thinking of something; then, when we are already there, we might need something we do not have. That is our thinking. We put ourselves where our skills best fit, and we do our best to develop a product with existing equipment that we have and not only skills.*

On the other hand, the findings also support the idea of the resource-based view in which a firm uses its resources to develop innovative new products (Eisenhardt & Martin, 2000). Similarly, UPLB BIOTECH utilizes its own skilled (see 4.2.1.1) and competent innovators, who shape the very foundation of innovation in the institution. These innovators use their human assets to create technologies that help sustain not only the economic growth of the institution but the society and country in general. For instance, as discussed earlier, findings revealed that innovators possess various innovative skills (see Table 4.2 on Tabular Summary for Innovative Skills), which they optimized to find solutions to environmental problems through their innovative products. According to Eisenhardt and Martin (2000), Conner and Prahalad (1996), Grant (1996), and Wernerfelt (1995), the resource-based view of innovation believes that a firm's resources provide a much more stable context in which to develop innovation activities and shape the market in accordance to its research direction. In addition to this view, UPLB BIOTECH's innovation is concentrated on the university's research direction and focused on its organization's

resources, capabilities, and skills in coming up with unique products that are hard to imitate. This finding is consistent with the resource-based view of innovation that when firms like higher education institutions have valuable resources and are not hard to copy, they can achieve a sustainable competitive advantage – frequently in innovative new products (Eisenhardt & Martin, 2000).

While all the innovation factors and innovation competencies certainly contribute to successful innovation, an explicit question allowed innovators to respond; What UPLB BIOTECH attributed as a driver to innovation success. The elements to which innovators felt UPLB BIOTECH attributed success could be loosely grouped into two general focus areas. The first is related to environmental problems. The second area relates directly to the UPLB Biotechnology innovation process itself, which, fueled by the factors of innovation and innovation competencies, is systematically followed and implemented. The related response in these areas is detailed below.

4.4.1 External Drivers as the Impetus for Innovation

As detailed earlier in this chapter, external drivers (see 4.1.1) from which the agricultural sector is significantly affected by the proposed product innovation model. The impetus for the innovators to create product innovation is the environmental problems that beset society. This study confirms previous findings in the research that one of the alarming reasons why minimal attention is given to innovation in agriculture is the sporadic climate of the country, mainly due to climate change, as stated earlier in Chapter 2 (see 2.9.1.3). When catastrophes hit and destroy crops, plants, or agricultural products, people tend to be devastated, especially the farmers. They do not know how to sustain their products when environmental problems attack,

whether artificial or natural calamities. These perturbing issues that delay or obstruct agricultural activities make the innovators feel fretful. As Innovator D describes: *I feel sad when catastrophes are coming that destroy the root crops of the farmers helplessly because of the unpredictable weather caused by the climate change, as they say* [sobs]. *I feel the agony and anxiety because I come from a family of farmers. That is why I committed myself that I am going to helping them live amidst calamities. That is why I am here working hard to enrich and increase the varieties of bio-fertilizer.* Similarly, Innovator A says: *I got interested in what I am doing because we are farmers. Furthermore, just like the others, I desire to help our agricultural sector because this is where natural resources lie. And even to respond to the threat of climate change that causes unexpected calamities.*

Thus, they continually search (see 4.2.3.2.1.1) and, as was shown and exampled throughout this chapter, the creation of technologies (see 4.3.1.2.1) is their foremost concern, which can respond to the needs of the society, particularly the ordinary farmers as Innovator F says: *Yes, because if you do not know how to identify what you want to enter, you will not. You will grope in the dark. In other words, you need to feel it first* [laughs] *the process, so you can identify what you want to do with your research that can respond to the needs of the society, particularly the ordinary farmers.*

However, this does not necessarily mean that the innovators have to wait for calamities to arise before innovating. In fact, according to the technology transfer officer, instead of naming it as calamities, she recommends using the term environmental problems, which means that innovators may do something even before these environmental problems occur. One of the innovation competencies imprinted

in their system is foresight, as discussed in section 4.2.3.1.3.1. As DMO- TTBMP 3 says: *I am not sure if calamities are the correct term to use. Better yet, use environmental problems. Because using calamities is as if we are waiting for something to happen before we take action. However, the other things that they do are pre-empt, like, for instance, the SARAI. SARAI is an acronym for Smarter Approaches to Reinvigorate Agriculture as an Industry in the Philippines. It has many sub-projects of different kinds. For instance, farmers can use the hand-outs for rice and corn and manuals for an agricultural monitoring system of web applications. Technologies may not necessarily be a product at the laboratory. It could also be copyright materials.*

As introduced in 4.2.3.1.3.1, foresight skill is the ability to forecast potential product innovation based on the community's need, meaning that even before catastrophes hit the country, innovators have provided technologies that will somehow address the aftermath of those disasters. After using the technology, they enhance or improve it to better suit the needs of society. Very seldom do they implement radical innovation.

There is a need to calibrate the agricultural approaches and innovate. As Innovator G says: *It is high time that we restore and enhance the condition of our agriculture. Hmmm, I am not saying, you know, that you need to spend a significant amount in order to create something new. Look at what I have done, it is one million only. The others may reach ten to twenty million in their projects* [laughs]. *Secret? Materials should not be that expensive; they must be for the masses. Oh, yes, there is quality control also.*

According to reports, the Philippines was ahead in Asia in the agriculture industry in the 60s and 70s. However, they no longer enjoy the laurels of being the world's model and most productive in agriculture. Recently, in the article of de Carbon (2019), she stated that agriculture is a dying sector in the country, considering that the Philippines was once the envy of its neighboring countries. Furthermore, to add, the Philippines are prone to natural disasters, particularly typhoons and floods, and, as previously called out, suffers major human-caused environmental delinquency like deforestation (which causes soil erosion), air and water pollution, improper disposal of solid and toxic wastes, and many others which significantly affect the production of agricultural products (de Carbon, 2019).

Likewise, many daily newspaper commentators reveal the distressing plight of agriculture in the Philippines. Take, for example, the observations of De Guzman (2018), who says that the agriculture sector, contributing a mere 0.03% to the third quarter Gross Domestic Product (GDP) growth, continues to be the laggard among three major industry groups: services, industry, and education. It is also true in the study of Ebora et al. (2018) released by the Food and Fertilizer Technology Center (FFTC) Agricultural Policy (2018), albeit its relative contribution to the GDP has been declining over the years. The services sector, which contributed 4.1% to the GDP, remained the economy's main driver. On the other hand, the industry sector, which contributed 2.1% to the GDP, also grew slower by 6.2%. It is an adverse effect of the decline in agricultural outputs. An example is a massive increase in the price of sugar and tin cans, which caused the scarcity of necessities like food within the meager income of thousands of Filipino households. Based on the testimonies of the innovators, the present study significantly noted the devastating truth that the

agriculture sector is dying. As pointed out in our previous discussions, agricultural land turns into industrial areas, shopping malls, and subdivisions. In addition, many agricultural schools are producing office-oriented workers who would much rather do the paperwork than help improve the country's agricultural sector. Because of this, the Philippines are lagging in their long-term total factor productivity in agriculture.

Due to these various dilemmas faced by Filipinos, particularly in agricultural predicaments, farmers are greatly affected by the country's economic status. As was discovered in this study and detailed by interviewees repeatedly, one of the problematic issues that confront the farmers is the very low turn-out of harvest due to drought, lack of well-maintained irrigation, and bio-fertilizers that will nourish and sustain the growth of soil-based and water-based products. As has been exampled above, findings show that innovators are pro-environment advocates of organic products, meaning they use organic resources instead of synthetic chemicals that are harmful to people's health. They denounce using genetically modified organisms (GMO) in their products. For instance, hydroponics is a highly recommended technology for those who want to grow plants organically because the product does not use pesticides. The same is true with the technology on WiltCure, which does not support utilizing pesticides in cultivating plants, meaning both technologies advocate organic or natural planting. As Innovator H says: *I am working on the process of producing a bio-pesticidal or bio-pesticide. I will not tell where it came from* [laughs], *from a novel source, and maybe like that against fusarium wilt. Fusarium wilt is a plant disease in solanaceous plants like tomatoes, eggplants, and chili. Because we have a problem with fusarium wilt, our farmers use chemical pesticides. So, what! I do not think about GMOs. We are against it. Instead, we help our country to have an*

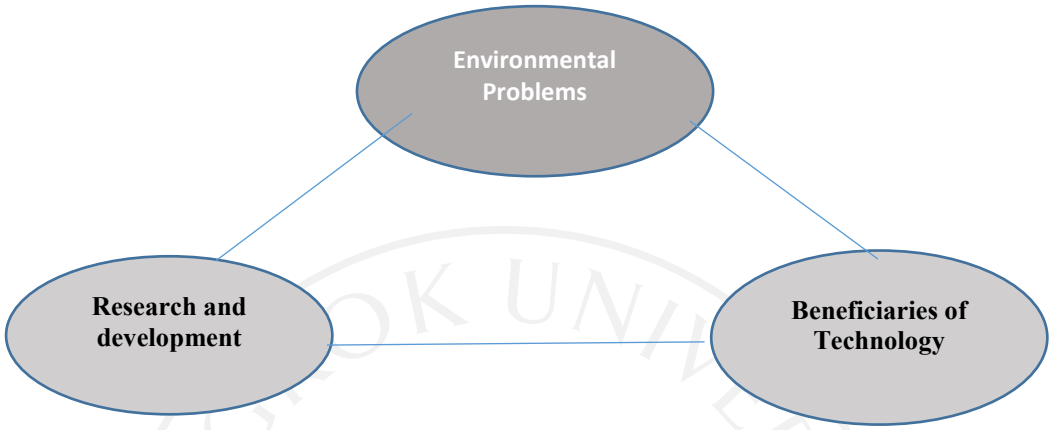
established, strong stand against GMO products. Is not it being discussed in the Senate already? Yes, it is like that; we are pro-environment. Also, eco-friendly.

As shown above, through the continuous development of new knowledge applied to current technologies, these innovators effectively address the country's needs. Extrapolating these innovators' approaches to agriculture in the country as a whole, it appears that the development of a knowledge economy offers a solution to the economic and social problems arising in the country. Unlike the structure of the simultaneous coupling model itself (see 2.6.1 for the details), it is evident that there is no starting point of how innovation occurs, which is similar to the observation of (Trott, 2012), that is, the marker of commencement for innovation is not known in advance. In contrast, in UPLB BIOTECH, it is palpable that environmental problems are the starting point of how innovation occurs. Furthermore, it has been noted and exampled that innovators produce technologies for the less marginalized instead of competing in the market, as forwarded by Galbraith (1982), who says that innovations are stimulated by technology, customer need, manufacturing, and other host factors, including competition and industry. As discussed earlier in the outlying thoughts, the need for the industry is also one consideration to begin innovation.

According to Galbraith (1982), this linear model, which is also referred to as the simultaneous coupling model mentioned above and shown in Figure 4.20, is the result of the quick link of knowledge within all three functions (Manufacturing, Research, and Development, and Marketing) that foster innovation. Contrary to this, findings from this study show that what triggers innovation are the society's needs, research, development, the market, and end-users (see 4.1.1.2.2 and 4.3.1.3.1, 4.2.1.1 and 4.2.3.2.3.1).

Figure 4.18

Simultaneous Coupling



As detailed earlier, innovators are seriously taking their time to study and develop the foresight (see 4.2.3.1.3.1) to predict the aftershock of the endemic problems besetting the community. Backed up by their expertise in research skills as one of the innovation competencies (see 4.2.3.2.3.1), innovators conduct massive investigations to rule out the damage to agriculture caused by societal issues such as typhoons, floods, and drought and among others, prompting them to work on technologies that respond to these rising problems before the problems occur. Innovator A shares: *We first study calamities like floods, drought, typhoons, and others. Yes. If you do not know the effects of these catastrophes, you will not know what to do. Remember, it* [innovation] *must respond to the illness of the society.*

Importantly, innovators promote pro-environment, eco-friendly, and natural methods of producing products for the healthy lifestyle of the beneficiaries of technology. Such actions show their commitment to the Filipino people (see 4.2.1.3.1.2) to providing exemplar innovation products and continuing the legacy as

exhibited by their forefathers in a way that becomes their advocacy (see 4.2.1.3.1.1). As described by Innovator E: *Almost all of us scientists, the direction of what we are doing is on how to optimize our natural resources because they naturally grow on the soil everywhere. For example, is the guava tree suitable? You do not plant them* [laughs]. *There are many health benefits, not only the fruits but also the leaves and many others. Camias may do. You can also make it your project* [laughs]. And as Innovator D shared: *If you notice, all of us inventors here have our foundation in what we are doing as a response brought about by the catastrophes. Even if there are no calamities yet, we are already thinking of ways. Have you heard the SARAI? Yes, SARAI, S…A…R…A…I… That is, it! That is a good example.* It is like an adaptor used to make data available and disseminate information even in the absence of internet connectivity.

4.4.2 The UPLB Biotechnology Process for Development of Technology

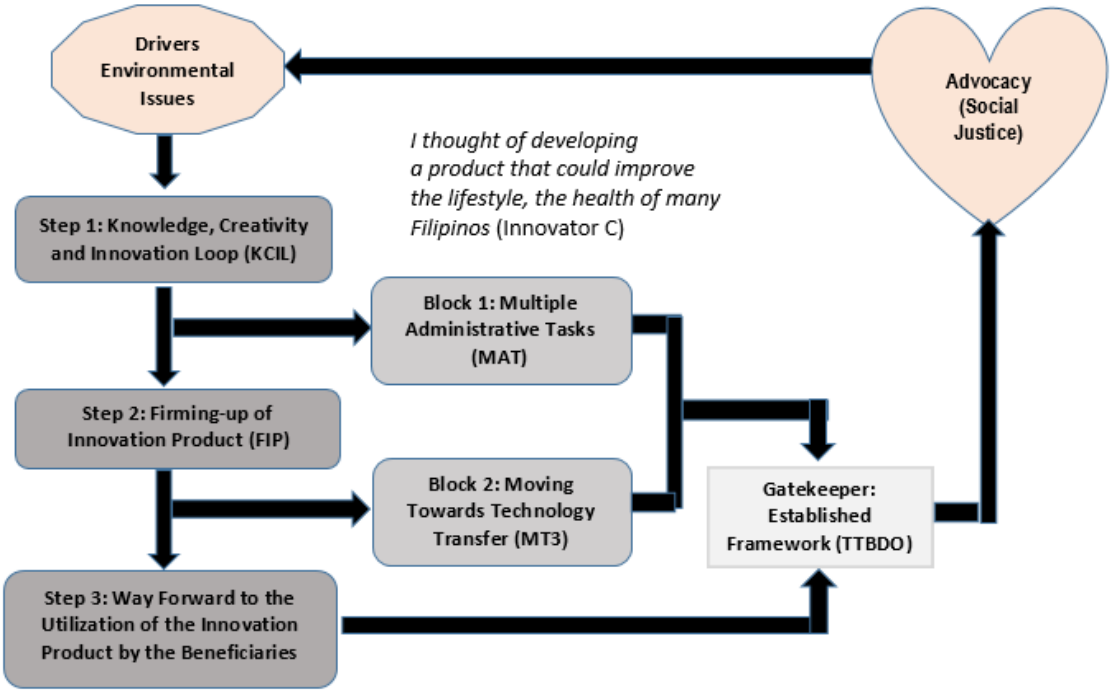
This section builds upon the findings forwarded in 4.1 (the characteristics of BIOTECH that influence innovation) and 4.2 (the innovator competencies and attributes), putting these into the context of the innovation process engaged by BIOTECH. In addition, to help validate the model developed here, links to the earlier findings, including examples and interview quotes, and links to literature resources are provided.

As illustrated in Figure 4.19 below, there are three steps or processes involved in developing the technology. As introduced previously, these steps are systematically followed and implemented—fueled both by the factors of innovation and innovation competencies—and thus, the process itself contributes to innovation success. However, in between each of these steps, a block hampers the speediness and

nimbleness of the product development. However, a gatekeeper acts as a bridge to proceed to the succeeding steps. It helps ensure that each innovator's interest in producing an outstanding innovation product is sustained amidst the bumpy road until it achieves the end goal of reaching the beneficiaries of the technology. Find below the detailed description of these steps and the blocks.

Figure 4.19

Three Steps or Processes Involved in the Development of the Technology



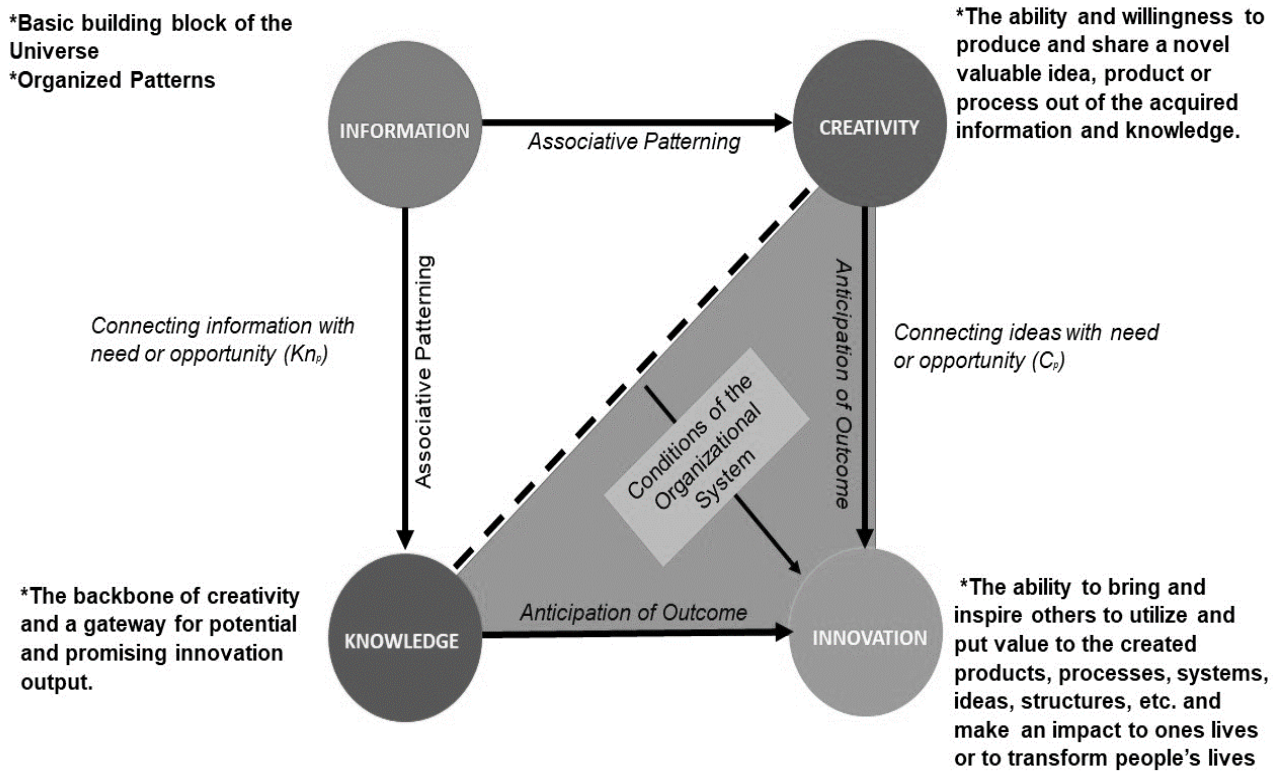
Note that the model Figure 4.19 is primarily derived from the interview findings and observations included in 4.1 and 4.2 above. Where appropriate, core findings and examples gained through the interviews will be repeated below in support of this process model.

4.4.2.1 Step 1: Knowledge, Creativity and Innovation Loop (KCIL). Having set the ground for technology, how does UPLB Biotechnology ascribe the interweaving association of knowledge, creativity, and innovation towards the development of product innovation? Findings from the interviews and observations revealed that the process of product innovation consisted of three elements: information, knowledge, and creativity. For instance, as described by Innovator C: *As I see it, the most important of the three is the idea. The 'ideation' in it. You know there is a bit of creativity in those that play within your mind. Because of the information, you can own it. What I mean is, you hear it, you get it, you gather it so you can enhance your idea. You can enhance your idea, and then you can widen your knowledge as long as you have ideas.)*

Thus, the findings are consistent with Bennet and Bennet (2005) framework on the Relationship between Innovation, Knowledge, and Creativity, as shown in Figure 4.20 below.

Figure 4.20

The Relationship of Innovation, Knowledge and Creativity.



Note. Adapted from Bennet & Bennet, 2005. Used with permission.

Figure 4.20 explains the three essential elements of innovation in attaining product innovation in UPLB BIOTECH. In the loop, the first concept is information derived from situational information driving need and demand coming from the aftermath of manufactured or natural calamities as detailed in 4.1.1.1.1. Innovators say they consider the following questions: What is the extent of the impact of these catastrophes? How many casualties? How many households and agricultural products are damaged? How many people are generally affected? Then, without hesitation, innovators establish facts and figures regarding these catastrophes and study the patterns, which eventually lead to creating technologies in response to these pressing calamities. This process relates to their Technical Skills, as detailed in 4.2.1.1, 4.1.1.1.3, 4.2.1.1.1, and 4.2.1.1.2.1.

As Bennet and Bennet (2008) forwarded, in this study, data (a form of information) is considered simple patterns, and data and information are both patterns but have no meaning until some organism recognizes and interprets the patterns. Innovators, by the nature of their work and the institution's thrust, recognize and construe the patterns for the people. For example, Microencapsulated Fruit Bioactive emerged from Bignay is an exotic Philippine fruit utilized in the production of red wine, which has a longer life span. For instance, SNAP Solution for a Hydroponics System is a low-cost and straightforward hydroponics system adapted to the Philippines, making growing crops hydroponically possible. It came into being because of limited space, especially in an urban environment. iDetect, a meat detection kit to identify consumed animal meat, was developed to address food fraud and adhere to the Food Safety Act. Dwarf Saba Variety is fruiting, high yielding, and

more resistant to typhoon damage. *Rennet* is an enzyme preparation that emerged as a substitute for animal rennet as a milk coagulant in cheese making.

Moreover, the innovators of the different technologies prepare themselves in specialty areas (as detailed in 4.3.1.1, 4.3.1.2.2, and 4.1.1.2) to come up with these products. As described by Innovator H: *It is related to what I have learned because I studied BS in Agriculture; my MS is in Botany. My Ph.D. is in Biotechnology, so it is all about plants.* Innovator F shares: *You know what? For example, here in BIOTECH, our specialization is handling microbes. So, using microbes to produce microbial base technologies that can produce products; is a process of using microbes to come up with a product.* Innovator A says: *So, there are times, just what I have said earlier, that we have our specialization, and we use it to understand things, right?*

Furthermore, Innovator C describes: *I thought of using technology to encapsulate a bioactive in the past decades when I took my training abroad on how to use novel processes in technologies, not just for food processing but also for developing products that may impact human's health. So, when I came back after getting my Ph.D., I thought of developing a product that could not just be an endpoint application of a technique that I learned abroad but something that could improve the lifestyle and the health of many Filipinos.*

Innovators expanded their knowledge of these areas (see 4.2.3.2.1.1) through observations and queries about various environmental problems and calamities and by observing why and how agricultural products live and thrive amidst wet and dry seasons. This information eventually formed patterns of systematic schema in the brain that stimulated the innovators to, within their areas of focus, explore and

critically understand their surroundings with ease and clarity as Innovator A describes: *Hmmm, one of the varieties of bananas. Is not we have Lakatan … are you familiar? Yes, because I said many bananas are saba, they are tall, very high; now we want the shorter variety. Why do we want short ones? You want them to be shorter because of several advantages: they are less vulnerable to typhoon, which is prominent in the Philippines, especially in Luzon. So, there are lots. Furthermore, every time there is a typhoon, you can have that saba, right? So, the idea is you like saba because it is resilient by having a shorter variety so that it will not easily get damaged from a typhoon.* It is consistent with the description of information as the basic building block of the universe (Bennet & Bennet, 2005; Bennet, Bennet & Avedisian, 2015). These patterns of information necessitate actions to give meaning to them.

In the context of this study, one innovator became intrigued with why cactus or other plants live amidst drylands. Her critical and evaluating skills are exemplified (see 4.2.1.1.2.1 and 4.2.1.1.1.2). What could be the dry soil's contents that make edible plants grow? This query gave her the idea to inquire and investigate more on why cactus thrives, to explore whether there could be alternate edible plants from which humans could benefit instead of planting cactus. She started gathering data and information by collecting various dry soil types nationwide and abroad, comparing and interpreting this data and information. The processes leading to the discovery of new technologies are rigorous. For example, as Innovator D shares her experience, it *started with "Micronesia," and biotech has started its vision. "Micro" is fungi, "Risa" roots. Roots of plants. They have a symbiotic relationship. So, the plants give carbohydrates to the molds; then, the molds get nutrients from the soil and water to*

give to the plants. So, these molds work very well in stressful conditions because when you put them in good soil, they will not work anymore. Yeah! No, there are molds that thrive better in a neutral ph. They are very effective in promoting growth in acidic soil. When I say practical, this is in terms of promoting the growth of the plants. So, in the beginning, we looked all over for Luzon. We searched around Cagayan everywhere to discover this project of mine. Since I am a forester and my boss was a forester, we targeted reforestation. We collected soil samples, "Rysusfir soil," if you know "Rysusfir," [they are] *those that have roots in the stress "collision," like the marginal lands or grasslands. If you say grassland, they are the dried roots, and the indication was, for example, all our plants die because we collect* [them] *during the summer. Supposedly in summer, they turn brown. And some plants would still be green, even the dried roots; others would already be dying, but the dried roots would still be green. So, we collected those with unusual growth, which you might expect to have died or paled already. Then from there, we brought them into the laboratory, and we got one by one the microbes—we have a technique on how to get those spores of the Mycorrhizal fungi—and then we increased them. There are a lot of them in one root sample; in the root-soil sample, you can see many of them. So, you would not know which one works, so you have to get the spores one at a time under the microscope, then put them in a plastic cup so they will increase; we let them increase in number. Yes, inside. So, we let them increase, and then after three months or six months, we check on them again. So, they keep increasing, and then we take the spores and put them in the plants. For example, our target plant is Narra or any plant, forest trees. We target reforestation, and so we use reforestation in different*

species. We put those different kinds; there are different kinds of microbes. But all of them are "Mycorrhizal"... and then you evaluate which one is good or not good.

Hence, the birth of Mykovam. Mykovam is a soil-based bio-fertilizer with beneficial mycorrhizal fungi active ingredients called Arbuscular Mycorrhizal Fungi (AMF) comprises 12 species collected from stressed environmental conditions. As presented in 4.2.3.2.3.1, Mykovam is very effective in improving plant growth and increasing the yield and survival of several agricultural and fruit crops and forest trees. It can also increase plant tolerance against root pathogens (Aggangan et al., 2013). The technology on Mykovam addresses the lack of harvest and plants dying due to soil aridness and the lack of irrigation to supply ample water to the plants. Mykovam is used nationwide and across Asia.

Along with the information gathered, innovators share and discuss ideas among their team members (see 4.3.1.2.2). As Innovator H shares: *So, I am the project leader in our team. We have our RA, Lab Tech, and phase two of our project here. Phase one was during the research part! It was indeed teamwork; that is where we can develop the technology. So, I have RA who helped me out. Yes, it is like screening that we are looking for what can control fusarium wilt. We have an organism called the pathogen fusarium; then, we are looking in the laboratory for something that can control that may come from different sources. We had information regarding patent that we could apply for. Yes, all of our work is according to our expertise.* Then, the individual members construct and elaborate on the acquired information to get the desired product innovation.

The study corresponds to the Diffusion of Innovation Theory, the process by which an innovation is communicated through channels over time among the

members of a social system (Roger, 1995). This theory has five stages of adoption: (1) Awareness; (2) Interest; (3) Evaluation; (4) Trial; and (5) Adoption. At the first stage, the awareness level, the individual is exposed to the innovation but lacks complete information. Findings of the study reveal that innovators, upon exposure to the technology, are required to weave and establish comprehensive information regarding something (the beginning of the act of innovation). Note that information is the foundation of knowledge, as explicated in the framework of Bennet and Bennet (2005). In the second stage, the interest level, the individual becomes interested in the new idea and seeks additional information about it. Findings of the study reveal that as innovators become interested in the new idea, they seek additional information about the technology, weaving their scientific knowledge (see 4.2.3.2.3.1**)** with that of their traditional knowledge handed down by their forefathers (see 4.2.1.2.1.1). In the third stage, the evaluation level, the individual mentally applies the innovation to his present and anticipated future situation and then decides whether or not to try his idea (radical and incremental). Findings of the study reveal that an innovator focuses (see 4.2.1.1.1.1) on product innovation and assesses the feasibility of the likeliness or advantage of the product innovation in the community. During the fourth stage, the trial level, the individual uses the technology. Findings of the study reveal that the innovator tries out and demonstrates the technology to the end-users (see 4.2.3.2.4.1) and gets feedback, incorporating that feedback into the refinement of the technology. Then, all the way to adoption, where the innovation is engaged in the fifth stage, the adoption level, where the individual decides to continue the full use of the innovation. Findings of the study reveal that the innovator collaborates with a potential adopter for funding (see Figure 4.7 and 4.1.1.2.2**)** and forge possible partnerships for adoption

and mass production of the technology (see 4.2.1.2.1.2). This interpreted information, which now has deeper context and meaning in its practical application, is knowledge. See 2.2.1 in Chapter 2 for a depth treatment of knowledge. How does an HEI view, create and utilize knowledge about product innovation? Connecting findings from observations and the innovator interviews with the literature review reveals that there are various ways that knowledge is classified that can help build an understanding of the link between knowledge and creativity. Two that appear immediately significant in this study are explicit and tacit knowledge.

Knowledge typically expressed easily refers to explicit knowledge. Innovators gained their knowledge through the formal and non-formal articulation of knowledge using figures, diagrams, various sources of multimedia, and manuals. For instance, innovators read the manuals (explicit) in addition to their understanding and experiences; they read and follow the instructions or procedures carefully to produce the desired technology. As described by Innovator E: *What I do, I read journals, manuals, and reading materials that I know can help me.* One innovator is a bit computer mania, her descriptive terminology, and she subscribes to various platforms that would enhance her knowledge. As Innovator B says: *I am a computer techno fab, so I have fun subscribing to different ways of learning online, even if I pay. It is a big help to me because time is of the essence.* More often than not, existing technology is used as their realia in explaining their ideas. As Innovator D says: *Because we already have this kind of technology started by our forefathers, it was easier for us to study and explore it. That is why we were able to multiply the fungus. Before, we only had eight of them. Now, we have about twelve.* Furthermore, as Innovator B says: *Your study is very nice and interesting! Through the result of your study, people will realize*

the value of the roles we play as innovators not only in the university but also in society. The DMO- TTBMP 3 has also affirmed this reality. She shares: *Indeed, our scientists-innovators play significant roles in the agriculture sector.*

On the other hand, tacit knowledge is difficult to share and transfer because it resides within the mind. An example in this study might be the forefathers' perceptions, ideas, and feelings. Even though tacit knowledge resides within them, these forefathers transferred it to the present technology developers through experiences such as mentoring, sharing, direct involvement or actual performance of the process, and open feedback channels among mentors and those being mentored (see 4.2.1.2.1.1). For example, innovator F says: *Because their mentoring has helped me a lot* [laughs]*, I learned the secret of rennet to come up with cheese. You know they always brought me in when they did a demonstration to the people. I watched them.*

Furthermore, now that I am the one demonstrating or doing it, even if at times they are non-reactive, I go on [laughs]. *I received much help from my former professors. For instance, I am from Sta. Cruz, Laguna, and I know we have a white cheese industry, and I enjoy eating it. So, I feel happy* [laughs]. *I learned, and now I am teaching and sharing. As I told you, if you keep teaching it, eventually, you will master one thing.* Furthermore, as Innovator G says*, our forefathers contributed much to the success of innovation because they patiently taught me. Nevertheless, instead of leveling up by using high-end materials, I used discarded materials.*

Verbal and continuous feedback from their mentors and among team members (see 4.2.3.1.3.2 and 4.3.1.2.2) is one of the best tools for enhancing their knowledge. This finding is consistent with Erns (2002) and Nonaka and Takeuchi (1995), who

says that for new product development to be effective, there must be a continuous sharing and utilization of knowledge to expand its breadth of usefulness to the organization and the community. Further, Tannenbaum and Nash (2002, p. 101) agree by saying, "The firm's ability and the innovator's agility to apply knowledge and information towards the discovery of new products and technologies and other related endeavors of the organization whose aim is to optimize the generated knowledge and information results in new product development." We add to this the findings of Goldenberg et al. (2001), who say that innovators are of chief significance in the life span of an organization. As consistently revealed through the interviews and observations in this study, innovation embeds in the life cycle of higher education institutions.

It is evident from these findings that knowledge creation involves the conversion of both tacit and explicit knowledge. Innovators have great regard for the teachings of their forefathers, referred to as traditional knowledge. As noted, traditional knowledge, which is tacit, is the knowledge verbally and directly passed on to them through mentoring and feedback (see 4.2.1.2.1.1 and 4.2.3.1.3.2). Such knowledge is the foundation of the innovators' quest to enhance the technology through more current scientific knowledge, which are findings more explicit. Scientific knowledge is gained through rigorous research to quantify the data and information; interpreted using graphs or figures (see 4.2.3.2.3.1 and 4.2.1.1.2). As Innovator F says, I remember those *teachings that I learned from my mentors through lecture-demo, those that I watched when they did demos to the people. Nevertheless, I came to know better what I learned when I started to do research [laughs]. Honestly, I have fully understood why there are graphs, tables, and figures.* As Innovator D

says: *It is better if data gathered is backed-up with figures or research. The things that I learned from my boss, I did research on, which is why I was able to increase the number of micro-organisms. That is why I do not get fed up with doing research for myself. I love doing research!* [laughs]. It is consistent with Agüero and Sánchez (2010) and Montero-Fleta and Pérez-Sabater (2011), who say that the construction of knowledge does not rely on machines and figures but is only possible as a human task, with every human embedded in their abstract information structure.

These findings also agree with Nonaka's (1994) view of knowledge creation, which involves transforming knowledge between tacit and explicit. In order to create new knowledge, innovators take existing knowledge and change it into a new form of knowledge. This process continues while working with their teammates in enhancing the technology (see 4.3.1.2.2), thus putting knowledge into action as Innovator G says: *The knowledge that we gained will only be realistic when put into action and bring life into it. For example, in doing our research, we learned that there is no need to have expensive materials to enhance this product. Yes, many are using this already because we enhanced this together. You said you live in a condo? Try this in your condo* [laughs]. Innovators usually converge in a physical space (introduced above in 4.1.1.2.1). As Innovator G says: *We have built this small space. It is out of the little income we got from the technology. It is where we hold meetings, or it serves as our meeting place – the members, farmers who have questions, and those interested in the technology. Building a space with* the fruit of their meager income from the technology brought them joy. It serves as a meeting place to share experiences among the team members and, at times, invites farmers for a dialogue. One of the team members who happened to be around during the interview mentioned that most of the

time, innovators are visited by those who are interested in their technologies, and they openly discuss the product. Together with the team members, potential end-users congregate, and the innovator/project leader invites each one to speak in a way that allows everyone to share and exchange ideas to create and recreate knowledge. Noticeably, people i*nterested in products like hydroponics and Mykovam* come and see the innovators. It is similar to Nonaka's (1994) *Ba* concept that contributes to understanding knowledge creation along with the SECI model. The Ba concept describes a shared physical, virtual, or mental space for individual relationships to converge to create new knowledge. In like manner, innovators continuously interact with the rest of the team members to exchange and create new ideas. Thus, knowledge is continuously converted and created as innovators practice, collaborate, interact, and learn. The process is continuous and self-motivated while knowledge is contextually applied.

To develop a deeper understanding of explicit and tacit (expert) knowledge concepts, let us look at an example of the conversion between explicit and tacit knowledge. We get our desired food by reading a cookbook (explicit), and simple instructions are carefully followed (given the ability to read and follow those simple instructions). Nonetheless, much more can be done. Let us say our cook reads a couple of articles on cooking this particular item, relates it to her experience and taste preferences, and creatively comes up with something new. As she repeats the process on the road to becoming a Master Chef, small minor changes occur, and the product becomes better and better. However, while it would be easy to write down the ingredients, the way they are combined. It may very well become tacit, that is, quite

difficult to explain since these actions are often unconscious (and therefore tacit knowledge). So, not just anyone can duplicate this newfound recipe!

As introduced earlier, the findings reveal that much of the innovator's knowledge is experiential, passed on through practice, guidance, imitation, and observation while among their forefathers. Innovators learn through guidance and constant socialization from their mentors and among their team members. As Innovator B says: *That is the benefit of having a senior* [laughs] *adviser. He is an excellent mentor. He taught me what to do; it is about technique because we have two techniques that we want to develop. That would mean with the same purpose only, which is to detect the presence or absence of specific animals in food. So, it is just a box of chemical reagents regarding meat detection. It is a DNA test to determine what the animal ingredients of the food are. So, I developed detection for 11 animals. Yes, if you want to ask. It can be used to verify labeling. My knowledge is enhanced through watching and observing; then, I do it and try it out. I also have two research assistants. I bring them to conferences so that they will already be exposed because that is what my previous boss did to me. She brought me to training even if I was a bit younger. Indeed, I am thankful to them for guiding me.* Through socialization (see 4.2.1.2), they imitated what they had observed, combined that with what they had previously learned, and eventually converted this learning in a manner that put these learnings into practice. This act of generous sharing of knowledge from the forefathers inspired the innovators to improve and enhance the usability of the technology. As Innovator H says: *That is the knowledge. We read a lot; we read much literature about inducing resistance. So how can plants be induced to resist their attackers of the pathogen? Sounds like that? What I have learned from my encounter*

with different people, yes, sort of socialization, from my mentor before. Guess what? The plants release a compound against the microbes that attack them. So, it seems like that is our idea here. So then, that is nature. On our part, we expanded the idea. We got an idea that intentional, that if we combine various compounds, we might produce another compound. Because of our basis to induce resistance, some metabolites are produced that can prevent microbes from attacking pathogens, so it is like that. So, we are promoting those who want to use it for now. Since we can enhance our knowledge, we need to actualize it. That is why we are aggressive in promoting. This chain of transferring and altering knowledge supports Nonaka's (1994) knowledge creation model. In this model, he described that socialization is the process of the four modes through which knowledge can be combined and converted for practical purposes. Innovator D provides a detailed example: *I am thankful for biotech because I got lots of opportunities, like the knowledge of discovering microbes that can be used in planting in a natural way, which I also share with people. While I am sharing and actualizing my knowledge with people, I harness my knowledge. Socializing through working with the farmers makes the technology better and better. Through their feedback and constant communication, I tend to improve the product. Moreover, the technology is shared throughout the country and beyond. That can be my legacy.*

In conclusion, based on the findings and in the context of this study, *knowledge is considered patterns of information that require viable actions.* It is consistent with Bennet and Bennet (2004), who point out that knowledge is the capacity (potential or actual) to take effective action. Furthermore, the study revealed that innovators establish scientific knowledge and use it with a purpose in

mind (see 4.2.3.2.1.1). It complements the argument from Bennet and Bennet (2007a) that knowing when not acted upon is squandered, and action with no knowledge is precarious. Such findings lead to the idea that knowledge is the headboard for creativity, which is next in our innovation model, as shown in Figure 4.25. The creativity of the individual innovators (see 4.2.1.1.2) or coming together as a group to maximize explicit and tacit (expert) knowledge can lead to budding innovation. As Innovator F says: *Actually, that is the research we had as the basis, but then, before it was all imported, there is importation, so it is expensive. You think how you can make that kind with good quality; it is different but cheaper. For me, knowledge is the headboard of creativity. You have to plan; you have to think about what is around you, look around. What is in there? Use it to improve, to come up with that kind of product. Yes, it must be unique. I think you need to go back to what you have seen before applying it. You have basic knowledge. So, you apply that basic knowledge. It serves as your guide in designing your process to achieve that product. So, I have this kind of material; there are lots, we have lots of that kind here. I am going to bring in microbes. What will happen? Can you produce the same kind or something different or something better if you assess it? So that is what we call creativity.*

In this research, innovators' creativity (see 4.2.1.1.2), emerging out of acquired information and knowledge coupled with a need, is seen as the ability to produce technologies. Chełmecka (2018) says that the openness of innovators to share either conventional or fresh and newer ideas unbolted more significant opportunities in improving the technology. This author expresses this ability through openness, originality, flexibility, and the innovator's eagerness and willingness to reach out to the marginalized. As Innovator E says: *In doing our research, we gathered scientific*

information and knowledge, which are tools for creativity and sharing without a doubt.

The innovation products produced by the innovators have been optimized and utilized by the people and significantly impact people's lives. Thus, it equally relates to what Mermiri (2009) firmly adheres to: that excellent products and services alter people's lives, affecting their rational thoughts and decision-making. As Innovator D shares: *So, and then we do not have yet that kind of technology of increasing; what I use are varieties of grasses scattered around. However, they are unsuitable for using spores of "Mycorrhizal" fungi. So, we saw that it was promising, and we brought them together for the nursery in the field. Nevertheless, the search goes on, the research continues on discovering the organisms, and while doing that, I went for my Ph.D. And then my Ph.D., the other site here in the Philippines, the soil comes from Bukidnon. So, I planted it in Bukidnon soil. I do not understand why the plants I planted in Bukidnon always die in good soil. Yes! Soil comes from Bukidnon, but I have lots of soil. I have lots of soil from around, from Bislig, Surigao, Luzon, and Pangasinan. So, I have those different kinds of soil analysis. Then I would like to transfer that. Still, the one that is in Bukidnon always dies. Then I said, what is happening? So, I brought the soil to Australia. We evaluated it, only to find out it is traumatic; it belongs to the ultramafic belt, as they call it. It originates in volcanic ash, so it is high in chromium and nickel. That is grassland, grassland. Then what I did, I searched for "Mycorrhizal" that would work. I collected heavy metal contaminated soil. So, that was from the beginning, so the three (microbes) became five. Because I saw it again, and I added it to my collection. And then the five (microbes) became eight. Because we continuously collected. The problem is problem*

sites. Yes! Because we target reforestation, and then later I became the program leader of the agricultural forestry. I also worked in crops is the scope of my reforestation widened. So, we realized those working in forestry also work in (cultural crops), also work in ornament towns, and food crops. So, it got widened now. So, I felt happy because those people, those farmers, felt happy. That inspired me; why, oh! I need to continue with this because you can help the poor; it's payback time. Because what I used in all my schooling came from the money of the people. That is the story that is why I am here. However, if I wanted to get rich? Oh! There is lots of money abroad. But why? Yeah, I am already committed. I saw an eagerness from the farmers. That really inspired me; I need to make it better. I was in a hurry to come home after my study abroad, even if there was an offer of a lucrative opportunity. I came home because my compatriots needed the technology.

Similarly, these findings are consistent with Amabile et al. (1996), who explains that creation begins with the dissolution of knowledge. It confirms the idea that knowledge is the backbone of creativity, as confirmed by Innovator F in 4.4.2.1. There is no creativity if there is no knowledge. One has to know something before creating something new. One can identify problems or what is lacking from an existing product, system, or process out of factual information or knowledge. Combined with the need identified earlier, new ideas emerge, and new products, systems, or processes, the invention is possible. Hence, creativity is a crucial element required for innovation; In a similar vein, these findings are consistent with Amabile et al. (1996), who explains that creation begins with the dissolution of knowledge. It confirms that knowledge is the backbone of creativity, as confirmed by Innovator F in 4.4.2.1. There is no creativity if there is no knowledge. One has to know something

before creating something new. Out of factual information or knowledge, one can identify problems or what is lacking from an existing product, system, or process. Combined with the need identified earlier, new ideas emerge, and new products, systems, or processes, can be invented. Hence, creativity is a crucial element required for innovation—for instance, the technologies on Rennet.

The findings revealed that innovators showed the uniqueness—and at the same time, usefulness—of those ideas produced, thus engaging in creative endeavors. These findings are consistent with Plucker et al. (2010), noting that novelty and usefulness, Mykovam, and Hydroponics, though already existing, are novel because of the additional unique features to which the innovators significantly contributed.

Engrossed with their primary goal to produce technology for the people, innovators are not conscious of their title as inventors, researchers, or scientists (see 4.2.2.6). Moreover, innovators' passion is to produce technologies as solutions to existing technical problems more than gaining benefits or awards. As Innovator A says: *Maybe it is passion. If you are passionate about something, it is not like you are working because you love what you are doing; you are enjoying, as if you are enjoying it, then you are still being paid, right? Then, the more you get inspired. But in terms of passion, the way I see it, something that you love most to do that can help, you come to the point that even if you are not being paid, you still do it because that is what you like.* In this context, the study supports the Intellectual Property Office of the Philippines (IPOPhl) 's definition of creativity as the technical solution to a technical problem, creative ability, or action of doing something new. As described by the administrative officer of IPO, Philippines: *Creativity is an answer to one problem.*

Like, for instance, the pencil is used for writing. And there are lots of those who are producing pencils already. Now you have to add some unique features to the pencil such that when you commit an error, you can still use your pencil; you can erase your writing. So, there is something different to what you have created. Specifically, creativity is a necessary trait to produce invention and innovation. As Innovator B shares: *In the first place, we will not make inventions that we know are not important and useful. That is why I will make something relevant to society, which is innovation. It happens because of being creative since not everyone has the abilities of a creative person.* However, the innovators developed the potential to be creative innovators, which they had become, and impressively exhibited by the time of this study. Hence, they were sensitive enough to explore new ideas and figure out what could be done with these ideas to address the issues at hand. Here is a sharing of the Deputy Director of the Agricultural Systems Institute (ASI) to affirm this definition. He says: *We derive our creativity from the knowledge we gain. We develop the skills of being creative because of the vast ideas and knowledge we accumulate. When I teach innovation in my class, I tell my students that creativity is necessary to become innovative—almost* all descriptions of creativity are inclusive. For instance, the technologies on Rennet.

Furthermore, the findings show no creativity if there is no knowledge. In every case, the innovators acquired knowledge in a specific domain (both tacit and explicit) before creating something new. As Innovator F shares: *Applying the basics. Because, if you go back, it is just really that you are in the system. That is, it. Many of my students came, and they were happy when I gave them a lecture. You give them basic principles. Knowledge is the application of fundamental principles that is why you*

can make something, because of the basic knowledge that you apply to the system so you can get it. It is how to apply the knowledge, like design. You design something unique. So that is creativity. For process, it is different in the process; you imagine how you are going to increase the number of these microbes faster so you will not find any difficulty, and less expensive and different [laughs]*; so that is creativity for me; the application of basic knowledge in design. It would help if you did plan first so that your work will be unique, right in creativity. You are designing the process and how it will come up into something unique to the product. I think that is creativity like the rennet. There is something different in what I did; that is why people prefer it. Other than possible application based on the basic principles, you design the process as long as I have the quality of my output. So, what is it?* [laughs] *I guess I was lost. The invention is like it is in creativity, how you did the design in a novel way. Yes, that is it, for me* [laughs].

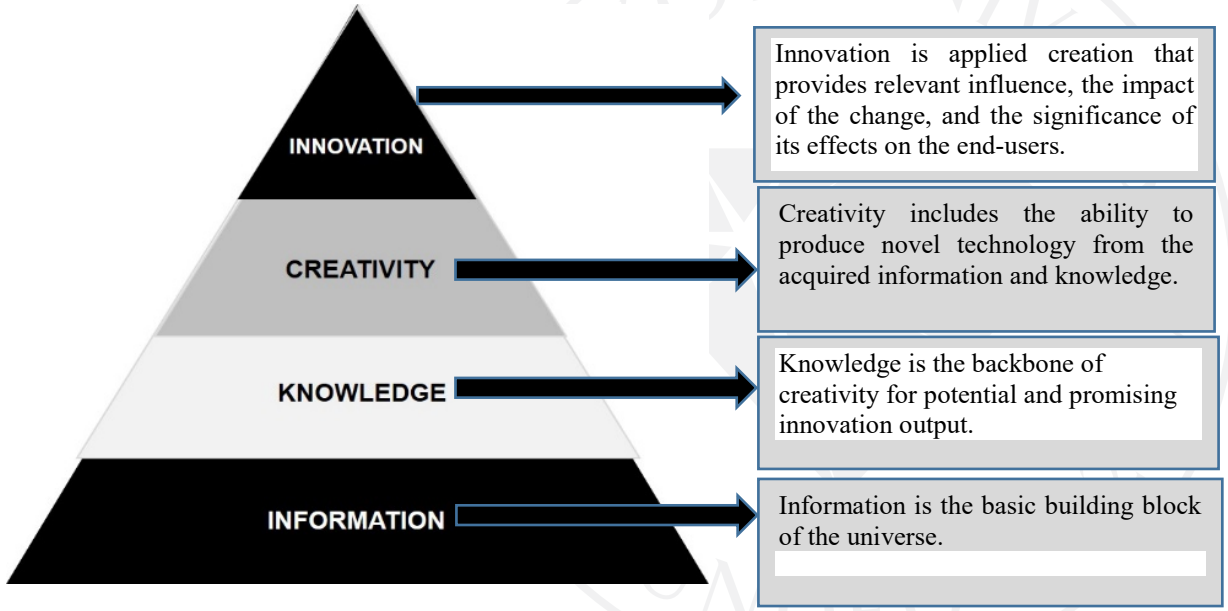
After working on the technology, the innovators then introduce and demonstrate the technologies to the people for proper utilization and function, without counting the cost (see 4.2.1.3), such that people who utilize the technologies improve their lives (see 4.3.1.3.1)**.** In case some beneficiaries of technology are not receptive, this particular innovator did not lose hope of demonstrating and giving lectures to them. Therefore, innovation is applied creativity or the usefulness of something created to make sense out of formed patterns. Innovator F says: *You use your basic knowledge or principles to design the process in which you can use what is around you. So, that is creativity. Then you come up with the product that can be used and utilized, which is innovation. In short, combining your knowledge and coming up with something new is created. So that the material or product or technology or anything*

you have produced, once utilized, is innovation. It is evident that innovators' technologies continuously impacted the end-users, making it an advocacy (see 4.2.1.3.1.1**)** of the innovators. When technologies are maximized and add value, it is ***innovation*** (see 2.4.1) for an in-depth discussion on innovation)**.** As Innovator B says: *No, I do not even; you will not think you are innovative. In my line of thinking, I need to deliver a technology because it is my work for which the National Meat Inspection Service (NMIS) is waiting. Is it liking a sense of responsibility? Because I feel it is my responsibility to develop a functioning technology for them, for other people, something that makes other lives better.*

Moreover, as Innovator F says: *The product of your creativity should reach the people to use. That is innovation. You cannot call it innovation if there is no use. That is why I see that what I am doing is valuable and can help.* Hence, we derive a definition of innovation- *innovation is the application of one's creativity that provides relevant influence, the impact of the change, and the significance of its effects on the end-users.* Our model (Figure 4.21 below) puts innovation at the peak of the pinnacle, as shown below.

Figure 4.21

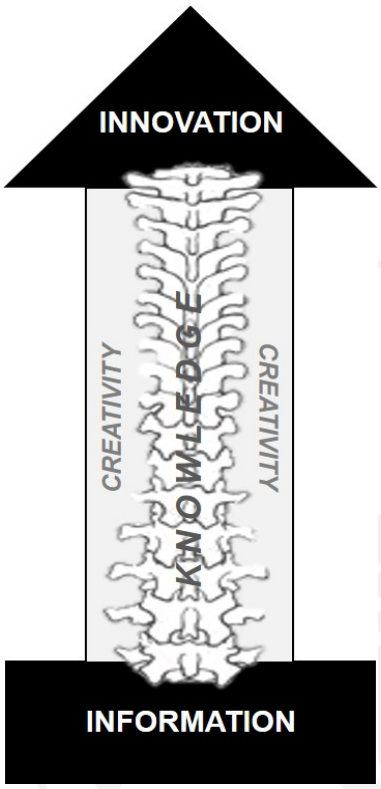
Progression of the Innovation Model from Information to Knowledge to Creativity to Innovation



As illustrated in Figure 4.21, we can see the progression of the innovation model from information to knowledge to creativity to innovation. As explained, information is organized in patterns and serves as the universe's building blocks (Bennet & Bennet, 2005). While information is organized and forms patterns with one another, knowledge, which is the backbone of creativity and a gateway for potential and promising innovation output, is creatively applied to produce an outcome. In the context of this study, creativity is the willingness and ability to effectively produce and share a technology based on the acquired information and knowledge. At the same time, innovation is the applied creation that provides relevant influence, the impact of the change, and the significance of its effects on the end-users. As Innovator C shares*, knowledge seems like the backbone of creativity. You have the basic skills; if you have comprehensive information, you can think of something creative. Understandably, some institutions advocate creativity without knowledge, and unsurprisingly many of their ideas fail. You cannot have one without the other. You can put it this way. There is knowledge first, then creativity, which brings you up to be innovative. Okay. So, if you have a diagram out of it, it will look like this* [makes a drawing, as shown in Figure 4.22 below]. *So, there you have your knowledge in here, and then creativity and then, as what I have said earlier, so you have something in mind, something that is new, and when this product that you have produced has been absorbed or accepted by the community or society, then you are here (pointing to innovation). I actually like to think of knowledge and creativity as they are linked to each other. Not in a hierarchal manner but related to each other.*

Figure 4.22

Knowledge as Backbone of Creativity



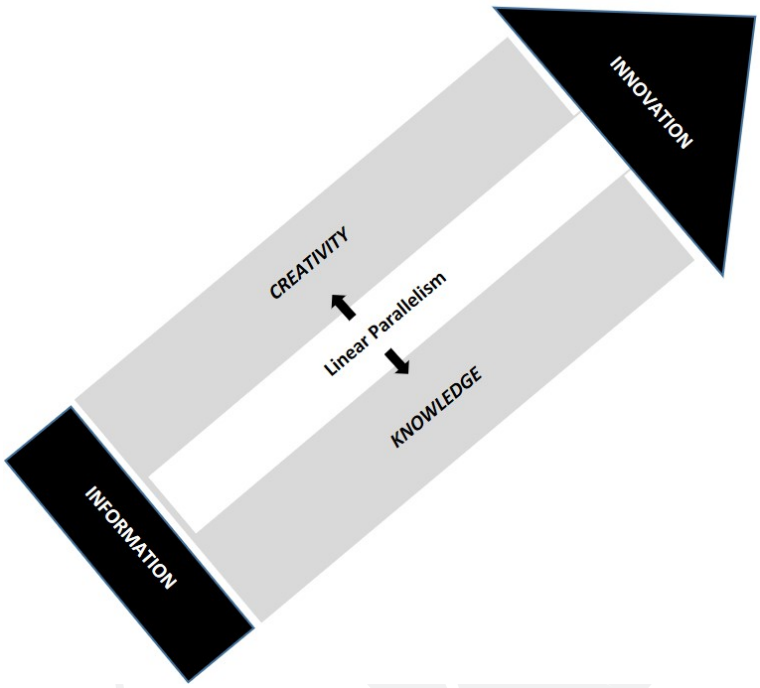
As Innovator C continues: *And then, they have a linear relationship. Ahh, No, No, No. Not like that. You have two concepts, knowledge and creativity, and you have an arrow going up* [drawing] *like that. So, knowledge is here as it is the backbone of creativity. You cannot be creative unless you are knowledgeable of something. However, I would like to believe that they work closely with each other so that if you have produced something unique and you want to improve on it while they are being utilized* [innovation]*, you refer back to knowledge. And yes, you can always… permanently alter knowledge to accommodate something new, something better, which leads to creativity. The result is innovation when the technology impact*

changes and brings significance to the lives of the end-users. And, of course, do not forget to pile in yourself [along] *with information your basic skills, for they are crucial to the success of your technology.*

The concept of knowledge and creativity linked to each other but not in a hierarchical manner is consistent with Bennet et al. (2018), where knowledge and creativity are both considered capacities, with knowledge considered the action lever for creativity (see 2.4.3). Similarly, Innovator G also sketched out a drawing: *If I may draw it, it looks like this. Before you innovate, you need to know creativity here; then we say they interact and support each other, but none is superior because they are parallel. They enhance each other. I cannot be creative if I do not know. Knowledge, therefore, is put into action through the innovative technologies I produce. Ah yes, information is the foundation of connectivity, knowledge, creativity, and innovation; the kind of process through products like the system itself, hydroponics.* This model was sketched more in the fashion of Figure 4.23 below.

Figure 4.23

Linear Relationship between Knowledge and Creativity



Then Innovator G continues to say: *Well, what I see here is that you need to know our readings. In my case, I got this knowledge through our forefathers, who unselfishly shared the information. Then I enhanced it. It is where I used my creative skills. However, in what I call degrading, I did not use expensive materials to enhance this; I just worked and worked so that our fellowmen would have something to use. When utilized, this is already the peak* [innovation]. *Yes, this is true* [pointing to his diagram] *innovation.*

This innovator inferred that information and innovation are "things," patterns we can get our hands around. At the same time, knowledge and creativity are capacities; that is, they denote movement and process, moving information to the

application, with one result (knowledge) ending effectively and one result (creativity) ending in use/benefit (Bennet & Bennet, 2008).

Findings from this study are also consistent with the *Revised Bloom's Taxonomy* (Anderson et al., 2001). Seemingly, knowledge is the foundation of the succeeding elements in this revised educational taxonomy until it reaches the creation level. Anderson et al. (2001) interpret creation as building something new out of the generated experiences, thoughts, ideas, and processes coming from the diverse elements that one went through; note that the term is "creation," not creativity. To achieve the relevance of the created product, that is, its use, innovation has occurred. Converting this created structure or idea into a defined product, we move on to measure marketing the product. As Innovator F says: *In marketing the product, you need to give also a lecture to the potential user. You cannot just bring* [the innovation] *and tell the people to patronize it; it cannot be that way. You need to promote it and advocate it also. You do not just bring it to them and ask them to try it.* Innovation, therefore, is interpreted as a socially-transformative product, service, or concept, which is a critical driver of value (Croitoru, 2012).

Finally, as can be seen, and similar to David and Foray (1995), the findings are consistent with the concept of a knowledge-based economy (KE), which places a phenomenal position on the dispersal and utilization of information and knowledge, as well as its creation, to generate potential outputs which reach the beneficiaries of the technology (see 4.3.1.3.1). It implies, and becomes apparent in further considering the innovator responses, that universities exude a primary function as part of the 21st-century knowledge economy in surviving in the techno mania service-based society (Kok & Abdullah, 2005 and Pinto, 2013; 2014). Likewise, as learning organizations,

higher education institutions (HEIs) produce top-quality graduates—like in the case of the innovators who were graduates of national and international universities— they are hired and paid for their knowledge contribution and who capacitate creativity and innovation to influx technologies for the welfare of the people. With their knowledge, creativity, and innovativeness, it means that innovators respond to the community's needs to achieve social justice without expecting anything in return, thus exemplifying the highest innovation competency, which is transcendence (see 4.2.1.3). As Innovator G says: *A unique quality means establishing needs because when you enter UPLB, established people who did the same thing. The only thing you can do to become unique is do something else. Moreover, that is the time when coming for my Ph.D.; few worked on hydroponics, an ancient system of growing plants developed around the 16th century, in the year of enlightenment. So, it was ancient technology, but there was no commercial production of food or vegetables during that time. I am bearing in mind that this technology is for people to use. No…no…no… I do not expect anything in return; I am sure the same with my other co-scientists. We do not even think of reward or recognition. Nevertheless, thank you for coming over to interview me. That alone makes me happy because I tend to share what I know.*

The findings discussed above relate to what Rowley (2000) affirmed: higher education institutions are in the knowledge business since they are engaged in substantial knowledge creation. As creators of knowledge, universities need to deliver an extraordinary impact on the organization's development through their technologies (Williams et al., 2008). Researchers and practitioners recognize that knowledge is an essential factor in creating a competitive edge (Carlile, 2002; Numprasertchai & Igel,

2004) that can bring impetus to development in the organization, most especially to its economic growth, which in turn is the lifeblood of all firms. It conveys that knowledge has become an essential factor for achieving economic development (Djonlagic & Kurtić, 2016) and innovation products.

In summary, pursuant to Republic Act (R.A.) 7722, An Act Creating the Commission on Higher Education (CHED), "The knowledge society or knowledge economy characterize the university not just as a generator of knowledge, an educator of young minds and a transmitter of culture, but also as a major agent of economic growth" (see 2.8.2). This creation of R.A. 7722 rings with the same thought that Etzkowitz and Zhou (2017) has when he says that the University has been traditionally viewed as a support structure for innovation, providing trained persons, research results, and knowledge to industry. It has become apparent through the findings from this study. Further, R.A. 7722 says that the University is both a research and development laboratory and a mechanism through which the nation builds its human capital to actively participate in the global economy (Angeles, 2017). It has also become apparent through the findings from this study. As Innovator E says: *Ah, knowledge* [laughs], *any knowledge, right? The process of doing something is knowledge and* [laughs] *the idea. However, if you say knowledge, you can already share; our publication is already knowledge. What is the other? Ah, information may not necessarily be original for you, any information. Yes. It is pretty deep* [laughs]. *Influential knowledge is what the University aims for. That is what I see because the University aims to become a research graduate university. So, for the research component, you have to come up with knowledge, and that is what the university likes.*

Your creativity comes out of that knowledge; you make a different or unique technology that will enrich the University.

4.4.2.2 Block 1: Multiple Administrative Tasks (MAT). In the emerging model, and as voiced by the innovators, multiple administrative tasks are considered a block to product innovation. Nonetheless, though faced with multifarious daily tasks, they take this as a challenge in carrying out their responsibilities and commitment to the people. Innovator D enthusiastically shares: *We cannot avoid and escape the various tasks here in the university. Though we have lots of things to do, these are not the reasons for us not to create products.* Similarly, Innovator C shares: *This has been my commitment long before when I was doing my doctorate abroad to create products for my fellow citizens. So, any other activities that I do in the university are not a hindrance to my passion because I think of the welfare of my fellow citizens from a national and global perspective)* Administrative tasks are responsibilities and duties attached to one's terms of reference (ToR) governed by a certain period, wherein innovators have no exemption from these multiple accountabilities. Aside from being a researcher (see 4.2.3.2.3.1), innovators perform all the peculiar tasks from writing a budget proposal (see 4.2.2.8), the tedium of looking for funding (see 4.1.1.2.2**),** to procurement, to fieldwork, up until the submission of technical reports, which have been attested by the Technology Transfer Officer 3. As she says: *What I noticed as a problem in UPLB is that they are the ones experimenting. They are the ones overseeing the funding. Ah, they are the researchers who are at the same time doing the administration. For example, the research assistants are working on papers. And besides, it is a bit chaotic. I am not sure because I have never been part of the research team yet. But, furthermore, that is what also the funding agency has noticed.*

Usually, we have products like projects that need funding, for example, PCAARRD of DOST. So, there must be someone who monitors their budget. Our researchers also do admin at the same time. That became our concern; I mean, I cannot speak on behalf of everyone, but that is what I have noticed. Sometimes procurement is a bit late because budget monitoring is slow. After all, our researchers have many things to do. As I have said earlier, they are the ones conducting the experiments; then they do admin work. Based on my observations from different universities, if you are a researcher, you are just a researcher. I mean, you can focus on your work as a researcher. You do not have other duties that are more administrative in general. It is not only about budget, monitoring the procurement, but even internal activities in the university like getting signatories. That is one thing that makes it slow in terms of progress. Yes. So, in general, more on administrative policies or on university policies. Yes, that is right. It is proper that there should be a designated staff so that, as I have earlier said, the researchers can focus on the development of the technology ... we can recommend that they would be free from administrative tasks.

The current role required of these researchers is unlike that of other universities, where if an individual is a researcher, he or she performs the tasks of being a researcher with minimal other duties so that he or she can focus. In addition, when it comes to funding, the faculty researcher is more favored than a full-time researcher.

Innovators look for their funding agency at the early stage of technology development (see 4.1.1.2.2). Along the way, innovators encounter difficult moments in this endeavor. Nevertheless, there was an emphasis that the university was supportive in this challenging time. As Innovator F says: *The institution is supportive.*

What is not supportive at times is the funding agency [laughs]. *Yes, like, for instance, when I was starting with that project. I was given money. My proposal is good for two years to improve on the process. To scale up the product, however, after a year, the DOST secretary then said, "We do not have milk; why would you still improve it? Why do you have to do that; why do we provide funding for that?" That is what I have heard on the news. I felt bad because here I was, working on something that had a good result, then suddenly, I had to stop. So that is it.* At times funding agencies would not want basic research, meaning they want to research with a tangible product because they want to own the finished product because of ownership, with which the innovators would disagree. As Innovator E says: *Because funding agencies like to have a product, when we propose, at the same time, we think of a product that we can do out of that research. So, that is how we do it. However, at the start, it is research. Many get near biotech as if to fish out information* [laughs]. *They said they needed a proposal, so we made an accurate proposal, and no need to put in the details. Until now, the staff of San Miguel did not come back anymore. Yes, in private talking about protection, but then they do not like it. Of course, they want ownership to be theirs, but I do not know-how.*

Innovators are also responsible for monitoring their budget, and, as noted previously, at times, this causes delays due to the timing around the funding agency's release of funds because of the preparation of required paperwork, which the researcher-innovators do themselves manually, and further slowed down by the system of bureaucracy. As Innovator A says: *We have submitted it already to the funding agency. Then we need to make a follow-up. Since we cannot make that idea if there is no funding, first, we make an effort in funding. Then after that, of course, if*

there is already funding, that is the time you can test your hypothesis to see if your ideas are correct. Of course, that had happened. We did test, and then, yeah! Innovator shares H: *Being lazy is not allowed. At times, they are contractual* [referring to the research assistants]. *I cannot ask them to do errands. That is what makes me at times; for example, they do not have a six-month salary. How would you ask them to do errands? It is good if I am rich so that I can give always. I have to shell out first. Although there is funding, the process is quite long because of the bureaucracy. It is already there; the budget is ready for the contract, then many will have to sign, and then their appointment will not go down immediately. And once the appointment is available, you have to make a voucher. So, it takes six months that they will not have a salary.* Innovator C says: *There is lots of bureaucracy that sometimes delays the process of projects.*

Moreover, another hurdle awaits when the funding is available concerning the procurement process vis-à-vis and bidding procedure since this is a state university where most of the funds come from government agencies; according to one innovator, at times, they will not get results just because they were not able to purchase materials. Some projects perish because there are still no chemicals to use within a year. As Innovator B shares: *So, the first year, you know Procurement in the government. It takes a while to start. So, I think that is one of the dilemmas of the researchers. Procurement?* [laughs] *Procurement means funding. Nevertheless, as I have said earlier to you, yes, I mentioned it already* [laughs], *there is the possibility that you will not have a result just because you could not buy the materials. Some projects die because they do not have chemicals for almost a year. Yes. My advantage is, before, I think I have shared with you earlier, I joined animal science, and my item*

at the start, I was a contractual researcher, so, not for bragging, I was exposed to the procurement process because it is part of TOR, but then Procurement is tedious because technical specifications are very detailed. It is pretty slow because it keeps coming back and forth. And, as Innovator H continues: *Then, for example, in purchasing our materials here, though the fund is already there, there is bidding because of the procurement process. Yes, sometimes that is a problem here in our government. Unlike in the private sector, they can buy right away what they need. For us, it cannot be. We have to count for months before we can get the resources, the chemicals, or the materials we like. Then, since it is government, you have to get the lowest price. Yes ... Bidding. At times, that is not good. In research, the materials you use are always of the best quality. But when it comes to bidding, no* [laughs]. *At the start, we are doing it a certain way so that we can buy the materials we want. Anyway, there is a way because they teach us how. But then, sometimes, the remedy that we do, for example, with branding, is not allowed; we cannot specify a brand. For example, we want sigma chemicals; we want sigma.*

There are lots of competitors of sigma coming from India. They come from poor quality chemicals, so the purity is low. So, what do we do? We copy the label of sigma. Sometimes we say 99% purity, blah blah blah blah…like that. But still, there are some things that we cannot specify, which the only thing that is not permissible is. But then, we copy the existing specs. Sometimes this weak chemical or chemical company, we do not know how they go about it. So, when it comes to bidding, we get the same. There are cases like that. And Innovator A shares: *Funding a project is one of our difficulties because of the procurement law, but then it is an excellent factor in the development and best results of the technology.*

Nonetheless, to overcome this concern of funding, as stated in the previous discussion, innovators display the *competency of collaborating skills* and the ability to pool various resources or expertise and forge potential partnerships to fund the project. It means that innovators work closely with potential funding agencies like PCAARRD and DOST. It is difficult for the innovators to look for resources, but they do not lose hope and are persistent with their tasks because they focus on the benefits of their product innovation to the farmers. Ringing true to these findings, Reichlmayr (2006) says that the process of soliciting sponsorship and vetting proposals is dreary and head-breaking. The innovators experience this, but they survive, and their efforts continue to reach fruition.

Since innovators are persistent with their commitment to producing functional technologies, even if at hand they would find difficulty with the funding, they push through and do not give up until they settle for an agency to support their projects. They collaborate with potential parties, so they can pool various resources or expertise and forge potential partnerships to fund the project (see 4.2.1.2.1.2). As Innovator F continues: I*n the beginning, there is none. But I know the potential of my product. My only problem then is how to increase that product from that point. I encountered many difficulties in funding, but then, maybe with my ongoing discussion with them, my colleagues encouraged me to have fellowship. Eventually, I got that fellowship. I was able to improve on my product. I got another supporter for my project, and my colleagues helped me out* [laughs]. *They joined me in teaching the farmer. Then we introduced the technology to the cooperatives supported by the National Dairy Authority (NDA) and the Philippine Carabao Center (PCC).*

These findings appear to be related to the triple helix model of Etzkowitz (2003), where interaction between industry-university-government is the key to improving the conditions for innovation in a knowledge-based society. Etzkowitz (2003) describes the industry as the locus of interaction, the government as the source of contractual relations that guarantee stable interactions and exchange, and the university as a source of new knowledge and technology (see 2.8.5). In the Philippines, UPLB BIOTECH serves as the prime source of knowledge and technology among its industry and government partners and collaborates with various private and public agencies to materialize the generated knowledge (see 4.2.1.1.2.2 and 4.3.1.1.1**).** As Innovator B shares: *Actually, he was once a researcher here, and then he became a faculty. So, during that first year as a faculty, DOST, PCAF, and The Philippine Council for Agriculture and Fisheries was our funding agency. They had an interest in traceability as an answer to the industry's demand. So, it is industry-driven; that is what PCAF do; they seem to get the needs of the industry. So, they are working on a part, and then they looked for a scientist in UPLB. So, since the technology is DNA for animals, we are the only two here in support of plausibility: Molecular Biologists Sir Jed and I were new when we came here. So, when I came, he gave me the leadership. I continued with the negotiations, and eventually, I continued with it when there was approved funding.*

The growing interdisciplinary nature of collaborating lends itself to such relationships, in which their social skills are exhibited (see 4.2.1.2). Social skills provide the ability to make extra efforts to learn on their own and learn from others (forefathers) the rigors of developing the technology and negotiate for funds to lead

the project, which leads the innovators to deliver new technologies that make a significant impact.

4.4.2.3 Step 2: Firming-up of Innovation Product (FIP). Generally, the innovation team players (see 4.3.1.2.2), including experts and technical and research assistants headed by the innovator (see 4.2.1.2.1), discussed the technology in full detail—both the evolution and how the technology works either on-site and off-site (see 4.1.1.2.1). The findings revealed that product development underwent an iterative process like in the case of Dwarf Saba, or they have plan B or plan C as detailed in 4.3.1.2.2. When innovators detect the ambiguities of the technology in its early stage of development or encounter along the way inaccuracies of the data and information, they seek the assistance of experts on the team (see 4.3.1.2.2) as Innovator B says: *So that is my chance* [laughs] *that I got the leadership. I am with the team, and he is still with the team. Yes, my master adviser. And I asked my master's adviser if he could be our senior consultant, and we hired a full-time researcher who is a fresh graduate. Most of the time, the two of us with the research assistant work. Or, if you have a bit of knowledge, like a better bird's eye view of everything, then that is the time I consult with our consultants, specifically our senior consultant. So, while doing this project, my senior consultant is mentoring me.* Moreover, Innovator E shares: *We have assignments. Then, of course, our experts. We have a bio expert, and we have different expertise and consultation according to the* [knowledge] *of each one. I placed all that is involved in the project; we are five. By chance, I was the project leader* [laughs]. *The project leader has the support of the university; that is what the TTBDO wants. We should go for the Nobel Prize award.*

If and when technology fails, they have a backup or other plans. These innovators have mental agility in conducting research. In other words, innovators have to do more research and critically evaluate the research process before continuing (see 4.2.1.1.2.1 and 4.2.1.1.1). As Innovator B says: *So, as long as you know what they need, you can be the one to adjust the technical side. I think I did not share this with you yet. We also have a Lamp Method, another way to detect the DNA, so we developed it, but it failed. So, I am doing two things, although they refer more often to the lamp technique because it can be brought along in the field. I am not a believer in the technique because I have technical knowledge. That technique is not weak; not popular, but it is very new. So, I ensure that the traditional backup is the polymerase chain reaction* [PCR]. *So, it is still traditional PCR in Deoxyribonucleic Acid* [DNA]. *And the lamp is very new, although the funding agency likes the lamp, so it would be the lamp to be used as a technique. It is like foresight, maybe. Plan B should be because we do not have anything if this fails. There is a plan B, which is the tradition with which we are all comfortable as MBB at UPLB. It is what we know. If I am successful with it, I am the first to know it. In other words, if you put all your cards, like that. You have to have plan B. If they want it, they will fund it; planning; I will still learn it* [laughs]. *That's it, so there we must have a plan B. I have plan B only. I may have plans A, B, C, D, and E. Planning is long. Because if plan A fails, there is a second chance immediately, because you might be in an idle mode* [laughs], *you will get depressed* [laughs]. *You do not have an option* [laughs]. *Yes, yes, maybe that is one of the critical competencies. I do not know the terminology for that* [laughs]. *It's like this is my plan, but if it fails, what will I do? So, this one only. Because if it fails, there is still another one. It is quite a long list. In my head, it is*

quite long. And if it is severe, I write it on paper. Things to do; It is like a diagram that branches out. I do not know. There is a term for that in Com Sci, in Psych, maybe; I have noticed it before. When I was a fresh graduate, it was a question in the interview. I am thinking at that very moment. What else am I thinking? Why is she asking about what am I thinking? I feel like how my brain can process situations in one second [laughs]. *That is, the more things that you think that is mental agility* [laughs].

Likewise, the study concurs with Cole et al. (2011) that for innovation to become successful, the researcher must conduct intensive research (see 4.2.3.2.3.1) and scrutinize the findings from continuous improvement to continuous innovation until they master the functionality of the technology. According to Flynn and Black (2011), failing to do this will lead to an inescapable compounding of errors that will fail the innovation. Thus, consistent with the findings in this study, innovators are open to failures and accept further improvement to hone their craft. As Innovator G shares: *There were many obstacles during the first phase of my work. For example, if there is a brown-out, no electricity is needed to pump water. The plants need the water's nutrients, so what will happen to the plants? They will get dry. So, I started to think that this product may still be used without electricity. IT ISN'T EASY since I experienced that we did not have electricity during my childhood days. But back then, it was not a reason for me not to succeed.* And as Innovator F shares: *I am just open if there is a need; if we are going to customize, I am open to their suggestions. Okay, let us try that. You have to know because you have the basic principles. Then, you will check where you failed. At least, there is traceability of where you did fail. Then you can explain where it came from and why it failed. So, it's possible, like during the*

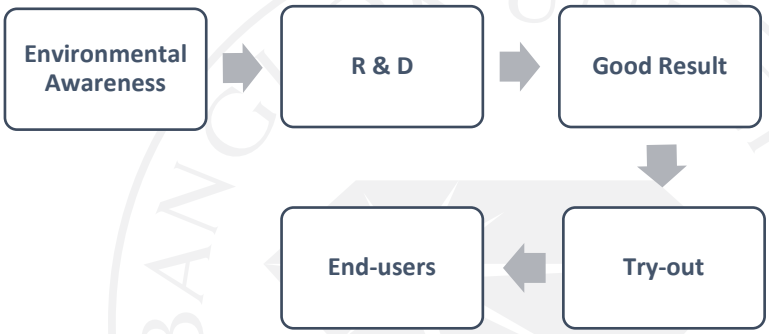
first, when I taught them how to use the granules of rennet. Then, when you learn why it cannot form into milk when you melt it with water. What is it? Okay, let me see the PH. Because I know this one taste sour. It's like it is a staple. When I saw the melting granules in PH 6, [I knew we were] *almost there, so we added a little vinegar, could you put it in whole-formed milk? So, there you can go back where and find why you failed. So then, when I read indeed, many factors can cause this, but then it should not be a reason not to continue. So, there you have lots of things to explain.*

All of the innovators interviewed revealed that it takes them two to three years to finish a product because, in the process of developing the technology, there are timing uncertainties, that is, the time required to develop the new technology, the time required for the market to emerge, and time required for complementary technologies to emerge. As Innovator H says: *So, this is already phase 2. Here, we start to look for something to control the fusarium wilt. We have an organism, the pathogen fusarium; then, we look at the laboratory first. We are looking for those that can control coming from different sources. Then, we are going to test them. If it is okay already, we will demonstrate it to the farmers. If I were to choose, I do not like to have an adorable packaging* [laughs]*; I like that it will go directly to the end-users for them to use.* And as Innovator C says: *The incubation period of projects here in the Philippines usually begins with the proposal until the signing of the Memorandum of Agreement (MOA), Memorandum of Agreement (MOA), in between one to one and half years. That is where the problem lies. But for me, at least I am doing a project within 2 to 3 years. Just the same, I need to follow the government procurement process, and honestly, it slows down the project implementation on our target time to finish.*

In other words, the technology undergoes different phases before being launched on the market. A simple diagram, shown below as Figure 4.24, describes this adoption process. There is much to this in the subsequent discussion regarding technology transfer as we proceed to the next step.

Figure 4.24

Process of Firming Up



UPLB specifically created an office called the Technology Transfer and Business Management Program (TTBMP), which manages technology transfer from laboratory to industry. This office is in charge of the transfer of technology to University-Private Partnership (UPP) for potential business partnerships to keep up with the community's demands. Here is an excerpt from the interview with the Development Management Officer III of TTBMP: *This is different from TTBDO. Here, if the product is ready right away, we help the inventor look for a company that wants to adopt the technology. First, you have to apply for patenting; yes, we have lots of them in the Intellectual Property Office (IPO) unit. Then we create a Memorandum of Agreement* [MOA]. *For example, as stated, the income shares of 40% goes to the inventor, and 60% goes to the university because they used the university's facilities, and most of the funds come from the government. Sometimes,*

production happens within the premise of the university. At times the microbes are kept and are increased here. In other words, if it is already a product, it will go directly to the industry to be utilized. TTBMP realizes its mandate of commercializing the technology for profit to sustain production; hence, there is a need for intellectual property ownership for the technology to last and survive for industry use.

As forwarded and exampled throughout this chapter, an innovator is a researcher by nature. Technology vividly begins with research from which ideas are born. Research is crucial to the development of technology; the conduct of the research is the development process. The laboratory is one of the places to conduct research, like in the cases detailed earlier of WiltCure (Callus and Microbe Co-Culture as a Novel Source of Biopesticides Against Fusarium Wilt of Solanaceous Crops), Probiotic Guava Tea (Probiotic Drink), Microencapsulated Fruit Bioactive Powder from Bignay Extract, and Mykovam. Development of other technologies happens in the field.

Before bringing technology to the market, it undergoes pilot tests with the end-users. Suppose the result of the pilot testing is negative, the researcher gets back the technology for further improvement. On the one hand, suppose the technology yields positive results; the technology goes to the patent review. Once patented, the adopters may wish to adopt the technology. Obtaining a patent applies only to Biotech since this technology is directly developed in a laboratory (see 4.1.1.2.1), unlike other technologies developed in the field like the Saba Variety.

Nonetheless, the university does not restrict technology commercialization from the laboratory (like food products). It also caters to other kinds of technology like software, procedures, and manuals to which the TTBDO facilitates its

commercialization. The university has dozens of copyright applications recorded on the web.

An excerpt from the interview with the PDO-TTBDO 3: *Yes. TTBDO caters to the whole university. It is not only restricted to products on food. Even in engineering, too. We have a high percentage of copyright applications like web applications and databases to date. If it is not printable, it can be for copyright. However, it has a higher potential for adoption, like the one for weather. We have a technology called SARAI used to check the weather conditions that can help the farmers for adoption.*

For instance, farmers can use the technology on Smarter Approaches to Reinvigorate Agriculture as an Industry in the Philippines (SARAI), an innovation because it has a high potential for adoption. SARAI checks the weather conditions, which direct the farmers in their activities. It is helpful as a way that farmers can get data online, and, since not everyone has access to the Internet, the innovators are looking for potential adopters to fast track the dissemination of information in a broader scope. Others make hand-outs for rice and corn, and there is an agricultural monitoring system through web application manuals. So, the farmers have helpful something that is not necessarily made directly from the laboratory. Here is an excerpt from the interview with the PDO-TTBDO 3: *It is called SARAI. It has a meaning. It is long [laughs]. Ah, it is used in a way that data is available online. But since the Internet is not reasonably accessible in other places, they are looking for adopters; then, it will be easy to disseminate information. We mean then by SARAI is Smarter Approaches to Reinvigorate the Agriculture as an Industry in the Philippines. So, it has lots of sub-projects that are different. The other projects they make, for example,*

hand-outs for rice and corn. The agricultural monitoring system, web applications, manuals. Our farmers have something to use, not necessarily from the laboratory.

In addition, according to the PDO-TTBDO 3 from her observations, most of the time, innovations are highly technical products. However, innovations need not be highly technical in some universities and even abroad as long as they solve a problem. She shares: *Because it is like it is a personal observation, most of the time, highly technical products, before considering innovations have exposure to different universities, most especially in other countries. However, even if it is not highly technical, it can be considered innovation as long as it solves a problem.*

This study has touched on two significant categories of innovation: incremental and radical innovation introduced in the literature review in 2.6.2. Incremental innovation is improving or revising what has already existed. The examples of the adoption of rennet (milk coagulant), Mykovam, and snap solution for hydroponics systems relate to incremental innovation. There was already a product of its kind existing. However, as the times required, the technologies were adapted. The innovators embraced the technologies, did more research on them to improve them, and added superior features to those technologies. They did this because they wanted to help the farmers, even if they experienced hardships and trials. As Innovator F says: *I just thought, we just screened; from what I know, it came out, and we keep improving it. Then some* [people] *used it. I think that is innovation because of its utility. So, when asked if they could use it, I said yes, you may. They started to formulate, made a good product, and now they made a good sale of it. It just comes out. It is a good feeling because, in the end, the product helped, even then, if we went through various obstacles* [laughs]. *Anyway, my angels were always there like Dr.*

Saguibo; I always bring her along on the team [laughs]. Innovator D shares almost the same experience: *By consistently improving it, we could enhance the technology; we were able to increase it. Of course, I am with my RAs throughout the conduct of the research. They are all excellent; also, my angels* [laughs]. *I am just a jolly person. There, we keep searching. Earlier I told you I even brought the soil to other countries. I tested it there until I was able to enhance the product.* [Laughs] *That is why the microbes increased* [laughs]. *I was so patient with it, even if it was lonely in other countries. I need to have an output because the farmers are waiting.*

The findings show that collaboration (see 4.2.1.2.1.2) between and among the members of the team (see 4.3.1.2.2) through the shepherding of the project leader (see 4.2.1.2.1), otherwise known as the forefathers (see 4.3.1) improved and enhanced the existing technology. It is consistent with Chang and Cho's (2008) view of incremental product innovation. A project team performs development tasks related to minor product revisions or product line extensions for existing markets and customers through collaboration and consistent interaction within the team.

On the contrary, radical innovation completely changes the technology into a whole new technology. An example of radical innovations achieved by innovators is microencapsulated fruit bioactive powder from bignay, dwarf saba variety, meat detection kit, probiotic guava tea, and will cure. Moreover, it is consistent with the work of Kessler and Chakrabarti (1998) and Garcı´a, Sanzo, and Trespalacios (2008), who describe radical product innovation as where a project team experiences fundamental technological changes which are high in complexity and uncertainty. Radical innovations involve more transfer of largely tacit knowledge than incremental innovations (Carmona-Lavado et al., 2010); thus, it is tough to transfer, so innovators

would instead start from scratch than continue the technology. Provided below are some excerpts from the innovators. In particular, Innovator C expressed: *I think I have shared with you earlier, already when I came back, after getting my Ph.D., I thought of developing a product using technology to encapsulate bioactive. I thought of this because the existing one, which you can see outside, is already obsolete. Oh no, do not get me wrong. What I mean is, it was an old-time technology and, yes, it can no longer be revived. So, I made a new proposal, and it took me almost three years to launch the product, unlike other products, which are offshoots of previous projects that existed already and enhanced or improved. That is also ok, as long as there is public. I am not against it. Anyway, I think the probiotic guava tea is also basically new. I saw it on your list* [laughs]. *Of course, I was with the team until the launch. Marketing? I do not have an incline toward marketing, and that is where my wife comes in. She is good at marketing* [laughs]. *We had our struggles like funding and procurement. So that is how I came up with the technology. Tech transfer? The office is there to help us out because it is new to us. We are thankful they always assist us. We credit it to the leadership of our good chancellor.* And as Innovator B shares: *In the third year, when I thought it was patentable, it was because it is marketable. But during the first two years, I did not think that I could gain something because the first problem was that there was much literature about pork detection already. So, in my mind, I thought maybe all of these* [would] *work; one of them will work, and then we can use it here in the Philippines. And if it works, it is their property; it is not mine. I mean the funding agency, the PCAF. But I validated it, and* [these other products were] *not working. So, I made a new one, and if something is new, it is patentable; and if it has market potential, it is patentable. So that is what I did. When did I think*

that it had market potential? It started with a problem identified by PCAF. The problem is that we cannot export pork meat to Japan. Yes, their target is Japan, which requires traceability. So, I learned about traceability. That is why I worked on a new product. Moreover, Innovator H says: *No one mentored me, unlike the other project leaders here; For me, this is new. I worked on tissue cultures with my former boss when I first came here. However, he was no longer there when I came back from Japan. So, I used what I learned in Japan from my professors. I worked on biological material. We needed to maintain its identity. It was contaminated, so we needed to go back and look again for another one just like this one in phase 1. It was 2015 when we finished the first phase. Then, again we proposed in 2017; it is almost two years, and the microbes were not maintained well. So, we were back again to find microbes, which we could find. However, it took us quite a long at that stage. Then, a second* [issue was] *the weather, the environment, because what we are doing depends on the environment. The technology controls the sickness of the plants; with the right environment, the microbes, the pathogen, are there. If the environment is not right, we will not be able to see the sickness of the plants. So that is how we do it—treating the plants. Yes, because there are instances the sickness of the plants is mixed together, and it is tough to identify the sickness that we want to see. So, we will not have good results then. And then, we did in-depth research. From there, we were able to see a potential source. We placed the plants in a laboratory to control the fusarium wilt; then, we tried to formulate a solution. Then it was formulated, and we made a dry powder for easy application on plants. Then we experimented. In the first plant, we applied our product, and in the second plant without our product. Moreover, we compared the results.*

Further, Innovator A says: *There are times that when somebody leaves, there is no replacement for him or her, and the knowledge remains. That is why I tell my RA, hmmm…research assistants I train them. I train them to be better than me, because if they are better than me, they will have a better job. That is why I tell my visitors that they are better than me.* Innovator E says: *(Sometime in 2013; I asked what the use of it anymore? It depends on the end-users; the public will patronize the product if the product is good. There is a question about the cell life of the technology. From there, I have another innovation. That is why you need to innovate again, and you are back to being industrious and collaborating with people. However, I cannot visualize myself in marketing. It just stays in my mind. So, I think of the lifestyle of the people. People today are into soft drinks, and they like cool drinks, which are no longer beneficial to one's health. Our product is a healthy drink, and it can be taken cold or hot. So, the potential end-users proposed a powder, and it is up to them if they want to mix it with another fruit to have a different taste. However, if it is not taken as cold or placed inside the refrigerator, the shelf life is short. So, we are thinking of creating a product that, once you open it, the microorganisms will fall on the tea without refrigerating it because the live bacteria would only live in a cold place. So here we have our chemical engineering students, who have subjects on plant design. They will be the ones to design the product because the extraction goes through different processes. Then, you will need lots of bottles, capital for the upright freezer, and a bio-freezer, which has four shelves. Inventions? That is an invention if you have done something new* [useful].

4.4.2.4 Block 2: Moving Towards Technology Transfer (MT3). What is technology transfer that makes the innovator find it hard to do? According to the

World Bank Technology, technology transfer is the formal and informal transfer of skills, technical knowledge, or technology from public research organizations to industry. It is essential because knowledge skills technology transfer promotes systematic process innovation that boosts productivity and economic development (World Bank, 2018). Transferring the technology to end-users takes at least 2-3 years, during which innovators are also engaged in various other university activities (see 4.4.2.2).

In technology transfer, it is not only the creation of knowledge that counts, but the flow of this knowledge to the company and the aptitude to absorb and transfer this knowledge (Jarohnovich & Avotis, 2009; Feria & Hidalgo, 2011). Some researchers have investigated why the inventions from many universities have not been able to produce any meaningful stream of income. There are several reasons. First, they have found that high technology is one of the most challenging things to market. Second, it takes considerable time to successfully license or market good university inventions/patents that often do not make business sense (i.e., cash flow). Furthermore, third, the university inventor may have no pre-invention/pre-transfer ties to a potential industrial user/licensee; in such cases, marketing of the technology is considerably more challenging because it starts from scratch after the disclosure to the University Office of Technology Transfer (OTT) (Swamidass & Vulasa, 2009).

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Ostensibly, when innovators reach the uttermost part of the process, that is reaching the final fruition of the research, meaning there is already the finished product ready for commercialization or utilization by the public or market. In short, all potential innovation products for commercialization pass the technology transfer process. However, things are re-directed with the Technology Transfer and Business Development Office (TTBDO) and Intellectual Property Office (IPO) in the university. It means that technologies need to undergo technology transfer to protect the product and the innovator, respectively. Unfortunately, technology transfer has not been the usual practice; hence, innovators grope in the dark. Nonetheless, TTBDO guides them in this endeavor. As Innovator F shares: *I am just happy because my hard work in research has finally come to fruition. It is coming out, working, and there is already an adopter. Marketing is in the process because we need to trade. When I was new here in the institute, there was a problem with the technology transfer. Me, too, I cannot understand it* [laughs]. *I do not know if the researcher wanted to transfer it now or not* [laughs]. *If the researcher wants his or her technology to be utilized, why would you keep it? Unfortunately, there are some those who keep it. They are hiding something with the technology; it creates trouble. That is what I want to change. You*

will be the one to teach. Teach them how you did your product so that it will work clearly, just like my product. I worked hand in hand with the adopter. If they did not use my product in formulating cheese, they would fail. Moreover, when they started using the product, they were already gaining popularity; the secret is the rennet, my product. So that is why I am delighted [laughs]. *I am thankful to the staff of TTBDO for helping me bring the product to the people.*

Fundamentally, innovators create technologies, not for commercialization but to help the farmers, the end-users or the beneficiaries of technology (see 4.3.1.3.1). As Innovator H says: *I used the information to gather and collate my knowledge. Then I used that knowledge in my experiment, in the actual experiment. I was able to create a compound that kills the fusarium. Now that they want it to be patented, there is a transfer, whatever it [laughs] is. I do not think of commercialization here at BIOTECH, but I hear it from the others. My only focus is to help the farmers. But still, I am thankful for helping me, though.*

More so, there is a lack of awareness about patenting and its advantages. The reason why patenting is not their immediate concern, as attested by one of the technology transfer officers. For many years, the innovators have been used to the practice of publication after their research. Moreover, the Intellectual Property Office of the Philippines (IPO) takes note of the technology once published; hence, it becomes property of the public domain. Henceforth, the office finds it challenging to apply for protection at that point. Here is an excerpt from an interview with PDO-TTBDO 2: *They* [innovators] *find it hard to disclose because they lack knowledge of the intellectual property. Yes, that is it! They do not have an awareness of our IP. But we are already receiving calls from them setting up a meeting on IP, which they can*

benefit from. in line with this, we are conducting an IP foundation course for our researchers to have a complete idea of what they can get if their technologies are protected. It is like giving a brief background: What is IP? What can they benefit from IP? Then another challenge is protection because once published for more than a year; it would be tough for us to apply for protection of their technology. After all, it is a public property already if a publication has reached the Intellectual Property Office of the Philippines and can no longer be protected. However, the office desires to assist the researchers in protection. Hence, we conduct IP awareness and training. They, too, want the utilization of the technologies produced. As PDO-TTBDO 1 says: *This is our training here on intellectual property, to orient them on intellectual property awareness to protect both the university and inventor.* Nonetheless, innovators appear to have at least an orientation on patenting awareness. As Innovator B shares: *But then the question of how do I get protected? I need help. So, what happened to me? I am aware that there is IP; in my master's in Molecular Biology, we had a subject about intellectual property. So, since I am working on this technology and I know I need protection, I am approaching the tech office and appealing to them to help me out* [laughs]. *However, I wish next time; it could be better if they were the ones approaching the scientist.*

Mission and environment are two key drivers of success for the commercialization of technology from universities. The clear establishment and broad commitment to a defined mission statement are critical to aligning each university's technology transfer strategy component. The mission of an OTT needs to be defined, or at least supported, at the top levels of the institution's administration (Warren et al., 2008). The alignment of OTTs activities with the broader goals of the institution

works to justify the investment of resources required to achieve the expected returns, which in this case, the TTBDO of the university plays such a significant role.

Turning research into viable output in product innovation is what the innovators have been doing since time immemorial, but though the people have utilized the technologies, they have never been patented and commercialized. Thus, enter the issues of authorship, inventor, and innovator. It was not until the establishment of the TTBDO that commercialization and protections were put in place to benefit the university, innovators, and the end-users (see 4.3.1.3.1). Please refer back to an equal sharing of Innovator H at 4.3.1.2.1, who said that the office of TTBDO, formerly known as CTTE, helped him get through technology transfer until it reached commercialization because he was focused more on helping the farmers.

Moreover, as noted in 2.3.1, according to the United Nations Department of Economic and Social Affairs (2013), technology transfer involves more than hardware supply; it can involve the complex processes of sharing knowledge and adapting a specific technology to meet local conditions. Domestic technical and managerial capacities, institutions, and investments in technological learning influence the effectiveness of which technology can be absorbed and adapted. The importance of knowledge absorption (see 4.2.3.2.4) is of central interest to some researchers for publication (Chen et al., 2009; Peeters et al., 2014; Senivongse et al., 2019). Human resources and institutional development are crucial to facilitating knowledge absorption to optimize technology utilization in addressing societal problems like climate change. Institutional development includes technology and business assessment capacities, incubation, and technology testing and demonstration. The integration of climate policies and national sustainable development strategies

enhances the countries' mitigation and adaptive capacities (United Nations Department of Economic and Social Affairs UN-DESA, 2013).

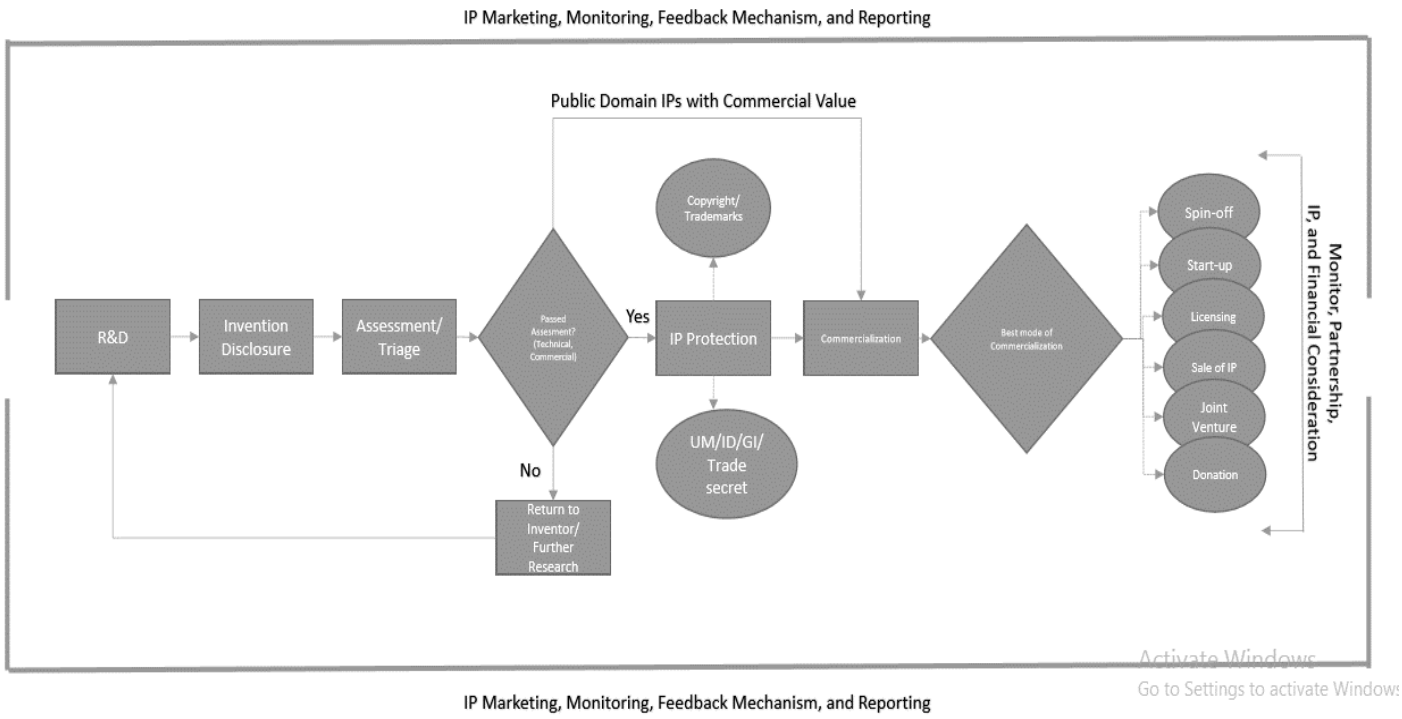
As mentioned earlier, since the conventional practice of researchers and faculty members is to publish and then leave them on the library shelves, the university with its administration is promoting the transfer of technology so that the society and community will utilize the technology. As PDO-TTBDO 1 noted. *Yes, research is placed only in the library; the conventional practice of our researchers and faculty members is to publish and leave that on the shelves of the library. Therefore, the university and the administration promote technology transfer to avoid technology wastage.*

UPLB likewise designed mechanisms for technology transfer to facilitate the support of financial, institutional, and methodological activities, hence creating the Technology for Transfer and Business Development Office (TTBDO). Innovators need to write and submit proposals, including their apparent budget (see 4.2.2.8), to develop the technology to TTBDO for scrutiny before proceeding with innovation product development; thus, TTBDO is in the role of gatekeeper.

4.4.2.5 Gatekeeper: Established Framework (TTBDO). As presented above, to bridge the gap of the concerns of innovators regarding commercializing their technology, UPLB created the Technology Transfer and Business Development Office (TTBDO); the whole relationship to the UPLB innovation process is shown below in Figure 4.25. The office, formerly called the Center for Technology Transfer and Entrepreneurship (CTTE), serves as a bridge to step 3, which focuses on commercialization for the target beneficiaries.

Figure 4.25

Technology Transfer and Business Development Office Framework



Note. Used with permission as a reference for discussion

TTBDO handles the technology transfer activities of the university. Its mandate is to integrate programs, policies, and activities toward the protection, promotion, and successful disposal of technologies through licensing or business incubation. Supporting the discussion with an interview with PDO-TTBDO 1, who says: *Our office is formerly called the CTTE, Center for Technology Transfer and Entrepreneurship, but now is called the Technology Transfer and Business Development Office. So, our office name is handling the technology transfer activities of the technology* [created] *in UPLB. Our mandate is to integrate programs, policies, and activities towards protection, promotion, and success through licensing or business incubation.*

In business incubation, the office helps the inventors create their own business or provides them a location to start their business. While doing so, TTBDO implements the three laws that govern the university: (1) IT code of the Philippines, (2) Technology Transfer Act of the Philippines, and (3) UPIP Policy. *Business incubation means we help the inventor himself or herself make his or her business, providing them with a location for starting businesses. We also implement the laws that govern the university. There are three: IP Code of the Philippines, Technology Transfer Act of the Philippines, and UPIP Policy.*

IP Code refers to Republic Act No. 8293, otherwise known as the "Intellectual Property Code of the Philippines. It recognizes and protects Intellectual Property (IP). IP is the term used to describe intangible assets resulting from the creative work of an individual or organization. IP also refers to creations of the mind, such as inventions, literary and artistic works, symbols, names, images, and designs used in commerce.

Republic Act (RA) 10055. This Act shall be known as the "Philippine Technology Transfer Act of 2009". An Act provides a framework and support system for the ownership, management, use, and commercialization of intellectual property generated from research and development funded by the government and other purposes. This Act aims to promote and facilitate the transfer, dissemination, and effective use, management, and commercialization of intellectual property, technology, and knowledge resulting from R&D funded by the government to benefit national economy and taxpayers (Intellectual Property Office of the Philippines, (2018).

Intellectual Property Rights (IPR) Policy of the University of the Philippines System. University resources should be used for university purposes and not for personal gain, commercial advantage, or non-university purposes. In line with this, the university subscribes to a policy of recognizing the traditional academic practice of treating faculty members as owners of inventions, works, and other intellectual creations. Consequently, they produce without university and third-party funding and without substantial university and/or third-party resources, which are resources that are not ordinarily available to all faculty for traditional academic purposes, including teaching, research, and extension work. TTBDO has three outlets:

1. APEC is the center for technology exchange and training for small and medium enterprises or outlets. Through this office, Small Medium Enterprises (SMEs) are given help in training when the technology is ready for the public. Hence, there is no need to protect the technology or go through technology transfer.

2. The intellectual property office focuses on protecting and safeguarding technology with commercial value and future commercialization. Examples are the meat detection kit, SNAP Solution for Hydroponics System, Dwarf Saba Variety, and Microencapsulated Fruit Bioactive Powder from Bignay, WiltCure, Rennet, Mykovam, and Probiotic Guava Tea, which may address third world problems in this specific industry.
3. The Science Technology Park (STP), or technology incubator, through which the office provides a location for inventors within the university.

The STP is a 40-hectare land for a possible building of a Science and Technology Park. It is available for those starting businesses and start-ups that cannot yet locate commercial space in the market, which is too expensive.

The leading partner with TTBDO in these outlets is the Department of Trade Industry (DTI) CALABARZON. DTI provides Small Medium Enterprises (SMEs) training on setting up and running businesses. TTBDO Officer 1 said that they teach the technical and organizational aspects, such as managing their business, promoting marketing, and creating a business plan and organizational chart. He continues to say: *Yes. The activities under the outlets and our direct partner are DTI, or the Department of Trade Industry, CALABARZON, DTI Laguna. The goal is to provide training to our Small Medium Enterprises to teach them in their businesses. It is not only the technical aspects; it could also be organizational aspects like "How to manage your business" or "How to promote marketing and creating a business plan, and organizational charts."*

The TTBDO office also conducts international networking activities with the Netherlands, which started in 2016 to promote technology transfer to increase potential markets and garner international funding. Annually, they conduct the same kinds of activities. As PDO-TTBDO 1 says: *We are also conducting networking activities with the Netherlands. We started in 2016, then every year since then, we conduct it. Mainly it looks like networking activities to promote what we have here in the Philippines, which is still emerging, to increase their market and get international funding.*

In like manner, they have also set up the negosyo centers and Go-negosyo in partnership with DTI to provide awareness on business enterprises for the innovators. As TTBDO Officer 1 describes: *We also have negosyo centers and go-negosyo. We partner with Go-negosyo and DTI to educate our inventors on business enterprises.* Go Negosyo is the Philippine Center for Entrepreneurship (PCE) advocacy, a non-stock, non-profit organization that advocates for a change in MINDSET and ATTITUDE. PCE believes Filipinos can address poverty by engaging in entrepreneurship and developing an optimistic, passionate, creative, innovative, resourceful, diligent, and persevering character. PCE encourages everyone to take charge and make the most of their resources and abilities by utilizing and transforming these into viable enterprises (Go Negosyo, n.d.).

On the one hand, Negosyo Center is a one-stop shop for services that cater to entrepreneurs' needs to process requirements to establish a business and access information essential for their growth. On the other hand, PDO-TTBDO 1 confirms:

It *is a center where we find all the documents needed by small businesses to set up their business.*

Moreover, the Olympics increase students' creativity and provide incentives for those unique or new technologies or innovations produced by their students. Olympics is a gathering of student-researcher wherein they are allowed to share in public their innovation.

As mentioned earlier, the Intellectual Property Office (IPO) serves as one of the three outlets of TTBDO that focuses on promoting, protecting, and commercializing the technology. Commercialization of technology starts with protecting intellectual properties. First is the invention disclosure, which means they interview the researchers about their technology, capabilities, and specifications. Afterward, IPO looks into previous research to see if there are similarities. Then, IPO returns the technology to inventors for further improvement. If there are no similarities, IPO proceeds with the protection and drafts the specifications, which say that it is the property of the Philippines that needs to be protected and grant Income Tax Return (ITR) to the creator. The owner, mainly the university, then gets the right to exclude others from using or selling the technology; only the university can distribute the product or technology. As PDO-TTBDO 2 affirms: *The intellectual property office has three functions: Promotion, protection, and commercialization. Commercialization of technology starts with the protection of intellectual properties. So, we conduct first an invention disclosure by interviewing the researchers: what is the technology, what the technology can do, or what is specific to their technology. Then we look at prior research and see if there is a duplicate of the technology in the*

market so that the researcher can improve on this aspect. If there is no duplicate, we proceed with the protection and draft the specification indicating Philippine property so that it can be protected and granted ITR for the creator, the owner, mainly UPLB, so that they can get the rights to exclude others from using or selling, such that it is [acknowledged that it is] *UPLB who made it and can distribute the product or technology.*

After ensuring protection, the IPO proceeds to promotion. They have promotional activities like joining the exhibits and conducting other networking activities to which they invite industry partners who can license the technology and commercialize it. The university cannot do mass production or commercially produce the technologies because the university's primary functions are teaching, extension and research. In short, the university cannot perform commercialization and mass production, so they are looking for a partner industry that can accommodate this stage. As PDO-TTBDO 2 says: *Then, after protection, we promote it. We have different promotional activities like joining the exhibits and conducting networking activities to invite industry partners who can license the technology and commercialize it. UPLB cannot do mass production or produce the technology of UPLB commercially because the main function of UPLB is teaching, extension and research; there is no commercialization and mass production. That is why we look for an industry that can commercialize the technology.*

As can be seen, the IPO's main task is awareness and orientation on intellectual property because the university researchers are focused primarily on publication and citations in journals and are not aware of patenting rights and

procedures. It would be a loss if the technologies produced were not commercialized and the university could not benefit from them. Once a technology is commercialized, it is advantageous for the researcher and the university, including the government agency that funded the project. Hence, the creation of intellectual property office to assist the researchers in patenting their technology. *The university researchers are focused only on publication and citations in journals, and the technology produced would be a waste if it was not commercialized, and the university and government would not benefit from it; we used government funds. It will delight everyone to see the use of technologies.*

UPLB BIOTECH is fervently conducting awareness on the patent and licensing process to eliminate the conventional practice whereby researchers and faculty members tend to publish their research outputs, which are left on the library shelves and rarely utilized. In addition, UPLB, through its current administration, is promoting the increased transfer of technology once completed for consumption. At this point, the innovator has moved on to a new project. It broadens the impact of the technology (see 4.4.2.4).

When published prior to disclosure, the technology can no longer be protected. However, at some point, for some published technologies, we submit for evaluation to see if there is still potential commercial value that may benefit the university and the people. As PDO-TTBDO 2 says: *If we do not protect it, we return it to the inventor. The technology might be of the same kind but still can be improved. So, we advise the inventors to conduct further research to improve so that it may be different from what is available to the market or field. Then we come back to our technologies with*

commercial value. If we can protect it, we determine what kind of commercialization channels can fit it; there are six.

An ending message delivered by Dr. Rex B. Demafelis, UPLB Vice Chancellor for Research and Extension, on behalf of Chancellor Fernando C. Sanchez, expressed UPLB's support for promoting entrepreneurship and innovation, as quoted by *Arana* (2019). He said: *Our Technology Transfer and Business Development Office and its many projects and initiatives are testaments of our commitment to transforming the fruits of research into products for improving the communities and enriching lives* (*Arana,* 2019).

The TTBDO Framework warrants a deeper discussion. The phases, or levels of the framework, are R&D, technology disclosure, technology assessment, intellectual property protection, and commercialization.

4.4.2.5.1 R&D is the first step. Researchers, students, and faculty members in the university are all involved in R&D, which is then made known to the entire organization through IP Audit and prioritization. At this level, they call inventors one at a time and assist them in going through their inventions. Inventors make an account of the status of their technology. Then, given the voluminous outputs, we prioritize government-funded inventions for commercialization. As PDO-TTBDO 1 describes, we *will repeat stage 1 of our framework, an IP Audit and prioritization; then comes R&D and technology disclosure. So, in R&D, this is where there is mini-involvement of researchers, students, and faculty members of the university. They conduct research and development activities to produce our technology.*

4.4.2.5.2 To exercise fairness, qualified technologies may proceed to **technology disclosure at the first level.** The said office aggressively sets and conducts interviews and meetings with the inventors. They talk and discuss, in particular, the specifications of the technology. In short, inventors are encouraged to share and divulge their technology to provide the necessary help. This routine invites inventors to become proactive in terms of commercialization. Technologies bound for protection and commercialization get to proceed to the next level: a technology assessment. PDO-TTBDO 1 continues explaining: *In the technology disclosure, we conduct interviews. We aggressively set interviews and meetings with* the innovators *to become proactive and gather information if there are technologies that can be protectable and commercialized in their research.*

4.4.2.5.3 The Technology Assessment phase, sometimes called technology triage, selects inventions with at least a reasonable chance of being *commercialized.* It includes the procedure of assigning levels of priority to tasks. When technologies do not meet the triaging criteria, inventors get them back for further study, which offers the opportunity to improve the technology so that it may become uniquely different from what is already available in the market. As PDO-TTBDO 1 continues: *And then next, we conduct assessments of those technologies we have gathered* [to decide] *if we are going to protect them. A priority level protects them. We determine the value of the technology through IP evaluation, and then if we cannot protect it because it was already published, which our researchers and faculty members may not be aware of; because they are more into publications and citations in published journals prior to disclosure. However, when we see that there is still commercial value, it will undergo*

a technology evaluation. It does not necessarily mean that there is no commercial value if we cannot protect it. We still see if there is commercial value and whether the university and inventors can benefit. Then we determine the technology's status and value.

4.4.2.5.4 Technologies that pass the triage may proceed for intellectual property (IP) **protection**. The inventors have copyright/trademark or utility model/trade secret options.

4.4.2.5.5 Commercialization. After the IP protection process, the commercialization **stage.** There are six modes of commercialization channels explicated below: spin-off, start-up, joint venture, buyout, licensing, and donation. Each of these is explained thoroughly to the inventors so that they have the option to choose.

4.4.2.5.5.1 First is the spin-off. In spin-offs, the researcher-inventor or creator will create a company outside the university composed of an external business person and entrepreneur. There has to be an entrepreneur since, by definition, an entrepreneur knows what is outside the industry and the company's practice. Spin-offs are not necessarily new firms of experienced businesspeople; entrepreneurs take resources from existing companies (Koster, 2005). A spin-off is a new company formed from an existing one. It means that inventors may create a company out of the parent company. Therefore, they have a clear view of the parent company's reputation, infrastructure, and credentials, to which they attach their technology. PDO-TTBDO 1: *In the spin-off of a company, the researcher, inventor or creator will create a company comprising external people in business and entrepreneurs. Sir Glenn*

suggests that there must be an entrepreneur in the company that the inventor creates because the entrepreneur knows what is outside the industry, including policy. The entrepreneur provides expertise to the company, that is, the company's spin-off.

4.4.2.5.5.2 Second, start-up. Inventors who lack sufficient funds may venture into external capital, looking into potential investors that might be likely to finance the mass production of the technology for commercialization. Lebret (2017) describes that there are not enough paying customers, and the company will most likely need external capital (business angels, venture capital) unless future customers agree to pay a lot in advance to survive commercialization. PDO-TTBDO 1 says: *If the inventors lack the capacity, they can look for potential investors who are willing to spend for the production of the technology. For example, Mykovam. A big company is willing to finance mass production of the commercialized product. The company likes the potential benefits of the product.*

4.4.2.5.5.3 Third, joint venture. Inventors engage in a joint venture between and among businesses, pooling their resources and expertise to achieve commercialization. While an investor's technology may have strong potential for growth, a joint venture can provide more resources, which translates into a more excellent opportunity for the technology to become successful. For example, PDO-TTBDO 1 says: *Our inventor here may communicate with different businesses. Here, the product will be more enhanced because of the expertise of each. The example here is microencapsulated fruit bioactive from Bignay, in which the interested party during the exhibit is still negotiating with our inventor. Hopefully, they meet with their*

negotiations joining in an expo. Innovators establish joint ventures with interested parties through exhibits or expos.

4.4.2.5.5.4 Fourth, buyout. Inventors may have the option to sell the entire technology once and for all to the industry. Then, the industry gets all the rights on what to do with the technology, and the inventor has no longer say in it. PDO-TTBDO 1 says: *The inventors here have the chance to sell the technology to interested industries. Then the investor has no more rights over the technology, whatever they do with the product. It is very seldom that this one is adapted.*

4.4.2.5.5.5 Fifth, licensing. Inventors allow an industry partner to mass-produce the technology because the university cannot do so. The university's mandates are teaching, research and extension. There is no commercialization until the end-users and the university sees them in the market, and both parties (end-users and the university) benefit from it. PDO-TTBDO 1 describes: *The last mode is licensing, where we allow the industry partner and existing company to mass-produce the technology because the university's mandate is to have and conduct research extension and teaching. Commercialization is not there; there is no capability to mass-produce the technology our researchers and faculty invent. After a successful negotiation comes commercialization, there is some time until the end-users see it in the market. That is technology transfer. Once the end-user sees it in the market; and sees that the university benefits from it, technology transfer is successful.*

In a nutshell, the university mainly practices licensing and spin-off companies. PDO-TTBDO 1 confirms that licensing *in the university is mainly practiced, including companies' spin.*

4.4.2.5.5.6 Finally, donation. Technology goes for donation to the community for a cause in this mode. PDO-TTBDO 1 shares: *Donation depends if it is his or her advocacy; that is why he or she follows it up. I cannot say which technologies in your interview were donated* [laughs].

From these findings, it is clear that all of the innovators interviewed have built advocacy focused on a concern for the end-user, primarily the Filipino farmers. In this context, the end of their journey is very much to donate their technologies to benefit the people.

Scrutinizing some of the models of innovation detailed in Chapter 2, ***Stage-Gate®***, an exemplary model, appears congruent with the study undertaken. Correspondingly, the innovation process in UPLB starts from ideas rooted in the social problems ignited by the forefathers. As Innovator A says: *Actually, during the conceptualization, it was not just my idea, because, during the beginning, it was a team* [effort]. *What I mean is, it is the ideas of all. One person, Dr. Dela Cruz, was really in charge of the banana. We said we have many varieties of bananas, but which one among them can resist a typhoon* [laughs]. *It is like a person, as the saying goes, not being carried away by a typhoon. Eventually, we had a project funded by PCAF, the reviewer of this. However, the project leader left. In other words, I just followed the footsteps of our forefathers, anchoring the product on society's problems brought about by natural calamities. Then I changed the variety of the technology. Instead of using fruits, I used seeds.* Moreover, as Innovator G says: *Let us say one good thing; I would like to do it. We are importing more than 1 billion Styrofoam boxes every year for this project. But, as I have already said to you, Styrofoam boxes will not be re-*

used but become garbage for decades, tons of landfills that will affect climate change. Moreover, the decomposition of these materials takes a century. So, it will end up in a landfill. I learned this from our forefathers, and what I like most about this project is that it has a concern for the environment.

Innovation does not end when the product innovation has successfully reached the market; innovators tend to see still the impact of their products and how they can be further improved by engaging with the end-users. They are hands-on as to the use of their products, meaning they are handling the seminars themselves for the farmers, for free, because they have seen and experienced the hardships of the farmers. More so, they believe that the actual learning of the farmers takes place in the field like the technologies on Mykovam and Wiltcure. Both innovators still visit the farmers and engage in dialogue with them, meaning they check on the long-term effect of the products on the plants. As Innovator D says: *Ms. Shine, please come later and let Ma'am see the field. A while ago, I excused myself and visited them to check how the biofertilizer was applied. I gave them a seminar; we are only two with Del. Yes, it's not a joke to be hands-on because I experienced the hardship of the farmers. I give them a salary out of the income from the harvest. My sale goes to the university with my boss, who gets a royalty share. But you need to do a demo initially, so I do a demo, demo plans everywhere* [laughs]. *I am happy and feel delighted because people interview me, I get to share everything that I know [laughs]. Did you see the field? With the farmers? There is no overdose of the product. It is better if they put a lot on so that it will sell* [laughs] *Ahhh. Joke only, but it would be better so that the growth of the plants is good.*

The *s*ame is true with the technology on Rennet. From time to time, the innovator and her students visit the end-users and conduct free lectures-demonstrations (see 4.2.3.2.4.1) on how to improve their skills in making cheese. Suppose there are any discrepancies in the use of the technology, she can immediately comment and give suggestions. At the same time, she allows her students to experiential learning. As Innovator F shares: *Remember, there was a knock when we talked. My students are going* [with me] *to the site because I will give a lecture and demo to the end-users. In short, I regularly do this to enhance the cheese making. because at times, it is sour* [laughs]. *It is different when it comes to mixing. The reason I bring along my students is that it is on-the-job training. Yes, then they already have an experience. Moreover, besides, they are part of the team.*

One particular instance experienced by Innovator D was when a company bought the products, tried to alter them, and sold them to the farmers. The company even imitated the name of the product. The problem was that it was not effective. It was the farmers themselves who reported the incident to the innovator. And then, Innovator D just advised them to buy directly from her legitimate outlets or directly from the office. The difficulty is that the farmers are in Mindanao while the innovator lives in Luzon. As Innovator D shares: *What I do not like … for example, I have an outlet in Mindanao. My competitor put a shop in front of my outlet, bought my product, and altered it. He then changed the product's name and sold it to the farmers. It turned out that it was ineffective because it was not the original product. Someone reported it to me, and I told them to buy where you are supposed to. Do not*

buy where you are not sure. My point is either that or come directly to me. The problem is that the one who reported it is from Mindanao, and I am here in Luzon.

As has been previously evidenced in this study, UPLB also established a well-founded TTBDO operated by well-versed professionals who oversee UPLB's innovation products from conception to birth to utilization (see 4.4.2.5).

The findings of this study are consistent with the belief forwarded in the ***Stage-Gate®*** model (see 2.6.3) that product innovation begins with ideas and ends once successfully launched into the market. Then the project passes through a decision gate on whether or not to continue investing in the project (a Go/Kill decision). These gates serve as quality-control checkpoints with three goals to (1) ensure the quality of execution, (2) evaluate business rationale, and (3) approve the project plan and resources. Similarly, as detailed above as modes, UPLB has the following gates in the framework: R&D, technology disclosure, technology assessment, intellectual property protection, commercialization, and donation.
For UPLB to engage in a globally competitive industry and sustain its title as a Center of Excellence (COE), it continuously invents, reinvents, and innovates significant products for society. However, in realizing its full potential and impact, it is necessary to commercialize technologies. It means that the target users utilize technologies to serve the entire purpose, leading to the third and last step – the way forward to utilizing the innovation produced by the beneficiaries.

4.4.2.6 Step 3: Way Forward to the Utilization of the Innovation Product (WWUIP) by the Beneficiaries

Innovators have the option of whether to reveal or not reveal their technologies to accelerate the utilization of the brand-new technologies. Nonetheless, all the innovators in the study submitted themselves for invention disclosure, meaning they are more than willing to expose and release their inventions to the public for utilization and not to receive awards or benefits, not even for entrepreneurial or marketing or attempt to gain profit, nor for royalty and promotion (see 4.2.2.5).

As repeatedly emerges in earlier discussions, the innovators aim to create products in response to the environmental issues and improve the lives of the end-users (see 4.3.1.3.1), most especially the farmers making this their advocacy (see 4.2.1.3.1.1).

As defined in the previous discussion, advocacy is the ability to inspire the local people to utilize the product and transform their lives. As Innovator E says: *I want to innovate because I do not plan to become an inventor when I am in research. I can invent one like this, and you would not think it would be like this. It comes along when you are working on your project. You see something that you can work on, a product or technology that you pursue, and you keep researching* [laughs]. *I am thinking only of helping our fellowmen, especially when it comes to a healthy lifestyle. Aren't all soft drinks unhealthy? However, this one is a healthy drink. They requested that even if you do not place it inside the refrigerator, it is still healthy and safe to drink. When it comes to the community getting it, yes, of course, this is for them anyway. My only request is for the office to approach us for the said disclosure. To be honest, you know* [laughs]*, I do not understand it* [laughs]. *I just wanted to make*

advocacy like the old technology. They made the product as if a child. For example, they take care of it, the Mykovam, until it becomes their advocacy.

As introduced in 4.4.2.5 above, the next step is assessment triage. At this stage, technologies are evaluated for technical receptiveness to see if they satisfy the technical specifications of the products, particularly in terms of benefits and advantages. As the PDO-TTBDO 1 explains, we *are the ones checking if the technology meets the requirements of the technical specifications in the office. For instance, the benefits and advantages of the product.]* If the technology passes the assessment triage stage, intellectual property protection takes over protection, at which the innovators have the option either to go for copyrights/trademarks or utility model/trade secret. For example, the technology of microencapsulated fruit bioactive from Bignay has already reached this stage and even joined the expo to attract a potential partner for production. As Innovator C says: *Yes, we attended the exhibit so that people would know of our product. It is a sort of promotion.*

Again, in all instances, the innovators opted for copyright because they wanted to share the products totally as a commitment to the people and society (see 4.2.1.3.1.2). As Innovator B says: *I am giving it anyway to PCAARRD because that is my promise. Once done, they can make use of it. Anyway, it is copyrighted, so no problem. I commit to my fellowmen, most especially our brothers and sisters who are conscious of eating pork.* As can be seen, the Innovators' commitment was not the result of their personal goals but the communal goal of serving the people's best interest.

In cases where the technology did not pass the assessment triage, it is returned to the inventor for further research and improvement, after which it would undergo the same process again. There was no instance of returning the technologies created by the innovator.

Before commercializing, innovators get to experience packaging their products-ideas on how to prepare catchy and affordable packaging ready for the market since this is one of the weak points of the innovators other than marketing. As attested by PDO-TTBDO 2: *We just come in when they need funding for commercialization, or we give them an idea if they want to enhance their products, like an excellent packaging presentation. So, a funding agency offers it; then, we assess them. But in the early stages, the innovators themselves are looking for a funding agency.* In addition, the PDO-TTBDO 3 says: *Ah, I mean packaging in a way that is acceptable to the market. For example, you have that prototype, but you cannot present it to the public. It should be nice to see, worth buying. Yes, the production is usually lab-scale, so the product is expensive, even the other materials. Then, the packaging is ugly, so we assist them in this packaging aspect.*

In addition, as a mandate, TTBDO assists the innovators in identifying funding industries for commercialization or assists them in transfer commercialization. The innovators can choose the commercialization model that best suits their personality. Since the innovators and the University do not have the machines and facility for mass production, innovators opted for licensing. Here, TTBDO helps the innovators look for industry partners who could mass-produce the technology. PDO-TTBDO 2 says: *Because we do not have machines for* [mass

production]*, how would you -present to the public what it looks like; that it costs that much. So, for us, as TTBDO, it is one of the rules to look for industry partners who would produce because they have the skills, the machines, the facilities. So, the partner industry will be the one to introduce it to the end-users and tell them that the technology is ready for utilization.* At this point, the negotiating is between UPLB and the industry partner; thus, UPLB, the home base of product development, now owns the technology. Examples of these innovation products are Microbial Rennet and Mykovam. As part of the commercialization process of state-funded technologies, these products underwent deliberation by the Department of Science and Technology Fairness Opinion Board (FOB) to evaluate the price and terms between the licensors and licensees.

Moreover, TTBDO conducts dialogues with the Department of Information and Communications Technology (DICT) to ensure that TTBDO retains control over the prices and avoids the industries themselves licensing the product. Otherwise, the product becomes too expensive when it reaches the market. Further, this process enables TTBDO to maintain the purpose of licensing such that the innovation benefits the familiar majority and is not used just to gain profit. And to maintain the real intent of helping the ordinary people. Therefore, PDO-TTBDO 3 says we are *talking to the Department of Information and Communication Technology to ensure that licensing is still under our custody even if the technology is with the industry.*

Moreover, to avoid the higher price of products our fellowmen could not afford. When that occurs, we lose the essence of our intention to help ordinary workers. That is why we connect with DICT.

In an article released on their website (Arana, 2019), the Department of Science and Technology-Fairness Opinion Board (DOST-FOB) has approved products chosen by the private sector for commercialization and is currently making a significant impact on the community. Examples are Microbial Rennet, a substitute for animal rennet used in cheese making, and Mykovam, a soil-based biological fertilizer that is very effective in improving plant growth and increasing the yield and survival of several agricultural and fruit crops and forest trees.

In a short message delivered in one of his speeches, UPLB Chancellor Fernando C. Sanchez, Jr. said that commercialization is a significant step toward ensuring that the University's research outputs are promoted to the general public, allowing UPLB to contribute further to national development. Similarly, Glenn N. Baticados, director of the TTBDO and faculty member at the College of Economics and Management, vowed that the Center would build good relationships with its stakeholders to bring UPLB's technologies to the market. In an interview, he further said, "With closer ties and collaboration between the academe, the government, and industry, we hope to foster an inclusive innovation ecosystem wherein the University is in touch with the actual needs of the public and industry."

Parallel to their advocacy competency, the same skill is exhibited in the model, meaning that after the beneficiaries adopted the technology and utilized it, the innovators would come and personally ask the recipients about the impact of the technology (see 4.3.1.3.1). As Innovator F says: *I mentioned to you already that I visit personally those who are using the technology, and I bring along with me my students, sometimes my colleagues in the office, right Dr. Saguibo? I always tag her*

along. I persistently teach them until they master the cheese-making [laughs]. Then, I ask them how they are doing in making the cheese. Others would ask why it is sour and quickly gets spoiled. I told them it could be there was much vinegar and the mixture was not correct. If the mixture…is not proper, it will be a waste. That is why I keep doing demos and lectures. Without asking for anything in return (see 4.2.3), the innovators go the extra mile to assist recipients (beneficiaries of the technology) in making sure the technology is utilized correctly or implemented. As Innovator D says: *I go around Luzon, Visayas at Mindanao to monitor the product personally because the problem is how to use the product. Who imitated the product, which caused the original product to get destroyed. I tell the farmers to buy from our legitimate outlets. However, I am far away from them, especially those from Visayas and Mindanao. That is why I intentionally visit them.*

4.5 Summary Thoughts

Based on the findings, this study offers a stand out reality - with knowledge comes creation, with the two irrevocably connected to produce innovation, and so that whatever is thought of and put into action **(*knowledge*)** to produce something to be novel **(*creation*)** to be utilized by the society and impact lives is ***innovation***. Linking all these concepts in a broader perspective **(*knowledge/creation/innovation*)**, it appears there is altruism in the context of this study: **Information** is the key to knowledge, which stems from the Innovator's previous experience and current environmental issues, and **knowledge** is building upon and acting on collected information through socialization.

As recalled, one of the core competencies carried on by the innovators is transcendence (see 4.2.1.3), which is a unique and exemplar innovation competency in the attainment of innovation products. As the researcher was about to end her observations and interviews with the innovators, noticeably, there is one standard denominator answer that encapsulates the essence of why innovators produce innovative products, that is, to respond to the community's needs for social justice without expecting anything in return. At the same time, they take charge and are responsible for the notable impact of the technology in the community (see 4.2.1.3.1.2), inspiring the local people to utilize the product to transform their lives (see 4.2.3.1.2.1). It is in contrast to the standard definition of innovation (see 2.4.1), where the goal of the industries or the business sector to innovate is for their company's economic growth and gains competitive profit. It is a heartbreaking realization felt by the innovators. In Innovator D's words: *We are creating products for the citizens, not to gain profit and become rich. If I had wanted to be rich, I would have done it long before because our product sales are fast and high. I do not want to earn-out from the farmers. It is hard to think that way. That is the reason I am against giving this product to the industry because it is hard to think that the industry is earning big while our farmers are getting poorer.*

Similarly, Innovator C says: *I create a unique product for my fellowmen to use. We are not profit-oriented. That is our difference from the industries in the business world. It is a heartbreaking reality that these companies innovate for the economic growth of their company and lucrative returns on investments.* An Innovator F shares: *Indeed, the big companies' goal is to earn, which is why they like*

to have new products. That is also why they invest in research. I am happy that I can help with my product. We are doing advocacy, not business [laughs].

It brings to light the thought that UPLB Biotechnology, and particularly its agricultural training institutes, innovate for the welfare of the society, and the country in general, to boost economic growth, achieve Sustainable Development Goals (SDG), contribute to the attainment of Ambisyon 2040 and the Philippine Development Plan (APDP) 2017-2020, and contribute to the agricultural sector because that is where our farmers belong. As Innovator H says: *You ask anyone; we have only one goal: To package innovative products for all Filipinos; they are answers to the calamities, Ambition 2040, and the government programs,* [specifically]*, the Philippine Development Plan (APDP) 2017-2020. Oh, so happy.* [laughs]. *Of course, over and above, our agriculture because it is where the farmers belong.* And in Innovator G's words: *You know, not for bragging. I feel happy about my output because it helps in eradicating climate change. Moreover,* [supplies] *healthy food because our plants are all organic. Healthy living. Then, we also help mitigate climate change because we are not burning the Styrofoam. Instead of ending up in a landfill, we tend to recycle it. It is our advocacy to take care of the environment.*

Ultimately, this study unraveled an exemplar innovation path model, which will be available for all higher education institutions seeking tremendous innovation success to adopt contextually. See Appendix J.

CHAPTER 5

CONCLUSIONS

This study aimed to determine why and how R & R&D BIOTECH innovators in higher education institutes achieve success, highlighting the interweaving association of knowledge, creativity, and innovation towards developing an innovation model for higher education institutions. Specifically, this research sought to answer the following secondary questions: (1) What unique characteristics of the R&D BIOTECH agricultural sector influence innovation? (2) What innovator competencies and attributes enable successful R&D BIOTECH innovation in HEIs? (3) How is innovator success in R&D BIOTECH supported and encouraged in HEIs?

Building toward addressing the primary question, it is deemed first to present the findings regarding the secondary questions. One-on-one interviews and observations were utilized to elicit the unique characteristics related to the R&D BIOTECH agricultural sector that influence innovation, the innovator competencies and attributes that enable successful R&D BIOTECH innovation in HEIs, and how innovator success is in R&D BIOTECH supported and encouraged in HEIs. In addition, the researcher interviewed other significant individuals that gave additional substance to the study.

5.1 Sub-question 1: What are the Unique Characteristics Related to the R&D BIOTECH Agricultural Sector that Influence Innovation?

The findings show that external drivers in the areas of Environmental Aspects and External Relations—having unique characteristics related to the R&D BIOTECH agricultural sector—that influence innovation. Further, it is clear that in BIOTECH, these external drivers helped fuel success in innovation. The two emergent themes

related to environmental aspects are natural calamities and societal problems, and the two themes related to external relations are stat-of-the-art facilities and funding agencies. While natural calamities and societal problems are beyond the control of the innovators, with pre-cognition, they can be mitigated. Biotechnology responds according to the community's needs, especially in alleviating the aftershock of natural calamities to people's livelihood. It is consistent with Briseno and Zorrilla (2017), who says that firms are increasingly responding to social and environmental claims from society. Innovation practices are encouraged to attend to poverty, work equality, renewable energy, and food production, not to withstand the hazardous effects of climate change, frequently implemented to address impacts on sustainability (2.9.1.4). External drivers are grouped loosely into environmental aspects and external relations.

5.1.1 Environmental Aspects

As forwarded in 2.9.1.3**,** the Philippines are prone to natural disasters and suffers significant human-caused environmental degradation aggravated by a high annual population growth rate, including loss of agricultural lands, deforestation, soil erosion, air and water pollution, improper disposal of solid and toxic wastes, loss of coral reefs, mismanagement and abuse of coastal resources, and overfishing.

These devastating and alarming realities compel the scientists-innovators to develop technologies that somehow mitigate such disasters, if not to assuage the aftermath to the society and the people greatly affected by them. The two themes related to environmental aspects that emerged from the interviews fall in the areas of natural calamities and societal issues.

5.1.1.1 Natural Calamities *refer to environmental problems which serve as the impetus for producing technology*. Instead of feeling appalled at the frequent visits of natural calamities, innovators use these events as a springboard to their research in finding solutions and offering substantial technology to assuage the effects on humanity, precisely the society (see 4.1.1.1.1 and 4.2.3.2.3.1). Innovators are motivated and challenged to produce technology to address the conditions of the environment and erratic weather. The environmental problems of society impel them to create and co-create products that have potential market value.

Although the Philippines has disaster-mitigating agencies that manage the devastating impacts of such vulnerable disasters across sectors of the country, technologies are still needed, which the innovators offer, to help mitigate disasters. There is a recognition of their expertise and agricultural innovations.

While this is consistent with Benson and Clay (2003) saying that major natural disasters can have severe negative short-run economic impacts, disasters also have longer-term consequences for economic growth, development, and poverty reduction. As forwarded by the innovators, negative impacts are not inevitable, especially in the agricultural sector, but much can be done to mitigate these negative impacts. In line with this, innovators expressed their observations on the fundamental fact that natural disasters pose a severe threat to the economies of the world, especially those of developing countries, in terms of economic losses and physical damage, including the present society.

Fundamentally, innovators deem it imperative to focus on technologies in agriculture because they are alarmed with what the research says regarding the plight of agriculture in the country. Further, they focus on technologies in agriculture

because of the critical societal need in this area. It is clear that these issues are critical to the innovators and fan their passions for improving living conditions across society through worthwhile technologies.

5.1.1.2 Societal Issues *refer to the issues that hamper agricultural growth in sustaining economic growth, achieving sustainable development, and mitigating climate change.* The most alarming environmental issues are climate change, which affects food production needed for survival, which is very much affected by the choices made by society (see 4.1.1.1.2). The innovator's creativity offers the opportunity to move through these problems through research. To discover the inescapable natural endemic problems beneath this reality, innovators conduct massive investigations to rule out various potential causes of the problems and earnestly search for solutions to help the farmers. For instance, there is a general awareness of the deleterious effects of chemical pesticides on the human body and the environment (see 4.1.1). This fact ignites the innovator's eagerness to produce technologies that use safe alternatives like bio-pesticides in such a way that they are pro-environment and support a conscious and healthy lifestyle (see 4.2.1.1.1.1). Such an approach has helped elevate the lifestyle of the poor who cannot afford to bring palatable and mouth-watery foods onto their plates.

Investment in technology and innovation and the necessary support services are essential to achieving successful agricultural transformation (Brown et al. (2018)). Similarly, innovators invest their time, energy, and expertise, meaning they take their time seriously to study the endemic problems to produce product innovations that address the national appeal of restoring the agricultural sector and the university and government thrusts to establish economic growth and attain sustainable development.

5.1.2 External Relations

External relations have two sub-clusters: (1) state-of-the-art facilities and (2) funding agencies. These factors appear to be equally important in the discharge of innovator responsibilities since they have both direct and indirect influences on innovator outputs (see 4.1.1.2). Though innovators appeared eager and exceptionally optimistic in their response to the innovation activities of the university, if the development of technologies did not match with the facilities and equipment available, the labors of the innovators would be futile. The facilities have to support their skills because these are essential means to develop, access, and understand knowledge (see 4.1.1.2.1). Elements of external relations include state-of-the-art facilities and funding agencies that contribute to successful product innovation. State-of-the-art facilities refer to the technology's location, including on-site facilities (laboratories) for storing specimens such as fungi and bacteria and off-site facilities (fields) for growing root crops, grains, or fruit-bearing trees.

5.1.2.1 State-of-the-art Facilities *refer to the combination of the on-site (laboratory) for strong specimens such as fungi and bacteria and the off-site (field) for growing root crops, grains, or fruit-bearing trees.* The former refers to the laboratory located within the university equipped with hygienic and well-maintained temperatures where specific specimens are stored and treated with utmost care. The latter facility reference is the external natural field where innovators grow their technologies until they mature. Both facilities observe similar processes and considerations when engaged in technology development. The only difference is that some product innovations, such as Dwarf Saba, have to be planted and grown on soil (see 4.2.1.2.1). Moreover, experts [innovators] and authorized individuals [staff] run

these laboratories (see 4.2.3.1.2.2 and 4.2.3.2.1.1**)**. There is also an access with computers and Wifi connectivity that helped them connect with the virtual world and link with their teammates anytime, anywhere (see 4.1.1.2.1).

5.1.2.2 Funding Agencies *refer to interested parties who wish to finance the development of technologies.* Funding agencies play an essential role in the advancement of technologies. While many feasible technologies are available, they are not all commercially competitive without government subsidies or other support. To produce exemplar technologies, innovators find potential funding from either a public or private entity to help them finance their projects (see 4.1.1.2.2).

The majority of the innovators seek government funds, which requires that they undergo the policies of procurement law, which are the guidelines relative to innovation in a university. One specific law that innovators know well and understand is the 2016 Revised Implementing Rules and Regulations, hereinafter called the IRR (2.8.2.2). This law was promulgated pursuant to Section 75 of Republic Act No. (R.A.) 9184, otherwise known as the "Government Procurement Reform Act," to prescribe the necessary rules and regulations for the modernization, standardization, and regulation of procurement activities of the Government of the Philippines (GoP). The provisions of this IRR are in line with the commitment of the GoP to promote good governance and its effort to adhere to the principles of transparency, accountability, equity, efficiency, and economy in its procurement process.

UPLB Biotechnology is strict in implementing IRR to maintain smooth sailing and peace and order in the development of technologies. Since this is a state university where funding comes from the government, the individual is accountable for the disposal of funds. However, because of some unavoidable circumstances, there

are sometimes delays in releasing the approved budget. In these cases, innovators often shell out money from their own pockets to beat the timeframe allotted for the disposal of the technology.

In the absence of non-availability of government funds, innovators may opt to forge private agency partnerships to finance their technology, meaning they individually look for their possible financer. For example, innovator C narrated: *The Department of Science and Technology funded my research.* Innovator H said: *The Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD*). While Innovator F enthusiastically shared: *My technology was both funded by PCAARRD and an Australian agency.* Furthermore, innovators would attend exhibits or a technology fair as a first step in introducing the technology to the potential market. If and when agencies show interest in the technology, they would finance the project (see 4.1.1.2.2; 4.2.1.2 and 4.2.1.2.1.2).

5.2 Sub-question 2: Innovation Competencies and Attributes

The findings show a unique competency pattern and specific attributes that enable successful R&D BIOTECH innovation in HEIs. In addition, individual influencers emerged through observation and as voiced in the interviews. These are ideas, pieces of words, or phrases shared by one or two innovators or emerging from observable behaviors that appear to influence innovator success (see 4.2.2**)**. Finally, we add knowledge sharing (see 4.2.3) to this competency set—which came up throughout the interviews—specifically looking at this from the viewpoint of the interviewed innovators and mainly in the vertical passing down of knowledge from the forefathers to the current innovators. Three key areas and related core

competencies emerged: technical (hard skills), social (soft skills), and transcendence skills. See Table 5.1 below.

Table 5.1

Innovation Competencies

Key AREA	**CORE COMPETENCY**	**INNIVATION COMPETENCIES**
Technical Skills (Hard Skills)	Problems-Solving Creativity	Focusing Evaluating Critical Thinking Resourcefulness
Social Skills (Soft Skills)	Leadership	Mentoring Collaborating
Transcendence Skills	Altruism	Advocacy Commitment

For these innovators, both hard and soft skills (see 4.2.1) have been carefully honed and cultivated through time. Through their rigorous efforts and commitment, they can deliver powerful technologies to society. It agrees with the work of Lumague (2017); Balcar (2016); Han (2015); Balcar et al. (2014); Bacolod and Blum (2008), Borghans et al. (2006), and Reber and Reber (2001), whom all claim that both types of skills significantly increase an individual's productivity (2.9.4.4). The innovators have not only increased their productivity but have generated equitable productivity for the campus and the country.

5.2.1 Technical Skills

Technical skills include problem-solving skills and creativity skills (see 4.2.1.1). In this research, technical skills refer to applying the expertise and training

gained (see 4.2.3.1.2.2 and 4.3.1.1.2**)** to develop products and deliver high-quality outputs, particularly innovative products that address societal issues. It is consistent with the work of García-Goñi et al. (2007), who say that innovation depends mainly on the professionals who can create and apply new ideas and knowledge in their daily work (2.2.4.3). Indeed, successful product innovations lie in the skills applied by the innovators.

5.2.1.1 Problem-solving Skills include focusing skills and evaluating skills (see 4.2.1.1.1). *Problem-solving skills are the ability to recognize prevalent problems and find a solution to overcome them*. Innovators are sensitive to the needs of the people and, from there, take the responsibility to create solutions to appease difficulties in daily living. Innovator G repeatedly said: *You know we are always thinking about the welfare of our fellow citizens. We are creating technologies to help them get out of their difficulties; know our hearts and minds are always.* The innovators find solutions to tormenting societal issues in the agricultural field (see 4.1.1 and 4.2.1.1.2.2). When creating technologies for solving problems, these innovators consider existing facts, compare previous data, and have an intuitive sense of how to proceed. Isaksen (1987) supports the findings by saying that intuitive problem-solving styles tend to process information from different paradigms simultaneously (2.3.1), and also by Jabri's (1991) position that intuitive problem-solving ability focuses on problem-solving, not tied to existing rules with multiple ideas (2.3.1). The innovators in this study followed their instincts rather than being tied to what the literature said. Moreover, when they present these new technologies in society, the products are affordable, aggressively help the farmers gain profits, and, foremost, are eco-friendly (see 4.3.1.1).

Another way of solving a problem is using logic and reason to justify claims, accompanied by hard facts and data using scientific explanation to describe the product's benefits, how it supports their needs, and the product's lifespan. This approach is consistent with Jabri's (1991) conceptualization of problem-solving, which is that the structured problem-solving styles based on associative thinking follow a set of rules and are resolved reasonably and logically.

Innovators use both structured problem-solving styles based on associative thinking focusing on a set of rules, resolving problems reasonably and logically, and intuitive problem-solving, focusing on problem-solving itself with multiple ideas and is not tied to existing rules (see 4.2.1.1.2, 4.2.1.1.1.1 and 4.2.1.1.2.1). Jabri (1991) describes these as the two independent thinking styles of problem-solving: structured problem-solving styles and intuitive problem-solving ability. It is also consistent with Anderson and Anderson's (1995) view of problem-solving abilities. Furthermore, it is proven to be one of the critical factors for success in organizations (2.3.1) and personal careers and in any other related field of interest, including successful innovation. Thus, this study strongly advocates that problem-solving abilities are an essential ability to drive innovation and sustainable growth and development in the industry and that these specific problem-solving skills are a contributory factor for successful innovation products.

5.2.1.1.1 Focusing Skills *include the ability to develop products one at a time to avoid mixed up and shambolic output*. In line with this competency, innovators ascertain that research conducted was of no waste because before conducting and focusing on an intensive area of research, innovators first identified the technology they intended to develop based on the immediate concern about agricultural problems

besetting the environment (see 4.1.1.1). They then conducted research based on what they thought was best for all. Headed by the project leader, the team surveyed the community regarding concerns that needed immediate attention and, one at a time developed the technologies to address those needs. Innovators prefer to concentrate and dedicate resources such as time, energy, and monetary expenditures to a single project rather than simultaneously attending to so many technologies. As a result, they do not accomplish their innovation product; thus, focusing skills are considered a competency for successful innovation (see 4.1.1.2.1).

Compelled by their desire to create products, they focus clearly on their endeavors. Innovators gave their full attention and followed a timetable on when to achieve their goals. Innovator B says *Our time timetable guides us in tracking and accomplishing our tasks on time. We also prepare prior to starting our project.* Within the domain of their team (see 4.3.1.2.2), innovators shared the results of continuous research in diverse expertise and related fields to discover new and audacious technology and assimilate and accommodate information that brought light to refine the technology. If the technology failed, they gladly accepted failure with clarity and started anew, trying possible options to improve technology. They accurately predicted essential changes and exploited results-based research to adjust the technology to achieve the desired results. They ventured on possibilities confidently and prospered in future directions (see 4.2.1.1.2.2 and 4.2.1.2.1.3).

It is clear from this study that innovators have the focusing skills to ascertain and achieve the specific goals and objectives they need to ensure that every Centavo spent on research benefits the people and has the most significant impact on the resolved.

5.2.1.1.2 Evaluating Skills *refers to assessing the impact of product innovation in the community.* Innovators seriously consider the advantage of evaluation as potentially empowering. Therefore, innovators are directly involved in the impact assessment of technology and firmed with the basic evaluation principles, they confidently confront failures (see 4.2.1.1.1.2). Thus, it confirms the work of Patton (1994) describing evaluation with the provocative phrase "empowerment" since the ultimate purpose of an evaluation is to expose problems due to imperfections such as inadequately assessed needs, fuzzy and conflicting goals, poorly defined targets, insufficient resources, and sloppy implementation of plans (2.8.2.1). However, these problems did not stop the innovators from achieving their goal of contributing to society (see 4.2.1.3.1.1 and 4.2.1.3.1.2).

Furthermore, innovators regularly review their projects and the Technology Transfer and Business Development Office (TTBDO) to avoid difficulties. The projects must be in sync with the vision mission and respond to the thrust of the university-addressing the society's pressing needs regarding food production and health (see 4.4.2.5). Importantly, innovators allot time during the planning stage to foresee potential difficulties and are ready to address technical difficulties (see 4.2.3.1.3.1).

Moreover, innovators conduct tryouts of the technology with some potential clients before finally launching it into the market. They also provide gratuitous lecture demonstrations and explain how to use the technology (see 4.2.3.2.4.1). In her words, they do not just introduce the product and advertise its benefits but are focused on utilizing the technology, ensuring it can achieve its full potential. This effort alone

shows that innovators personally see and observe the immediate impact of the technologies.

Through their evaluating skills, innovators can determine any weakness of the product and take the opportunity to improve or enhance the technology (see 4.2.3.1.3.2**)**. Moreover, it is consistent with the general purpose of evaluating skills; for example, House (1996) says that the emergence of evaluation as a profession means assessing needs, identifying solutions, targeting populations, setting goals, procuring resources, implementing programs, and, of course, evaluating results (2.8.2.1). Thus, innovators seriously consider evaluating skills as vital to successful innovation products. For example, innovator F said *I join my team when we evaluate our product's impact so that I precisely know its weakness and strength.*

5.2.1.2 Creativity Skills (CS) include critical thinking skills and resourcefulness. *Creativity refers to producing novel technology of the acquired information and knowledge*. The second core competency under technical skills is creativity, which is imperative for innovation (see 4.2.1.1.2). Innovators learned many things from their mentors, training, exposure outside and socialization from the masses, and the predominant environmental issues that affect the agriculture sector. Thus, they come home working on something novel. Through their massive research (see 4.2.3.2.3.1), they arrived at a solid product innovation grounded on the needs of the society and working within the social context of the farmers and laborers (see 4.3.1.3.1). Creativity underlies the contextual manufacture of something new, something novel from the various knowledge gained. This newness of the product produced was optimized or used by the market; hence the product becomes innovative. This derived view of creativity is similar to the definition shared by the

Intellectual Property Office of the Philippines (2018). Creativity is the technical solution to a technical problem, creative ability, or action of doing something new. A creative person constantly searches for knowledge through reading, watching, and analyzing films, mingling and talking with people, Socratic questioning, hearing and listening, accepting criticisms and feedback, learning from mistakes, and having the audacity to experience novel things. A person (in this case, an innovator) has many memories to associate with incoming information to create new knowledge (see 2.3.1 and 4.2.1.1.2).

Creativity is a necessary trait to produce invention and innovation. Innovator C shared: C*reativity leads one to produce something new, which brings to being innovative when people utilize the product—the* literature review (2.4.3) confirms and according to Christopher M.
Kalanje (Consultant, SMEs Division, WIPO), innovation is a process from the outset of an idea until it reaches the market to serve its purpose. Moreover, in the case of these innovators, these ideas come from creative individuals who have the inspiration and motivation to help society and the country (see 4.3.1.3.2).

Furthermore, innovators sensibly select and ponder on those products that alter the lives of the end-users. It is similar to Mermiri's (2009) findings that products and services are carefully selected based on how they alter people's lives, affect rational thoughts, and make decisions. Innovators repeatedly shared: *We create technologies that are relevant to the pressing needs of society and improve the lifestyle of the people.* Apart from the practicality of the technologies, the newness of the innovator's technologies adds value to the innovative product. The novelty of their technology carries greater usefulness because they have crafted contextually. It is consistent with

Chełmecka (2018) saying that creativity influences the emergence of new, socially accepted solutions (2.3.1) and affirms the study of Plucker et al. (2010) regarding the relationship of creativity to the social context, which has been widely adopted in the literature and broadens in this context the traditional definition (2.3.1).

Hence, innovators not only engage in creativity but exemplify the skill of creativity. Furthermore, it signifies that there must be uniqueness and, at the same time, the usefulness of those ideas produced [innovation] in order to be engaged in a successful creative endeavor.

5.2.1.2.1 Critical Thinking Skills as defined in this study, *critical thinking skills are the ability to discern and make sound decisions in finding practical solutions to social issues*. These innovators continually sought solutions to problems—revolving around the idea that society cannot escape the upshot of calamities and the plight of the poor. Aware of their responsibility to society and fully embracing it, the innovators pondered these problems. Their cohesive teamwork put all their resources together, each functioning according to their expertise. Guided by the project leader, they took the risk on the possibilities of the technology. The innovators discussed the problems thoroughly, looked at things from different perspectives, and exchanged ideas and opinions, finally coming up with decisions on how to potentially solve existing social problems. Before modifying any existing technology, they discerned whether to continue with it or design another technology that would suit in answering the current problem. Throughout this process, they worked collaboratively, maximizing the members' contributions.

Finding potential solutions to problems allowed the innovators to become reflective yet aggressive in seeking information. Through their proficiency, they

interpret, analyze, and evaluate information and viable knowledge and develop a solid project to address the problem at hand. Their interaction with people and their psychological and spiritual preparation were ingredients to enhance their critical thinking skills. They were beneficial thinking skills that enabled them to distinguish the accurate and valuable information from the vast amount of gathered and accumulated data. Innovator D consistently mentioned: We *go to the field and converse with the farmers, observe them understand the predicament, and address their concerns. We pray with them as well.* This finding builds on the work of Zhong (2002), saying that critical thinking guides people's beliefs and actions through observing, reflecting, reasoning, and communicating psychological processes, and Zhou (2018) and Wen et al. (2009) claim that critical thinking is conscious and reflective thinking (2.3.1).

In other words, innovators took a rational method as the foundation of their work. It means they used their critical thinking skills and were apt in their decision-making skills vis-à-vis critical thinking as factors for successful innovation.

5.2.1.2.2 Resourcefulness *is the ability to source knowledge, think outside the box, and the maturity to deal with the complexities of the technology.* Innovators use recycled materials (for example, hydroponics technology) to improve current and future technology, transmit indigenous resources and are imaginative in dealing with various situations. Moreover, they can identify how different possible approaches work in making sound judgments. They learn from failures and, when possible, use these failures as stepping stones to success. As one participant shared, pinpointing the actual nature and cause of problems and the dynamics that underlie them make the task easier and lighter.

As forwarded earlier in this section, these innovators think 'outside the box even if it may go against popular opinion**.** It expands on the work **of** Okoye and Caleb (2019) that resourcefulness takes more than cognitive skills; it takes the ability to process information emotionally and intellectually (2.9.4.3). Innovators' resourcefulness is seen as the capacity to source knowledge and uses available resources in achieving set goals.

Seemingly understanding resourcefulness, innovators exhibit the authentic skill of addressing the complexities of the technology. For instance, when the technology fails, they immediately investigate or research why the technology failed and jump off from that learning. They look deeply into the details and think outside the box, meaning they are open to conventional and modern ways of doing things. For example, innovator G shared that we i*mproved technology by recycling discarded materials* [indigenous resources]. While Innovator H said: We *believe this technology is possible for natural farming. We explained the health benefits and the impact on our environment to our fellowmen so that we would see a healthy lifestyle.*

In short, innovators widen their scope of understanding and put on their creative imagination and resourcefulness to improve the technology that may impact human health and the environment (see 4.2.1.1.2.2). Thus, resourcefulness is one of the skills that lead to successful innovation.

5.2.2 Social Skills **(**SS) involve the core competency of leadership, with the two innovation competencies of mentoring and collaborating skills.

Social skills include the ability to make extra efforts to learn independently and learn from others (including colleagues, team members, and forefathers), the rigors of developing the technology, and negotiating for funds to run the project

linking to the core competency of leadership. This skill is significant because innovators deal with various stakeholders, and they need to build connections and rapport with individuals while maintaining the responsibility of leading a transformative project. It is the ability to exemplify responsible leadership skills to maintain smooth mentor-mentee interpersonal relationships in passing knowledge from the forefathers to the innovators through the intertwining relationship of knowledge, creativity, and innovation, as shown in the developed model [see Fig. 6-3]. The two innovation competencies emerging in this core competency are mentoring and collaborating skills.

5.2.2.1 Leadership Skills *include the ability to exemplify responsible leadership to maintain mentor-mentee smooth interpersonal relationships in leading a transformative project*. Innovators display exemplar leadership skills because each plays critical roles within the team based on their expertise. Innovation is embedded throughout the team and is at the start of changing culture and mindset. Innovators create a space for innovation to grow and thrive. This practice shows that innovators were serious and committed to their technology. They look at things from fresh perspectives, and it takes various mindsets and ways of looking at problems and opportunities to reach a consensus. Hence, these leaders exude charisma that inspires the team to do extraordinary things (4.2.1.2.1). This finding supports the work of Deschamps (2005) that leadership skills, charisma, and determination can lead to a significant innovation initiative and Carmeli et al. (2006) that self-leadership skills affect innovative behaviors at work (2.9.3.2).

Furthermore, innovators showed a distinct trademark on their kind of leadership in guiding their teammates in the pursuit of producing quality technology.

As Innovator A described: Our *leadership technique was delegating things based on one's team's capabilities to focus on the things that no one else could do, and we listen to each other's ideas.* This gesture is a demonstration of them being excellent leaders and followers. Innovators manage the team with transparency and are accountable for all decisions and actions. However, when things do not go well, they remain composed and still believe in their teammates' capability and their collective ability to overcome the trial and stay with the team amidst challenges. It is consistent with the findings of Gilley et al. (2008), claiming that leadership effectiveness drives change and innovation and the skills necessary to do so (2.9.3.2).

This study postulates an informal leadership where team members perform their tasks with trust and confidence (see 4.2.3.1.1.2 and 4.3.1.2.2). They do not dwell on their weaknesses; instead, they move through frustration and move forward. It agrees with the thought escalated by Pearce and Conger (2003), saying that informal leadership is an activity that can be shared or distributed among members of a group or organization. Furthermore, it opens up new lines of thinking about informal leadership in organizations (Fletcher & Kaufer, 2003). People are empowered to make decisions concerning their tasks at work and implement them (2.9.3.2).

Innovators listened with a disposition to suggestions, sought the opinions of others, and were not afraid to try new ideas to reach a creative solution, having the faculty integrate multiple perspectives harmoniously and honor both time and the members of the team. They perform the expertise required and optimize teammates' potentials to the fullest (see 4.2.3.2.1.1). They raise the value of the technology, which leads to productive and successful product innovation.

5.2.2.1.1 Mentoring Skill*s, the first innovation competency under the leadership core competency, *include t*he ability to mentor and guide the next generation of innovators in producing profitable products. Innovators were once members of a research team headed by tenured and hard-core researchers called forefathers. These forefathers were the first handlers of the technology who willingly and unselfishly shared their skills, God-given talents, and time in mentoring aspiring innovators, involving them fully in technology development.

Forefathers mentored the new generation of innovators conscientiously. Then, as blossoming innovators, they went through a rigorous process of developing the technology from its inception to commercialization. Once these forefathers retire, current innovators take on the next responsibility of leading the project. During this study, that same level of mentoring was evident during product development (see 4.2.1.2.1.1). In addition, to intensify the team's knowledge of the technology through hands-on involvement, mentors also bring team members to conferences, seminars, and other related activities. For example, innovator B said: *I tagged along with me my team members to conferences and seminars and even to exhibits so that they would learn more because that is what my former mentor did to me.*

In other words, innovators carried on the best practices they experienced from their forefathers and were very generous and patient in mentoring one another. Indeed, mentoring is significant to the success of innovation

5.2.2.1.2 Collaborating Skills *include the ability to pool various resources or expertise and forge potential partnerships to fund the project.* Collaborating is a competency tied to mentoring. Innovators went through the rigor of preparing proposals as an essential requirement for conducting research, part of which is

preparing the budget proposal. It is the same feeling that Reichlmayr (2006) shares when he says that soliciting sponsorship, vetting proposals, and collaborating with various agencies is tedious (2.8.2.2), though, in discussions, innovators did note that this process is tedious. Instead, innovators embrace the process as a challenge, considering that millions of people will benefit from their worthwhile projects.

Once the budget is approved, innovators conduct the research for almost a year or more. After getting successful results, they join exhibits or an expo to advertise the product and source funds to finance their projects' roll-out (4.2.1.2.1.2). Other means of financing include actively collaborating on project proposals with a variety of entities such as nonprofit organizations, local industry, and industry from outside the area, as well as different government agencies like the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD) of the Department of Science and Technology (DOST). As Innovator B said: *To create the technology, we need funding agencies, so we collaborate with all people involved and other experts because not all are within the coverage of what we know.*

When an entity is interested in a project, innovators establish a Memorandum of Agreement (MOA) between the two parties to proceed with the technology development as discussed in the TTBDO's framework and identified as an essential element in the model.

The growing interdisciplinary nature of collaborating skills of the innovators lends itself to building social relationships, which leads to successful innovation where the work of innovators can deliver a high impact on society.

5.2.3 Transcendence

Transcendence is the ability to respond to the community's needs without expecting anything in return. Transcendence includes the core competency of altruism, the ability to forget oneself in favor of the less fortunate who will benefit from the technology. Innovators' sole motive for creating technologies is to address the apparent concerns of society. Brown et al. (2005); Dunlin and Hill (2003); Parke and Chappell (2008); Poortinga (2006); Serrat et al. (2018), and Warburton and McLaughlin (2005) found out that older adults, more often than not are helping others because it has a positive effect on their well-being and life satisfaction.

The study challenged the findings mentioned above since innovators, young and old, are on the verge of helping people through their technologies, regardless of their status and educational background. Transcendence kept the zealous character of the innovators to succeed in their product innovation.

5.2.3.1 Altruism includes advocacy and commitment. *Altruism is the ability to forget oneself in favor of the less fortunate who will benefit from the technology*. Innovators do not think only in terms of income-generating, but they enjoy and like to innovate for the welfare of the common good. Moreover, as Innovator D said, if I *wanted to become wealthy because of my product, I should have done it a long time ago. However, I did not. I am thinking of the welfare of my fellowmen.* They tend to give selflessly, which by definition pronounces them as altruistic. Hence, altruism describes the essence of true sharing. Moreover, as Yalom and Leszcz (2005) forwarded, altruism is commonly thought of as unselfish concern and actions for the welfare of others, which fosters personal psychological growth and increases an individual’s ability to connect with others. It certainly appears to be the

case with these innovators. Throughout their journey to successful innovation products, they voluntarily assisted the farmers. There were times when they even threshed pennies out of their pockets to meet both ends with the townspeople (see 4.2.1.3.1). In other words, they go the extra mile to enable their technologies to reach the target beneficiaries. As Innovator G said: *I have grown old helping, but I have never thought of making a profit from this technology. Even when I am already old, I still engage with the people who need my assistance.*

It is consistent with Theurer and Wister (2010) saying that assisting others in volunteer activities and informal support of neighbors are the necessary forms of helping behavior understood based on a sense of altruism. Their contributions depict conceptualized roles as resources for action and agency (Piliavin, Grube & Callero 2002) in response to the needs of the society (2.3.5). As recalled, Innovator G humbly said: *I have been doing this low-cost technology for so long to help our farmers improve their way of living. There is no other joy than seeing them delighted and living a sustainable life.*

Remarkably, the roles played by the innovators through their significant product innovations are vital efforts in addressing the problems brought about by unavoidable natural calamities.

5.2.3.1.1 Advocacy, the first innovation competency under the altruism core competency, *is defined as the ability to inspire the local people to utilize the product and transform their lives*. Innovators served as heralds of activities that call for a cause – to uplift the lives of the marginalized and bring sufficient, nutritious, and affordable food to every Filipino family, and, foremost, refurbish and curate the damaged and maltreated ecosystem of the country (see 4.2.1.3.1.1). This behavior

goes back to the origin of the term "advocacy," which comes from the Latin *advocate* and means *to call out for support*. As Innovator D firmly said: *One way of looking into national perspective is bringing back ourselves on the map through our advocacy of restoring our agriculture which is the primary source of living for our fellow citizens. Helping the marginalized advance their lives through our technologies is our utmost goal as inventors. No more, no less.*

Innovators create technology to help the government achieve the Sustainable Development Goals (SDGs), the blueprint for achieving a better and more sustainable future for all (2.8.2). The SDGs address the global challenges we face, including poverty, inequality, climate, environmental degradation, prosperity, and peace and justice. As one participant acknowledged: *We are committed to restoring, caring for, and protecting mother earth as a gesture of love for the country. We do advocate for organic products to mitigate climate change.*

Innovators love to form advocacy out of their technology, meaning it is their joy to stay in touch with the beneficiaries of the technology even if it costs them time and energy to do so. As we have repeatedly recognized throughout this study, the main goal or agenda of the innovators in producing technologies is to improve people's lives and for sustainable development.

5.2.3.1.2 Commitment *is considered the ability to take charge and be responsible for technology's notable impact on the community*. Coupling advocacy with commitment is gearing toward maintaining the quality and impact of the technology. Innovators' commitment was not the result of their personal goals but rather the collective goal of serving the best interest of the farmers. Contrary to most researchers' view of commitment which is closely tied to goal setting (Locke et al.,

1988) and is perceived as directed toward one's personal goals. As Innovator H states: We *worked on this technology, not for our personal goal. However, it is a collective goal of serving our fellow citizens. All of us are part of a committee to serve our people.*

Reviewing one of the articles of Locke et al. (1988), the authors contradicted their previous definition of commitment, concentrated on the self. According to these authors, commitment refers to one's attachment to or determination to reach a goal, regardless of the goal's origin. Thus, it can apply to any goal, whether self-set, participative or assigned. This study proves true for the innovators, whose commitment was not for self-service, but a commitment to a certain degree of responsibility outside of self, which is the result of advocacy. As Innovator A says: *We have a great responsibility, and that is our commitment to being of service to the Filipino people unselfishly.*

In other words, innovators give totally of themselves to attaining successful product innovations because their technology is a tool to respond to corporate social responsibility (CSR). This commitment is built within their system, thus becoming part of their advocacy to society.

5.2.4 Individual Influencers

Individual influencers emerged from the interviews and observations. These are ideas, pieces of words, or phrases shared by one or two innovators or emerging from observable behaviors. The ideas shared in this category are: (1) family history; (2) concept of resonance**;** (3) trait of persistence; (4) tolerance; (5) contentment over royalty and promotion; (6) insignificance of title; (7); innovation as self-initiated (skill of transcendence); (8) writing skills; (9) prayers matter; (10)

humility; (11) role of belief or religion; and (12) the joy of laughter. We briefly discuss each with a chapter 4 reference for a deeper discussion.

5.2.4.1 Family History. It refers to a previous family episode that triggered innovators to share their knowledge and engage in knowledge sharing to produce technologies. Innovators come from a family of farmers, and they saw the adversities these farmers directly experience. They had witnessed that farming is recurrent and thus the struggle to sustain it with a low investment return. For this disquieting concern, innovators developed technologies that have been tried and are successful and currently used nationwide. With this remarkable product on the market, the institution achieved both national and international recognition along with the innovators. Furthermore, this noble action demonstrates the love and care for family, which the innovators have extended to society and the country. Hence, parents' hardships to provide good educational opportunities to their offspring serve as inspiration to their children. In return, successful children look back to their supportive, proud parents and give back the favor [with gratitude to parents] a "hundredfold."

5.2.4.2 Concept of Resonance. It refers to the zealous character of enriching and amplifying clear direction to be involved in knowledge sharing. In addition, the innovators are fully aware of their strategic path to deliver quality technologies that can help produce sufficient and edible food for Filipinos, and they respond to this challenge without hesitation. Finally, the innovators' zealous character of conscientiously addressing the societal challenge manifests their desire to help society and the country.

5.2.4.3 The Trait of Persistence. It refers to the determination of the innovators to draw their attention to knowledge sharing to deliver the product to the end-users repeatedly and persistently demonstrating the skill. When end-users find it hard to absorb the knowledge about the technology, they repeatedly and persistently demonstrate the skill. Meaning that they do not have to give up because it is their commitment to helping the people. Innovators take their time to teach and demonstrate how to use the technology to the end-users.

5.2.4.4 Tolerance. It refers to the recognition that innovators exercise understanding when they commit a mistake. In other words, tolerance for making mistakes also plays a significant role in knowledge sharing. Innovators exercise a high level of tolerance in knowledge sharing, meaning that innovators acknowledge they also commit mistakes as they share the knowledge. While they may have experienced some difficulties along the way, they are being assisted or helped by their teammates. Since there is a genuine established relationship and trust, innovators are not hesitant to report errors with their teammates and agree on how to solve them.

5.2.4.5 Contentment over Royalty and Promotion. It refers to the innovators' fulfillment to help other than external rewards. If benefits such as enjoyment and earning respect were motivational factors for sharing their knowledge freely to be able to create products, another reward that innovators could receive out of their technology is royalty. Regardless, the innovators are pleased with what they are doing; there is contentment because they see that what they are doing is beneficial; promotion is of minor importance.

5.2.4.6 Insignificance of Title. It refers to the titles [inventor, researcher, scientist instead of innovator], addressed to the innovators that the innovators are

unaware of seeing these as descriptive terms rather than titles. What matters most to them is that they could utilize the knowledge well. Whether they are called researchers or inventors or scientists or innovators, they remain faithful to their commitment to continuing the legacy of their forefathers in serving the marginalized. Indeed, as the end goal of knowledge sharing is to produce technology for the people, they are not conscious of their different titles.

5.2.4.7 Innovation is Self-initiated (Skill of Transcendence). It refers to the innovators' self-impelled intention to produce innovation. The innovators lead projects that respond to the problems brought about by these catastrophes. However, it is self-initiated, and they still have the institution's support. Not all people have this mindset and can become innovators. Innovators' eagerness to transfer knowledge is facilitated and mediated by the team and some members.

5.2.4.8 The Writing Skills. It refers to the innovators' ability to inscribe or write correctly. Writing skill here means the quickness and accuracy of jotting down ideas and information. They refer to these notes when verifying unclear messages. It is also a way to keep storing the shared knowledge. This skill enables innovators to write and prepare a concrete budget proposal. Before engaging in research, innovators go through the rigors of preparing proposals, part of which is preparing the budget proposal. No doubt, innovators are intelligible in this area.

5.2.4.9 Prayers Matter. It refers to the innovators' trust in the greater source in imploring the guidance of the Almighty. Even though they have all the knowledge, they do not know everything. Moreover, they may commit errors along the way, so they pray for enlightenment as they work on their technology and aspire to carry on

the legacy to boost the economy of the country efficiently and make the life of every Filipino better.

5.2.4.10 Humility. This refers to the innovators being low-profile individuals. Their modest attitude to integrating feedback in their desire to produce quality technologies delight the end-users. Innovators' humility boils down to their commitment to serve humanity without counting the cost. For these scientist-innovators, humility occurs at the individual and interpersonal (team) levels. As an individual, humility is having an accurate view of who you are, not too high or low, knowing your strengths and abilities, recognizing any weaknesses and limitations, and being honest about who you are and what you know about yourself and others.

5.2.4.11 Role of Belief or Religion to Altruism. It refers to the innovators' conviction or creed, which led to being altruistic. Altruism involves behavior shown in the apparent absence of external reinforcers; even without the rewards or recognition applauded by the innovators, they still produce technologies for the target end-users without expecting anything from them. The sole intent of the innovators in producing technologies is for the target end-users to improve their lifestyles. They are not after the profit gained, the awards, recognition, or even promotion but to uplift the present condition of the users.

5.2.4.12 The Joy of Laughter. This refers to the jubilation of the innovators in sharing their insights, experiences and knowledge in their journey towards product innovation. Generally, it has been observed and quite noticeable that innovators more often than not replied with 'ahh'. Reading between the lines, innovators replied spontaneously with awe and strong conviction about their technologies. In fact, without realizing it, their actions towards the development of product innovation are

great contributions in addressing the pressing issues of our agricultural sector. Their technologies also responded to one of the Sustainable Development Goals (SDGs). Over and above, in responding to the needs of the people most especially the farmers. The innovators appear to have incorporated laughter into their everyday conversations giving lighter mood and getting most out of the members' creative abilities. There is a balance in between workload.

5.2.5 Knowledge Sharing

Knowledge Sharing—both horizontal and vertical over time—is core to the success of these innovators. In recent times, Biotechnology has introduced product innovations aimed at meeting the needs of industry, community, and national policy but failed to discuss knowledge sharing flows that influence innovation. Similar to how (Srivastava et al., 2006, p. 4) define knowledge sharing as "team members sharing task-relevant ideas, information, and suggestions with each other"; the knowledge shared over time from the forefathers to the innovators and within the group's members and the end-users, each having a special responsibility to play. The availability of shared knowledge is necessary for adapting, extending, and creating new knowledge and innovation (Hislop, 2007).

The move towards sustainable agriculture requires a more detailed understanding of farmers' knowledge(s) and knowledge practices. Increasingly, it is essential to understand what farmers understand and how their knowledge practices incorporate others – especially given the emerging call for environmentally-oriented policy measures to move beyond an individual farmer focus (Thomas et al., 2020). On the contrary, this research considers how innovators engage with, utilize, and share

knowledge with the end-users, including farmers. The process of knowledge sharing includes a prompting stage and an expending stage. See Table 5.2.

Table 5.2

The Knowledge Sharing Process

Knowledge Sharing Stage	**Sub-Stage**	**Elements**
Prompting Stage	Stimulation Elements	Passion Trust Enriched Environment
	Matching Mate	Emphatic Nature Well-Grounded Background Appreciative Inquiry
	Viability Analysis	Foresight Feedback Multiple Administrative Tasks
Expending Stage	Knowledge Ground Knowledge Transmission Knowledge Exposition Knowledge Absorption	Constant Search for Knowledge Community of Practice Research Shills Demonstrating Skills

5.2.5.1 The Prompting Stage. This stage describes the knowledge source or receiver to create the KS process and how the innovator identifies the other members involved from the innovator's point of view. It is also in this stage that knowledge sharing comes into existence. There have been identified factors that actively stimulate innovators to participate in knowledge sharing. In other words, the innovators are motivated, affirmed, and supported to start EKS. This stage weaves the motives for sharing knowledge as each sub-category and theme are explained.

The Prompting stage includes vital elements, matching mate, and viability analysis.

5.2.5.1.1 Stimulating Elements are the primary reasons that lead to initiating KSP. Seeing the plight of the farmers from their familial background and having concern for the beneficiaries of the technology, innovators resolve to help them. It is why they are very eager and willing to participate and share their knowledge with their colleagues. Their commitment, dedication, and passion for actively partaking in knowledge sharing for successful innovate. Stimulating elements mean that innovators are transparent with their objective of participating in knowledge sharing. At BIOTECH, the forefathers or experts, project leaders, and other team members create open communication. Therefore, project leaders (innovators) and research assistants (understudies) are free to express themselves or share information. Through this stage, members of the team get to know each other and establish rapport. At the onset, the innovator's conviction to share the knowledge is evident. Meaning to say they are very supportive of the idea of knowledge sharing because of their commitment to producing technologies to mitigate manufactured or natural calamities. Stimulating elements include passion, trust and enriched environment

5.2.5.1.1.1 Passion. It refers to the driving force, commitment, and a sense of urgency to respond to pressing environmental issues, hence the need to share the knowledge and coach one another in the team. The majority of the scientists-innovators—in their desire to help the farmers achieve a sustainable lifestyle—zealously study the possibility of radical or incremental innovation. Scientists-innovators in the study may not be gifted individuals. However, their passion and commitment to serving the marginalized drove their creative instinct [creativity] to do

something essential to the community [innovation]. They do it out of service to the nation. Either way, their creative minds led them to develop technologies that address the concern of the beneficiaries of technology [farmers] and are carried on until it becomes their advocacy which is of highest value more than the rewards or benefits they get out of the created products.

5.2.5.1.1.2 Trust. It refers to the team leaders showing belief and confidence towards the members and vice versa and never doubting their performance capacity. It is an essential ingredient to successfully creating, sharing, and applying knowledge in teams. Trust in teams becomes essential when a team process, like knowledge sharing, requires interdependence, information sharing, and collaboration. Team leaders showed trust and confidence towards the members and vice versa. Never did they doubt the capacity of each one. They are open to checks and refer things to their data-based storage, storing explicit knowledge so that they have free access to it when they need it. While tacit knowledge is hard to capture, they see that they conduct demonstrations and constant feedback. They meet regularly for mentoring and close monitoring of updates. Likewise, innovators were more than willing to listen and open to suggestions.

5.2.5.1.1.3 Enriched Environment. It refers to the working atmosphere of the innovators as they continuously share and transfer knowledge in the completion of their journey to successful product innovation. An enriched environment includes space, design, and plants [including outside fields, laboratories]. It is a space intended for open discussion between and among team members. By doing so, the neurons in the brain start to recognize their various potentials, which brings out creativity among individual members achieving performance level is, and there is a display of positive

and pleasant behavior. Social interaction is built and established, and affective attunement is developed, which is a learning relationship with a trusted other; in the case of this research are the forefathers whom the innovators built their trust and confidence in sharing the knowledge pushing forward the radical or incremental innovation.

5.2.5.1.2 Matching Mate. It is the second stage under the prompting stage. This stage begins with an attempt to search for a suitable partner to share the information. Innovators prefer to receive or share knowledge with those people who are more accessible, regardless of their status in the team or their relationship. On numerous practical junctures, we refer to knowledge as information, meaning that one has to have a handful of knowledge and informed decisions on how one does things to serve the purpose of one's current undertaking.

Furthermore, knowledge alone is not enough; good information supports good knowledge; one needs both information and knowledge. Thus, we can conclude that knowledge requires information—yet it is information connected to experience and related to action. Accumulation of knowledge is through experience, but in its most actual essence, knowledge can only have meaning once articulated and shared. Matching mates include emphatic nature, well-grounded background, and appreciative inquiry.

5.2.5.1.2.1 Emphatic Nature. It refers to the innovators' identifying with the situation of the beneficiaries of technology and the eagerness to share information in developing technologies. Continuing innovation success requires an empathetic understanding of the end-users. It is a display of genuine empathy for the welfare of the end-users. "While innovation can certainly equate to 'success," innovators equate

innovation to service, processes, and products others will use to make or do something better. Generally, to make their lives better in some way and perhaps provide the opportunity for them to improve others' lives somehow. Innovation requires letting go of one's ideas, sharing them, applying them, taking responsibility for them, and, as appropriate, expanding on them. through iterative process.

5.2.5.1.2.2 Well-grounded Background. It refers to the technical adeptness and preparedness of the innovators. The partner's reliability is a determinant for successful matching. Innovators prefer to receive knowledge from those who are more experienced. Innovators are grounded in their technical adeptness and preparedness to address environmental problems. It means that their in-depth educational background ignites their production activities as supported by their educational qualifications, training, and exposure, making them adept at their current work, especially in sharing the essential information and taking action (knowledge) in producing sophisticated contextual technologies. Their education played a significant role in fostering the skill sets required for each particular endeavor.

5.2.5.1.2.3 Appreciative Inquiry. It refers to the positive recognition and reinforcement received when sharing and expanding knowledge from the gurus to the innovators and understudies. There were certain gurus called forefathers [first handlers of technologies] who, upon seeing and appreciating the potentials of the aspirant innovators (who were called Research Assistants (RAs), conscientiously mentored them. It means the forefathers meticulously guided the rising innovators in product development. Being appreciative of the forefathers for sharing the information caused a ripple effect, meaning that the new breed of innovators is mentoring the young Research Assistants. Forefathers mentoring the innovators and

innovators mentoring the understudies form various vital patterns, but they consider only the essentials. Viability analysis includes foresight, feedback, and multiple administrative tasks.

5.2.5.1.3 Viability Analysis. The third stage under prompting is viability analysis. This stage allows the team leader to re-kindle the members' attention to be in full swing on knowledge sharing and affirm those involved in the product development of their contribution. In most cases, innovators are willing to help. It is because there is mutual trust between and among the team members. This mutual trust establishes a positive attitude about participating in EKS. The innovators know that their colleagues will not negatively take advantage of their knowledge since the end-users welfare is their topmost priority. Most innovators want their colleagues to know—and be able to apply—the best practices and thus provide the best help for the beneficiaries of technologies. This concept gives birth to the idea that as information is applied, knowledge enables creativity, and creativity enables innovation. Therefore, what is thought of as known [knowledge] and combined with a need or desire that something new emerges [creation], and when that something novel is produced and utilized by the market and impacts lives, it is considered [innovation].

5.2.5.1.3.1 Foresight. It refers to the ability to look beyond and become proactive in knowledge sharing to curate and design relevant product innovations to address the community's needs. Innovators are copiously aware of existing and potentially social issues. However, these innovators look beyond voiced issues and become pro-active; instead of grumbling over issues, they broaden their imagination and conduct extensive relevant research, which supports applying the basic knowledge and expanding on it. In addition, innovators do scenario building when

sharing knowledge in designing the technology in anticipation of its positive outcome. Scenarios can be considered pictures (mental representations) of future situations designed to help organizations make better decisions in the present. These innovators use scenarios to interpret knowledge fully and build patterns used in designing potential technology that will address social issues and positively affect the end-users through innovation, bringing the possible into the probable.

The skill of foresight is a significant and relevant factor for EKS toward successful innovation. Innovators do not wait for the reverberation of unnatural and natural disasters before they create technologies. Even before these calamities entered the Philippine area of responsibility (PAR), innovators shared knowledge, worked, and developed product innovations. When calamities hit the Philippines, there are ready technologies to revive and sustain economic growth.

5.2.5.1.3.2 Feedback. It refers to the ability to clarify and point out missed things. It is crucial in knowledge sharing because it clarifies and points out missed things. It is a tool to ensure properly documented or decoded shared knowledge. Feedback from the members and end-users is a vital facet of sharing knowledge. Feedback usefulness is one factor associated with the feedback provided by each one that adds value to the knowledge-sharing aspect of the innovation process. Innovators and end-users share knowledge in insightful, constructive, and formative feedback.

5.2.5.1.3.3 Multiple Administrative Tasks. It refers to the increased workload that delays their duties to create technologies. Knowledge sharing is undoubtedly a fluid process at biotech because the requirements are available and accessible to the innovators. Appropriate training sessions are available within their domain whenever innovators and other teams need training for a specific task or skill. However, when it

comes to face-to-face communications, the challenge is that everybody is busy. It means that innovators have an increased workload, and sometimes, they do not have enough time to allocate for KS. In these situations, innovators postpone the sharing of knowledge. Nonetheless, this does not mean that the practice of KS stopped, but it does mean that the implementation stage occurs with delay and that increased workload slows down KS. From the above discussion, it is clear that although some issues slow down the process of KS, we completed the prompting stage and entered the requisite stage. Finally, we do not see these as barriers, but they are a significant stumbling block to initiating the KS since they are committed to their mission of sharing and creating.

5.2.5.2 Expending Stage. The second stage of the knowledge-sharing process is the expending stage. The experience of knowledge sharing takes place at this stage, which consists of four sub-stages: knowledge ground, knowledge transmission, knowledge exposition, and knowledge absorption. After identifying the technology, the leader situates the members and gets the full approval to participate in the process. Then, the team meets and discusses and agrees on the technology to work on that will make an impact. This task is challenging because they have to work within a timeframe. Therefore, taking part in knowledge sharing entails time, effort, and commitment. Innovators are vowed for their exemplary attitude and honesty to ensure a successful innovation capability.

5.2.5.2.1 Knowledge Ground. The knowledge source [forefathers] prepares the required experiential knowledge at this stage. The findings revealed that forefathers, bearing the entire technology background, unceasingly shared the information with the innovators. Indigenous knowledge is traced back from the first

handlers of the technology, with the forefather orienting the innovator on the processes of creating the product. Under knowledge ground, is the constant search for knowledge.

5.2.5.2.1.1 Constant Search for Knowledge. It refers to the continuous exploration of traditional and scientific knowledge in creating remarkable technology. Scientist-innovators collaborate with the end-users to be able to enhance further or even scale up the technology. They do not lose hope in improving the technology until they get the desired product. They get the feedback from the end-users (whoever that is) and incorporate it before bringing the products to the market. Feedback from the members of the team and the end-users is equally essential in the constant search for knowledge because this is where ideas are enhanced and created, expanded, converted into action, and turned into a product. There are incentives for commendable research outputs and encouraged for publication to keep the desire and passion for research.

5.2.5.2.2 Knowledge Transmission. At this point, knowledge transfer happens via face-to-face communications or training. Innovators are humbled and elated in this process of KS because if they encounter any problem or do not understand something and need clarifications, they have the opportunity to raise them in the team and make sure nothing is missing. Thus, transferred knowledge is accurately reliable. In addition, innovators are conversationalists, not to undermine their inputs and sharing. Thus, they can leverage the developed technology and make a good negotiation for funding.

5.2.5.2.2.1 Community of Practice. It refers to innovators who share a concern or a passion for creating technologies and learn how to do it better as they

interact regularly. Innovators formed a community where they could continuously gather and exchange and share their knowledge to enhance their understanding of the technology, similar to what Wenger et al. (2002) call a community of practice. In knowledge sharing, innovators make it a point that they frequently meet in their created space to intermingle and relate. They share their newfound and existing knowledge among the group. One thing that they have in common is passion. Driving them to get involved in sharing knowledge is their passion for their projects. No one is superior to the other, they treat each other equally, and each has something to contribute and share.

5.2.5.2.3 Knowledge Exposition. At this stage, the innovators absorb and filter the professional knowledge passed on to them, meaning that innovators remove the barriers to the shared knowledge to obtain the excellent part. Discarded information applies when not related to product development. Moreover, this assessment is done scientifically through their research skills; hence, knowledge is consistent with scientific bases. Pragmatically speaking, innovators are all engaged in research capabilities.

5.2.5.2.3.1 Research Skills. It refers to converting traditional knowledge into scientific knowledge to create sustainable product innovation. Research substantiates the knowledge acquired by the innovators, which is the tipping point to successful innovation, and the innovators unanimously agree that technology development starts with simple research. In all areas of undertakings in biotechnology, research and development (R&D) is the primary step towards successful activities knowledge sharing, including innovation. Research embodies their existence as an institution, and it is a way of life. In addition, forefathers stirred the passion for research among the

innovators who left a legacy at the heart of understanding the vital importance of research concerning knowledge sharing to have a complete understanding of the technology. They underwent the rigorous process of research where knowledge sharing is a crucial aspect of it.

5.2.5.2.4 Knowledge Absorption. At this stage, the innovators integrate the valuable part of experiential knowledge into their existing knowledge and apply it to fulfill their responsibility of creating innovative products. Individual knowledge [of the innovators], when combined with the knowledge absorbed by all the team members through teamwork, leads to desirable output. In this stage, knowledge is already free from unnecessary points, that is, focusing only on terms of its specific product. Hence, they can now utilize the knowledge to craft the technology. Innovators use these fractions of knowledge creation to produce technology. Moreover, since they are hands-on with the knowledge-sharing practices, they are confident in demonstrating the technology to the end-users.

5.2.5.2.4.1 Demonstrating Skills. It refers to the ability to take their time out to teach and demonstrate how to use the technology to the end-users. Innovators take their time to teach and demonstrate how to use the technology to the end-users. Knowledge sharing becomes fruitful with the culmination of innovative products. Just like how they have shared, absorbed, retained, and applied knowledge, on their end, they now have the responsibility to bring out their products and demonstrate them to the beneficiaries of technology. Innovators are buoyant and patient in dealing with people. Demonstrating is not an overnight ability to acquire. It comes from repeated practice until the recipients come to understand the dynamics of the technology.

5.3 Sub-Question 3: How is Innovator Success in R&D BIOTECH Supported and Encouraged in HEIs?

BIOTECH R&D supports and encourages innovator success through the identified and well-established organizational elements composed of organizational context, culture, and values. See Table 5.3.

These organizational elements were essential to subsist innovation and form the first significant innovation path to success (see 6.1.4). BIOTECH continues to outgrow its innovation platform in making a significant influence in their community and the country.

Table 5.3

Organizational Elements that Impact Innovation

Organizational Elements	Sub-elements
Organization Context	Management style Know hows of innovators
Organizational Culture	Procedural process of technology Cohesive teamwork
Organizational Values	Concern for beneficiaries of technology Consistent appreciation of mentors

Organizational performance in terms of product innovations improved and advanced because indigenous knowledge resides within the organization and the individuals whom the innovators call forefathers. Forefathers, who were the first handlers of technology, mentored the young and aspirant innovators and passed on to them the historical background of the technology through the dynamics of cohesive teamwork (see 4.3.1.2.2). Thus, an appropriate knowledge location is shared among

team members, leading to successful innovation. Innovators aptly shared: *We have our field of expertise, which we share with our team to ensure that the technology we produce serves its whole purpose and intent. We also consult one another before making decisions.*

This observation is consistent with the work of Davenport and Prusak (2000) on the underlying principles of knowledge management (KM). Further, as Turban and Aronson (2002) say, knowledge resides within the organization in an unstructured manner through organizational memory. With the help of KM, organizations can identify, select, organize, disseminate, and transfer important information and expertise as needed. Wiig (2004) also contends that this practice enables the organization to get the most out of the organizational knowledge-related effectiveness and prosperity (2.2.4).

In addition, when the forefathers retire, the innovators have the opportunity to implement either incremental or radical innovation. This pattern continued from generation to generation, thus becoming a distinct organizational practice.

5.3.1 Organizational Elements

Organizational elements represent the central innovation path to success. As part of UPLB and declared a Center of Excellence (COE) in Agriculture by the Commission on Higher Education, the Institute of Biotechnology continues to outgrow its innovation platform and value chain (see 2.6) to sustain its designation significantly influence its community and the country.

The university serves as the innovation platform focusing on agriculture. While the researcher-innovators, farmers, university officials, government entities, and significant others join forces in coming up with viable technologies or product

innovations in response to their current thrust on food production as one of the societal concerns of the Philippine government. Each of the entities plays a crucial role in the governance of knowledge, and with their contributions, knowledge sharing comes to fruition. For instance, the innovators used feedback from the farmers to tighten and affirm their farming knowledge. In addition, University officials supported advanced training in this context and other related activities (see 4.2.3.1.3.2 and 4.3.1.1.1).

Biotechnology's organizational performance in terms of product innovations improved and advanced, and they even became exemplars, with knowledge located within and shared among the team members. Forefathers are the first handlers of technology which passed knowledge emerging from the historical background of the technology on to the innovators. Indigenous knowledge is rooted in cultural values and transferred or passed on to innovators from generation to generation. The decision on whether to continue a product depends on its usefulness. In the words of PDO-TTBDO 1: *The other technologies here are already old and have been taken care of for generations. The forefathers, once they retired, passed the technology to the following young inventor like Mykovam, which is still valuable to the community. The young inventor enhanced it and utilized it by the end-users.*

5.3.1.1 Organizational Context. BIOTECH finds ways and strategies to incorporate innovation into their organization. First, people in the organization create and observe formal and informal structures to deliver their respective responsibilities, especially the innovators, whose task is to produce technologies for the people. It is consistent with the argument of Teece (2009) that the formal and informal structures of firms and their external linkages have an important bearing on the rate and

direction of innovation (2.9.3). In terms of formal structure, these individuals follow the line of authority in observance of their function as innovators. However, their teams observe informal ways of delineating individual and group tasks and swiftly adapt to conditions in developing innovation capacities (see 4.3.1.1).

UPLB BIOTECH has a unique perspective on organizational structure in the context of agricultural innovation in the attainment of innovation. Top management leaders consider the ideas of the people concerned through discussions, brainstorming, and workshops. PDO-TTBDO 1 shared: *We always involve our scientist-innovators, including their immediate heads and directors, through various activities such as round table discussion, brainstorming, and workshops to shed light concerning the product they want to develop.* Elements of organizational context include the management style and the know-how of innovators

5.3.1.1.1 Management Style *is the interplay of the institution, administration, and innovators in responding to the vision-mission of being a globally competitive graduate and research university contributing to national development through the produced technologies.* Innovators continuously produce technologies as mandated in the vision and mission of The National Institute of Molecular Biology and Biotechnology (BIOTECH), the home base of the innovators. There is generally a self-initiated response of the innovators, with the management team's support, to create technologies that reflect their commitment to the Filipino people. This commitment is an interplay between and among members of the institution headed by the chancellor. Innovators echo a similar foundational motivation. For example, as voiced by Innovator D: *It is our initiative to create technologies that will advance*

Philippine agriculture. Moreover, we are happy that the university gives us all the necessary assistance we need.

The top management views innovation as something that does not only put them ahead of the competitors and stay in the dome of excellence but, through product innovation, helps in the solution of problems besetting Philippine society, particularly in the glitches of agriculture. Therefore, the university chancellor's management style pushes everyone in the community to go out of the box, leaving their comfort zones once in a while and encouraging them to become sensitive to the needs of the society, to do something that contributes to the welfare of their fellow citizens (see 4.3.1.1.1).

The goal of the leader (chancellor) to produce technologies that can increase food production to provide staple food in every family is rooted in cultural values. Hence, innovators abide [and resonate with] with the thrust of the leader in addressing the pressing issues of society. Innovators consistently express their desire to think about the people's best interest-the underprivileged. Driven by their similar goals: to respond to the needs (brought about by environmental issues), they enjoy helping the less fortunate through their product innovation. This leader's gesture brings the idea that the management style of the current leadership bounded with cultural values elevates innovation.

5.3.1.1.2 Know-how of innovators *refers to the technical and soft skills through various exposures to responsibly produce technologies for the people*. Innovators possess both hard and soft skills to perform their role as scientists-innovators successfully. Hard skills relate to specific technical knowledge, training, and exposure to national and international opportunities. Innovators are not only

experts in one's field but also have encyclopedic experiences that they learned first from their forefathers to back up the theories they learned. It is like a hand-me-down opportunity to further explore the technology passed on to them. Innovators D, G, and C expressed this similarly. As voiced by Innovator D: We *owe it all to our forefathers. I have never regretted coming back after getting my Ph.D. abroad.* Their outside exposures allowed them also to apply the concepts and theories learned in the Philippines directly.

Furthermore, hard skills were acquired during their education and training in UPLB and other reputable institutions, here and abroad. As their credentials support, their intensive and massive education made them adept at their current job, especially in producing sophisticated and contextual technologies. Their education played a significant role in fostering the skill sets required for each particular endeavor. This finding has affirmed by Okoye and Caleb (2019) that when people become more educated, their ability to engage, participate and understand increases. Skills development is primarily through education and training, with these skills serving as drivers for innovation. This finding is consistent with the understanding of MacLeod and Clarke (2009) that hard skills are an essential driver and focus on the quality of labor inputs (2.9.4.3).

On the other hand, soft skills such as leadership, communication, time management, collaboration, and teamwork are competencies that directly influence successful innovation. Participants in this study were hardworking and patient and performed multi-tasks, meaning they were mindful and attended to tasks that needed their immediate attention. In addition, innovators' soft skills included the right attitude, intrinsically motivated, and high intrapersonal and interpersonal skills. They

exemplify the right attitude as they eagerly and earnestly respond to the needs of society without benefits or rewards for doing so. Their desire to help is their sole motivation to keep going. Further, these innovators get along well with their colleagues; they know precisely when one needs help or assistance and perform their duties without being told, often leading to successful innovation. This finding evidences Cimatti (2016) saying that soft skills are more than the amount of information that a person has acquired, nor even the 'kind' of knowledge, but the ability to act intelligently, continuously cultivating the ability to proceed for himself in a changing world through exemplar outputs.

5.3.1.2 Organizational Culture. Organizational culture dramatically influences the promotion of product innovation in UPLB. UPLB is consistent with its organizational culture incapacitating its human resources towards the goal of producing technologies for the community and staying attuned to its culture of continuously producing technologies for the marginalized. This finding is consistent with Bate and Johnston (2005), saying that the capacity for strategizing innovation is within the capabilities of any organization (2.9.3.1).

BIOTECH considers its technical preparations in all university units, including its indigenous materials, financial, and all areas of human resources, particularly the scientists-innovators including external stakeholders, to fulfill its vision-mission to the fullest. It means that they consider all the technical and workforce, including the recipients of the technology. It means the interplay of all concerned units in the university and other significant stakeholders anchored on the vision, mission, and goals bring successful product innovation. For example, as Innovator C recounts: *I discuss first my ideas with a potential collaborator within the university and other*

officials. Likewise, before developing a proposal, some stakeholders, including the target recipients. In that case, I know I can have all the necessary resources needed for the project. Having this preparation, we can create worthwhile technologies. Indeed, innovation requires technical preparation in all areas, including a clear direction, to succeed in the development of the product.

BIOTECH's unique organizational culture in terms of innovation endeavors is what persuades innovators to involve and create productive technologies that will elucidate societal issues. It is consistent with the literature—specifically, Hauser (1998) and Pervaiz (1998) —that organizational culture is the primary source of motivated and coordinated organizational activity that can serve (1) as a coping mechanism for solving problems and interpreting daily corporate events, (2) as a substitute to structure and as a complement to leadership, and (3) as the social glue that keeps employees together and increases the stability of the system (2.9.3.1).

In addition, innovation competencies and innovation factors are crucial determinants of organizational innovativeness. Similar to the study of Jaskyte and Dressler (2005), organizational culture and values are significant predictors of organizational innovativeness and clairvoyants for successful product innovation. Elements of organizational culture include a procedural process of technology utilization and cohesive teamwork that contributed to the successful product innovation.

5.3.1.2.1 The Procedural Process of Technology Utilization *refers to the systematic function of the gatekeeper*, which is the Technology Transfer and Business Development Office (TTBDO), which puts a premium on the technology to serve its purpose to the fullest. *Procedures* are systematically followed in the organization to

reach the finish line for the technology to be received and utilized by the market, and not just as a collection of various outputs displayed on the shelves or in museums. According to Nelson and Winder (1982), this procedural habit, also called organizational routines, ensures the complete optimization of the products by the end-users (2.9.3.1).

Gatekeeper refers to the established framework handled by the Technology Transfer and Business Development Office (TTBDO) to ensure that all technologies pass through quality control before reaching end-users. Qualified personnel manages the gatekeeping at the office that handles the technology transfer activities of the university. PDO-TTBDO 1 said: *Our office is handling the technology transfer activities of the technology* [created] *in UPLB. Our mandate is to integrate programs, policies, and activities towards protection, promotion, and success through licensing or business incubation. We also support the administration in promoting to transfer of the technology because the technology is a waste if the society or the community does not utilize it.*

In addition, TTBDO's framework, the so-called system, works collaboratively with various offices in the university, particularly with the innovators, to facilitate the progress of technology from its incubation until it reaches consumers. This routine activity constantly monitors the technology until it reaches the community, which otherwise might die a natural death. It complements Teece's (2009) statement that the performance of these routines is at the essence of an organization's technological capacity (2.9.3.1).

In short, the office has a structured system protocol that guides the innovators on how to commercialize their technologies. In addition, the office conducts

technology audits to identify the number of technologies with a potential market value that would undergo the process set by the established framework.

5.3.1.2.2 Cohesive Teamwork *refers to the teamwork demonstrated by the individuals in sharing their expertise to create powerful technology.* As previously mentioned, innovators belong to a research team. Along with this team, they served as project leaders with supportive and aggressive members. In this usage, aggressive means that even without the physical presence of the team leader, members still work without qualms and have practical decision-making skills. There are diverse individuals in the team, each with his / her field of expertise, and each plays a vital role in achieving congruent product innovation in the solution of societal issues. As Innovator C explained: *I was with a team. I was the program leader. I am very thankful because I am blessed with well-versed and kind team members. We optimize each other's expertise. And it works!*

Everyone observed promoted open communication within the team, and trust was evident. Indeed, this finding is an exemplar of the research of Messmer (2003), who forwards that the increase in using project teams requires members to communicate effectively and work well together to yield more significant value to product innovation (2.2.4.1).

Innovators prefer to work with a team because it is a confessed reality that they cannot do it alone. They need experts in the team to confirm their established patterns of information and double-check their knowledge acquisition. Innovator A shared a personal anecdote: *This is a team effort; we have the support of each other; I do not claim that I did it alone. There is a saying, 'Together, we achieve success for the Motherland.'*

While it is true that innovators can be influential when working alone, research indicates that teamwork with various personalities can dramatically achieve classic results attained by the same number of individuals working in isolation. When innovators are with their teammates, they can be more creative and innovative, develop more precise strategies, and respond more aggressively to competitive threats and environmental concerns. This finding agrees with Bunderson and Sutcliffe (2002), saying that by broadening the range of experience and expertise available to a team, functional diversity can promote team effectiveness resulting in a sound and productive output (2.2.4.1).

Furthermore, as project leaders, innovators have the full responsibility to guide the team members in just the way their former mentors have steered them. In other words, they belong to a cohesive team. The team is described as cohesive because it is related to a familial relationship where the leader acts as the family's father and gathers all the family members to discuss and work on a common goal.

5.3.1.3 Organizational Values. In BIOTECH, there is more than the organizational culture to consider. Instead, the organizational values consistently show appreciation of mentors as an element that means a lot. For the innovators, this innovation factor begins with showing gratitude to forefathers for mentoring them, exhibiting exemplar leadership, and being open to change so that they can withstand the test of time (see 4.2.1.2.1.1 and 4.3.1.3.2). Hence, they consistently appreciate their mentors, which is considered the main element of organizational values. Therefore, innovation results from a complex set of organizational values built with legacy's philosophical and sociological view. The innovator's motivation is to

continue the legacy of their forefathers, and their main goal is to build advocacy rather than prestige (see 4.3.1.3).

In addition, BIOTECH's chancellor, acting as the chief leader of the organization together with the director of TTBDO, directs and enforces whole members of the community, shifting their focus on food production in response to the crucial need of the society. Such an approach is instrumental in the process of innovation. This gesture of the chancellor is consistent with the findings of Cummings and Huse (1989), who suggest that a new vision or mission statement can change old values. Leaders can empower their employees to implement the new vision into reality and increase employees' motivation. This finding also expands on the statement of Doyle and Bridgewater (1988), who say that culture and leadership are essential elements to consider in innovation (2.9.3.1).

Finally, these innovators always beseech the guidance of the Almighty as they aspire to continue with the legacy passed on to them- that is, to boost the economy of the country efficiently and make the life of every Filipino better. Elements of organizational values include concern for beneficiaries of technology and consistent appreciation of mentors.

5.3.1.3.1 Concern for Beneficiaries of Technology *refers to the driving force to produce technology and leaves an extraordinary impact on people's lives.* Generally, innovators produce affordable technologies, improve lifestyles, sustain economic growth, and provide a lucrative return on investment to the end-users. Moreover, as reflected in cohesive teamwork, innovators increased the organization's productivity. They worked collectively for common task goals and

objectives to help the beneficiaries of the technology earn dignified, sustainable living (see 4.3.1.3.1).

In other words, innovators create technologies not for their prestige or lucrative income but for the prime beneficiaries of technology that significantly affect their lives. As Innovator B enthusiastically says*: It never dawned on me to gain popularity or earn a comparable income. I just thought of helping the Filipino people not have fraudulent food, especially HALAL foods.* Thus, beneficiaries of technology represent a distinct element of the organizational culture carried on from generation to generation, a knowing that beneficiaries of the technology take advantage of and enjoy its usability. It is consistent with ISO's conceptual definition of usability (International Organization for Standardization) 9241-11. Usability is when a product can achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context (Agarwal & Venkatesh, 2002; Sauro & Kindlund, 2005; Whitehead, 2006; Peevers et al., 2007). Expanding ISO's conceptual definition, usability in the context of UPLB BIOTECH includes utilizing the product innovation to improve the user's lives and address solutions to society's prevailing environmental problems.

Contrary to the corporate world, which keeps trade secrets to sustain the company's economic growth, UPLB BIOTECH does not keep trade secrets. Most respondents are not thinking of entrepreneurship but are willing to share their technology. If and when they do so, entrepreneurship is a secondary motivation. Innovators feel delighted and fulfilled once end-users have utilized the innovation.

5.3.1.3.2 Consistent Appreciation of Mentors *refers to the behavior exhibited by innovators to mentors, such as gratitude and credit for the insights/ideas shared in starting the technology.* As introduced above, among the team, there is an individual

or group of individuals whom all the innovators address as 'forefathers' who first started the technology [product innovation]. These forefathers, who were innovators themselves, mentored and guided the new generation breed of innovators, who are impressively indebted. These mentors shared knowledge with the innovators without hesitation, and that is why the innovators are very grateful. If this sharing had not occurred, the new round of innovators would have found it difficult to start (see 4.2.1.2.1.1 and 4.3.1.3.2).

It is relatable to Tarde's theory on The Laws of Imitation, where "every invention and every discovery consists of the interference in somebody's mind of certain old pieces of information that others have generally handed down" (Tarde, 1890 [1993], p. 3). Thus, imitation is the main element in social cohesiveness. It comprises individuals who resemble each other because they imitate (or counter-imitate) each other (Djellal & Gallouj, 2014). For the innovators in this study, 'others' refers to those individuals who are first and foremost the starters of inventions who create social change within societies or cultures (Kinnunen, 1996). Within UPLB BIOTECH, 'who' refers to the forefathers with their self-expertise (embodied knowledge). Correspondingly, this study elevates Tarde's ideas whereby the innovators continue with what their forefathers have taught them, which is then passed on to the next generation until it becomes a cyclic habit.

As can be seen, the innovators in this study feel that they owe what they are now to their forefathers. Armenta et al. (2017) also view gratitude as emotion after people receive valuable aid and altruism. Gratitude in this case, similar to the work of Wood et al. (2010), may have arisen from sources such as an appreciation of one's abilities or of a climate in which such successful work was possible.

Further, innovators are very appreciative of the advantages of technology; hence, they look up to their forefathers who initiated the technology. Gratitude, then, is one of the virtues exemplified by innovators. Based on this context, it is best to define gratitude as an emotional state that serves as the first driving force for the innovators in their quest to innovate and make a difference. Over and above, it is a remarkable value to which they adhere.

In conclusion, successful innovation is directly linked with factors of innovation competencies and provides vital elements to an innovation path model for Philippine state universities. Furthermore, the innovators' many projects and initiatives are testaments of their commitment to transforming the fruits of research into products for improving the communities and enriching lives. The study disclosed an exemplar innovation model for all higher education institutions to adopt contextually.

See Appendix J.

5.4 The Primary Question: Why and How R&D BIOTECH Innovators in Higher Education Institutes Achieve Success?

There are two compelling schools of thought on what drives successful innovation in BIOTECH: the market-based view and the resource-based view. Innovators are not only concerned with the conditions of the market, but they are more concerned with the farmers' conditions and are conscious and responsive to the existing social-environmental problems, which are one of the factors of innovation that led to their innovation activity. On the other hand, BIOTECH utilizes its own skilled and competent innovators—coupled with their identified innovation competencies—who shape the very foundation of innovation in the institution. They

use their human assets to create technologies that can help sustain not only the economic growth of the institution but the society and country in general. In other words, explicitly, factors of innovation, including organizational elements and personal influencers, tied with innovation competencies led to their successful product innovation.

There are three steps or processes involved in the development of successful innovation:

1. The intertwining of knowledge, creation and innovation tightened knowledge absorption
2. The firming-up of the innovation product along with the available set of emerging influencers
3. The way forward to the utilization of the innovation produced by the beneficiaries

Innovators systematically follow and implement these steps fueled both by factors of innovation and innovation competencies and individual influencers that emerged in this study. There are blocks between these three steps that hamper the speediness and nimbleness of the product development. Between steps 1 and 2, the block is multiple administrative tasks (MAT), and between steps 2 and 3, the block is necessary to move towards technology transfer. However, a gatekeeper serves as a bridge to enable the innovators to proceed, to help ensure and sustain the interest of the innovators to produce outstanding innovation products amidst the bumpy road through the end goal of reaching the beneficiaries of the technology. As detailed in Appendix J, this pathway to successful innovation supports the “how” these innovators achieve success.

The strong impetus for the innovators to create product innovation is environmental problems, which are one of the factors of innovation (identified and discussed in 4.1.1.1) that beset society. These perturbing issues that can delay or obstruct agricultural activities make the innovators feel fretful. Armed with their technical skills as one of their core competencies, these innovators continuously search for answers, with the creation of technologies their foremost concern to respond to the needs of the society, particularly the ordinary farmers. However, this does not necessarily mean they have to wait for calamities to arise before innovating. Foresight, a vital innovation competency, helps them see beyond the aftermath of these catastrophes. It means that even before cataclysms hit the country, they have provided incremental and radical technologies that can help address the outcome of those disasters.

In summary, societal problems trigger the innovators to create technologies that can address the injurious effect on the people and the society. Because of these inevitable circumstances, innovators conduct extensive research upon which they build. The legacy passed on to them by their forefathers ignites knowledge building.

Hence, this study supports the reality that as information is applied, knowledge enables creativity, and creativity enables innovation. Whatever is known and put into action [***knowledge***], combined with a need or desire such that something new emerges, creating something novel [***creation***]. When that something novel is produced and utilized by the market and impacts lives, it is considered ***innovation***.

In this study, there is a strong link between and among ***information, knowledge***, ***creation***, and ***innovation*** in a broader perspective: **Information** is the key to knowledge, which stems from environmental issues. **Knowledge** is acting upon

that collected information through socialization. The socialization transfers the forefathers' tacit knowledge to the current innovators through mentoring, sharing, direct involvement, or actual performance partnering in technology development. It offers a platform for creativity for promising innovation output. **Creativity** is the ability to produce technology from the acquired information and indigenous knowledge. Hence, the *commitment* to innovate. Lastly, **innovation** is applied creation that provides relevant influence, the impact of the change, and the significance of its effects once the innovation product reaches the end-users for utilization. Feedback among mentors and one another is equally imperative in refining and finalizing successful product innovation.

Based on the standard definition of innovation, industries or the business sector innovate for their company's economic growth and gain competitive profit. In contrast, UPLB, particularly its agricultural training institutes, innovate for the welfare of the society in particular and the country in general, to boost economic growth, achieve Sustainable Development Goals (SDG), and contribute to the attainment of Ambisyon 2040 and the Philippine Development Plan (APDP) 2017-2020. It supports the "why" these innovators are successful.

CHAPTER 6

INSIGHTS AND RECOMMENDATIONS

Earlier in the discussion, the findings were based on hard facts, interviews, and observations and categorized for clarity of presentation and ease of understanding. Moreover, in a qualitative study, findings may help us categorize the 'how' and all the 'whys' and help us understand through further conversations and dialogue. The insights presented below emerged by close listening to the interviews, which facilitated the opportunity for in-depth conversations, shedding light on questions and pointing out clarifications backed up with a literature review of related knowledge domains and analyzing data and information to understand the context of the study. In addition, qualitative interviews are penetrating, discerning understandings, unlock an occasion to draw more precise insights that can lead to actions, powerful thoughts. They may trigger the readers' attention apart from the conclusions to the primary and sub-questions of this research discussed in detail in Chapter 5.

6.1 Insights

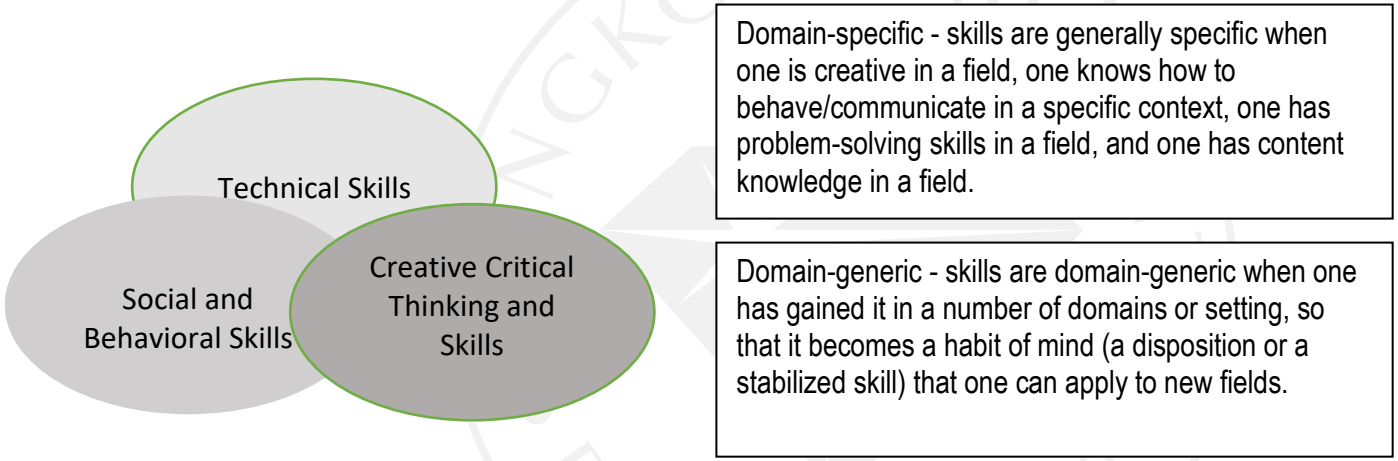
Four insights have significantly shifted the researcher's theoretical thinking. These are briefly shared below. In addition, other insights have emerged from the findings of this study that sharing may influence more significant innovation.

6.1.1 Emerging Innovation Competencies to achieve successful product innovation are cumulative in nature.

Vincent-Lancrin (2017) described what individual skills education systems should foster through a diagram as shown below in Figure 6.1.

Figure 6.1

Skills Education Systems Foster



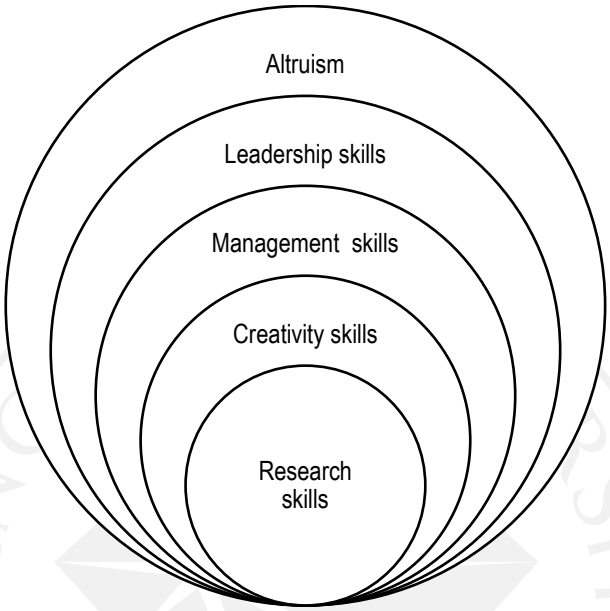
Note. Adapted from Vincent-Lancrin, 2017

As can be seen in the figure, technical, social and behavioral, and creative and critical thinking skills are, from this reference, the skills education systems foster. Reducing them into a single skill (or measure) is hard to realize while they overlap and reinforce each other. Contrary to the findings of Vincent-Lancrin, the innovative skills of the innovators in this study—such as research skills, creativity skills, management skills, leadership skills and altruism—are *cumulative,* meaning they build upon each other, and there is a progression in terms of *focus* and *level of achievement* of these skills from research to altruism. While there is certainly an overlap in terms of skill level, when one innovative skill is positively achieved, while sustaining the skills that have been obtained, the *focus* of these innovators moves to the next phase until they reach the highest peak, which is forgetting oneself in order to help others become actualized through product innovation, as shown in Figure 6.2 below.

Moreover, according to Vincent-Lancrin (2017), these skills can be domain-specific or domain-generic, meaning, skills are generally specific when one is creative in a field, knowing how to behave/communicate in a specific context, having problem-solving skills in a specific field, and having content knowledge in that field. On one hand, a skill becomes domain-generic when an individual has gained it in several domains or settings, such that it becomes a habit of mind (a disposition or a stabilized skill), a pattern that can be applied to new fields. Similarly, innovators' skills become a 'habit of mind' as they progress.

Figure 6.2

Progression of Innovation Core Competencies of the Innovators (RCMLA)



Let's follow that progression. First, innovators are adept in **research** because it is the baseline of their work. In line with this, they have an eye on what to prioritize about the technology they will produce. In other words, their ***focusing skills*** matter, and it is these focusing skills are critical to the progression and expansion of skills represented in Figure 6-2. Furthermore, innovators concentrated on the much need priority and the specific times and circumstances required, which provide the context for their research. For instance, they are to produce technology addressing food production as their current thrust, after which they are to develop the processes necessary to deliver quality output, and explore further the possibilities of their project. Aside from this thrust, which may vary from time to time because of the change of management, they focus also on the problems brought about by different

natural calamities. Thus, skills in ***problem-solving*** are necessary. Finally, innovators do not rest on their laurels, meaning they don't stay complacent in the aftermath of environmental disasters. Instead, they find solutions on how to help the victims of calamities amidst disasters through their successful technologies. It is helping the people, especially the farmers, alleviate potential economic—and even survival—burdens.

Second, braced with robust and sufficient research results accompanied with viable proposals, they can likewise create novel product innovations to respond to identified needs and in service to their potential beneficiaries. Hence, the second level is ***creativity***, which *lays the foundation* for producing something new, something novel. Finally, innovators come up with a solid production innovation grounded on the needs of the society and working within the social context of the farmers and laborers. Using their ***critical thinking skills***, they can discern and look at things from different perspectives. They don't take things in their hands alone; as they are wrestling with questions, they are open to suggestions and modifying old ways of analyzing things, all of which propel them to go the extra mile. In doing so, they have ***foresight*** as to the future direction of their project. Clearly, innovators need not wait for calamities to happen before innovating, but to recognize patterns and create technologies prior to the attack of calamities. Further, they use their creative imagination and planning tools such as scenario-building to forecast the weaknesses and strengths of these technology. Hence, they are *ready to troubleshoot* untoward incidents, leading to the third innovative skill area, which is management skills.

Third, with ***management skills***, innovators are equipped with sensitivity towards and careful technology supervision. Since they are hands-on in managing the

technology and are knowledgeable on the nature of the technology, building on their foresight, they can identify and recognize the weaknesses and strengths of their technology and *can trouble shoot* any unusual occurrence that may arise. One of the challenges in managing the technology is maintenance, which requires careful product preservation. In some instances, when technology needs to be improved, the innovators require additional resources. Thus, being ***resourceful*** is equally important, especially as things can change abruptly. Enhancing the technology may be perceived as either leveling up or downgrading a technology to lower the cost of expenses so that it may be utilized by the end-users regardless of their current status in life. Innovators must choose whether to improve or change the technology. In line with improving the technology, they conduct field assessments as to its impact. When there are loopholes in the technology, they can address them. Constantly ***evaluating*** the technology up-close and personal gives them insights on how to further improve it.

Fourth, innovators are confident of their treatment of the technology as they expand their focus and discover they have acquired good ***leadership skills,*** meaning innovators are bestowed with leadership skills from the inside-out as they have experienced first becoming a member of the team and acquired increasing responsibilities as they learned and expanded their management responsibilities. From this level of focus, they optimize and delegate tasks, with each team member contributing well according to their capability. The project leader called the forefather managed the team considered a legendary project founder who has constantly and relentlessly mentored the current innovators. When the forefather retires, the innovator, now the project leader, continues with the legacy of helping the people by producing the technology and continuing the practice of ***mentoring*** associates. To

date, there is a strong manifestation of this cyclic mentor-mentee relationship. In addition, the innovators build pools of resources and work collaboratively with various university sectors and current and potential stakeholders outside the university, including different private and public agencies. ***Collaborating*** with these agencies may forging partnership for potential future funding of their projects.

Finally, fifth, an expansion of altruism occurs. For the innovators, ***altruism*** is thinking of others over self. Beyond their title as innovator-scientist, it means that they can transcend their personal life to focus on community. The technology is now firm, available and in service to potential beneficiaries. Tangible and intangible recognition, which early-on certainly played some role, is no longer their focus, but rather their contribution and impact on the community matters the most. Their technology is a tool to respond to corporate social responsibility (CSR), thus becoming part of their ***advocacy***. In other words, they build the spirit of volunteerism, where they serve others without counting the cost.

These innovators who are heavily involved in agriculture have another common focus. They are not only committed to creating innovative products, but while they are using the gift of nature, they are committed to restoring, caring and protecting mother earth as a gesture of love of country, and perhaps even humanity. These innovators are true to their profession as agriculturists. They work toward making the land fertile and providing an opportunity for everyone to grow and live abundantly.

In a nutshell, this collection of innovation skills is what helps them excel, and what makes their contribution unique from the corporate world. In a competitive and aggressive modern society, industries respond through innovation to sustain the

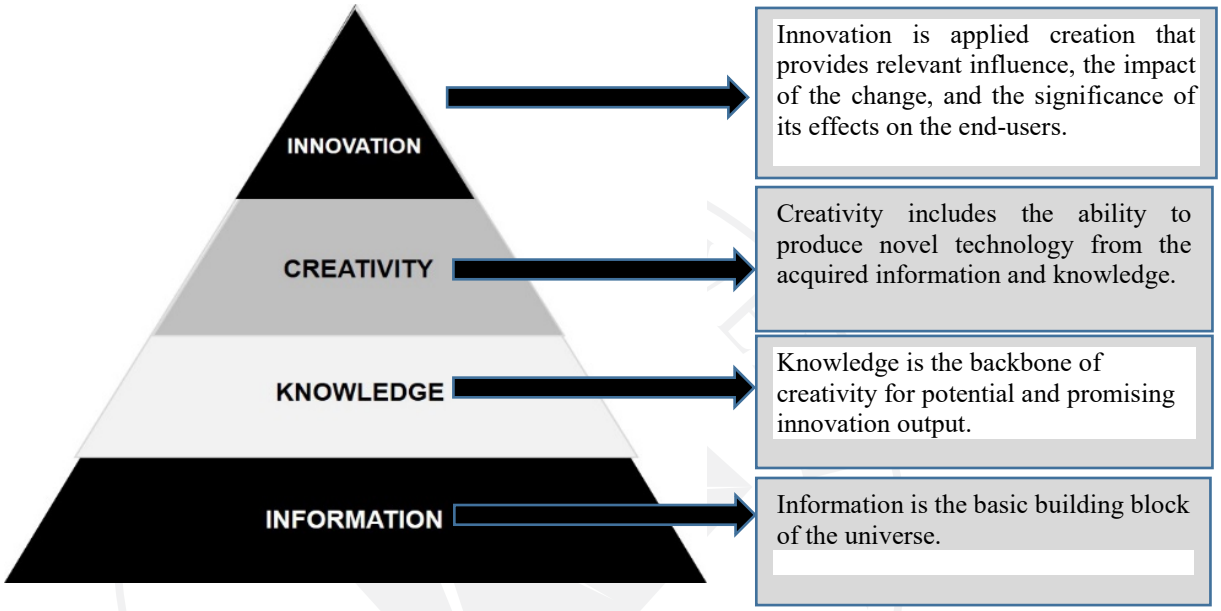
company's economic growth, sustain marketability and achieve lucrative return on investment. Whereas, UPLB innovates in keeping with their commitment as a Center of Excellence (COE) in retorting to the CHED's platforms, which include Food Production and Security; Environment, Disaster Prevention, Climate Change and Energy; Terrestrial and Marine Economy: Biodiversity and Conservation; Smart Analytics and Engineering Innovations; Health Systems and Education. Ultimately, UPLB and their innovator-researchers innovate not for prestige and recognition, but, over and above, in response to the alarming and pressing issues brought about by natural calamities, and true to UPLB's mandate of educating individuals for the people, for the society and the nation.

6.1.2 Identification and Strengthening of the Relationships between Information, Knowledge and Creativity call for a Change in the Foundational Pyramid Model.

There is a long recognition of the intertwining relationship between information, knowledge and creativity in order to achieve a successful innovation product, thus building a hierarchical order elevating innovation into the pinnacle as shown below, which was discussed in Figure 2.9 and introduced in Figure 4.20, respectively.

Figure 6.3

Progression of the Innovation Model from Information to Knowledge to Creativity to Innovation



As forwarded in 2.7.4, the innovation process builds on information with knowledge, creativity, and capacities that enable innovation (see Figure 2.8). Bennet and Bennet (2005) define information as organized patterns and the basic building block of the universe. Knowledge is applied information, taking effective action by applying available information. Meanwhile, creativity is considered the "bisociation" of two separate conceptual patterns and a learning process (using information in concert with knowledge), wherein innovation is applied creativity or the usefulness of something created. In other words, information is utilized or exploited to make sense out of the created patterns. When forms or processes are maximized, generating meaning and adding value, they become ***innovation. Innovation,*** therefore, is applied

creation that gives relevant influence, the impact of the change, and the significance of effect.

Emerging from this research, this deeper understanding of these relationships supports Innovation's placement at the pinnacle's peak, as seen in Figures 6.3. As supported in the literature and evident, hierarchically arranged are: information, knowledge, creativity and innovation. Meaning, one builds upon the other, and there is the necessity of having the first one to achieve the next concept.

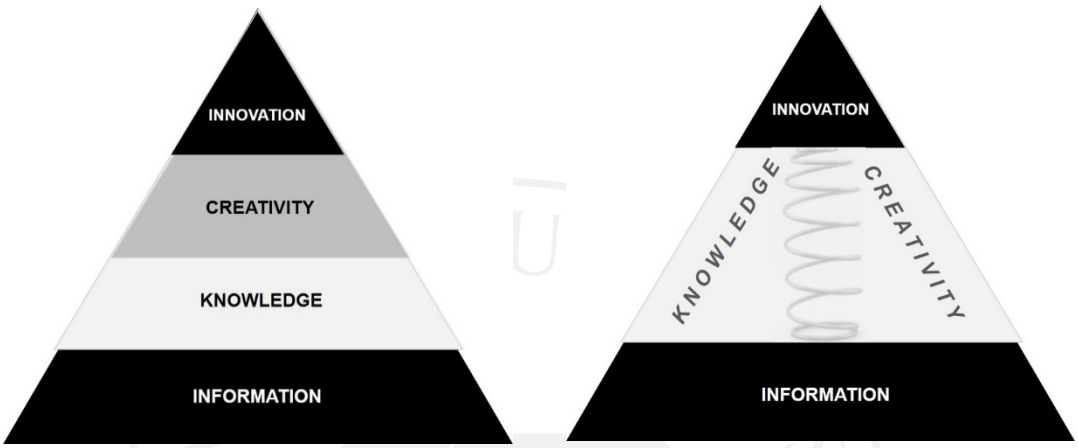
While information is organized and forms of patterns, knowledge— in this study is the backbone of creativity and a gateway for potential and promising innovation output—is creatively applied to produce an outcome, that is, innovation.

Figure 2.8 (Bennet et al., 2018) describes knowledge and creativity as capacities, and connects the two with a dotted line. While this study affirms that relationship, what emerged from the thoughts and experiences of these innovators shows a much stronger link between knowledge and creativity, that is, that *you cannot have one without the other*. The two are entangled. As one innovator conveyed that relationship in a scribbled drawing, it is as if there is a spine between information and innovation, with knowledge and creativity perhaps in this analogy representing the 31 spinal nerve pairs continuously sending and receiving signals from our mind/brain.

It is critical to note that this relationship IS NOT HIERARCHICAL. The vertical “stacking” of Knowledge and Creativity in Figure 6-4 below, the traditional model showing the relationship among information, knowledge, creativity and innovation, is not what occurs in the process of innovation. A shift in thinking is required. The model to the right shows the relationship among knowledge and creativity emerging from this study, described as entanglement.

Figure 6.4

Redefining the Relationship between Knowledge and Creativity.



As described by Innovator C: *To me, knowledge seems like the backbone of creativity. You have the basic skills, if you have comprehensive information, you can think of something creative. You cannot have one without the other. You can put it this way. There's knowledge first, then there is creativity, which brings you up to being innovative. As I've said earlier, you have something in mind, something that is new, and when this product that you have produced has been absorbed or accepted by the community or society, you are at the top (innovation). So, knowledge and creativity are linked to each other. Not in a hierarchal manner but related to each other.*

It parallels the findings of Bennet et al. (2018), where knowledge and creativity are both considered capacities, with knowledge considered the action lever for creativity. Innovator C added: *[You can always alter knowledge to accommodate something new, something better, which leads to creativity. The result is innovation when the technology impact changes, and bring significance to the lives of the end*

users. And, of course, don't forget to pile information into yourself, your basic skills, for they are crucial to the success of your technology.

While the innovators refer to creativity in terms of that which enables them to innovate specific to their technologies, as detailed in 2.3.2, there is a recognition that all people are creative, that creativity is an innate skill of the human mind. Thus, creativity as a capacity did not emerge AFTER knowledge, but *is in residence as knowledge emerges*, both highly dependent on a foundation of information.

Furthermore, information and innovation are "things", defined patterns we can get our hands/minds around. They can be grasped over time, stored, shared, manipulated, calculated, and measured, depending on our capabilities. Innovators have access to both the foundational information and the resultant innovations from various resources, largely including those shared and taught by the forefathers. Building on this, it was the innovators task to filter and sanitize information and innovation, engaging their knowledge and creativity to expand and shift that already in existence in response to current needs and opportunities.

On the other hand, knowledge and creativity are capacities, that is, they denote movement, moving information to application, with one result (knowledge) ending in effectiveness, and one result (creativity) having the potential to end in producing a process or product that is useful/beneficial. Both entail in-depth thought processes, both conscious and unconscious, and reflection so that these processes achieve their full intent. It requires careful deliberation on information so that knowledge put into action becomes effective and creativity applied becomes beneficial. It is consistent with Bennet and Bennet (2005) when that forward knowledge is effectively applied, information, with the older philosophic description of knowledge as justified true

belief. It is also consistent with creativity as the “bisociation” of two or more conceptual patterns, with innovation as applied creativity, or the usefulness of something created.

6.1.3 There is a Strong Positive Relationship between Innovators’ Positional Development Cycle and Expansion of Specific Innovation Skills

As forwarded in 6.1.1 above (see Figure 6.2), there is a progression of innovation core competencies of the innovators (RCMLA). While skills are cumulative, they go hand in hand with the innovators’ focus and advancement, and there appears to be an evolution of advancement in competencies, responsibility and commitment to the greater good. (See Figure 6.5 below.)

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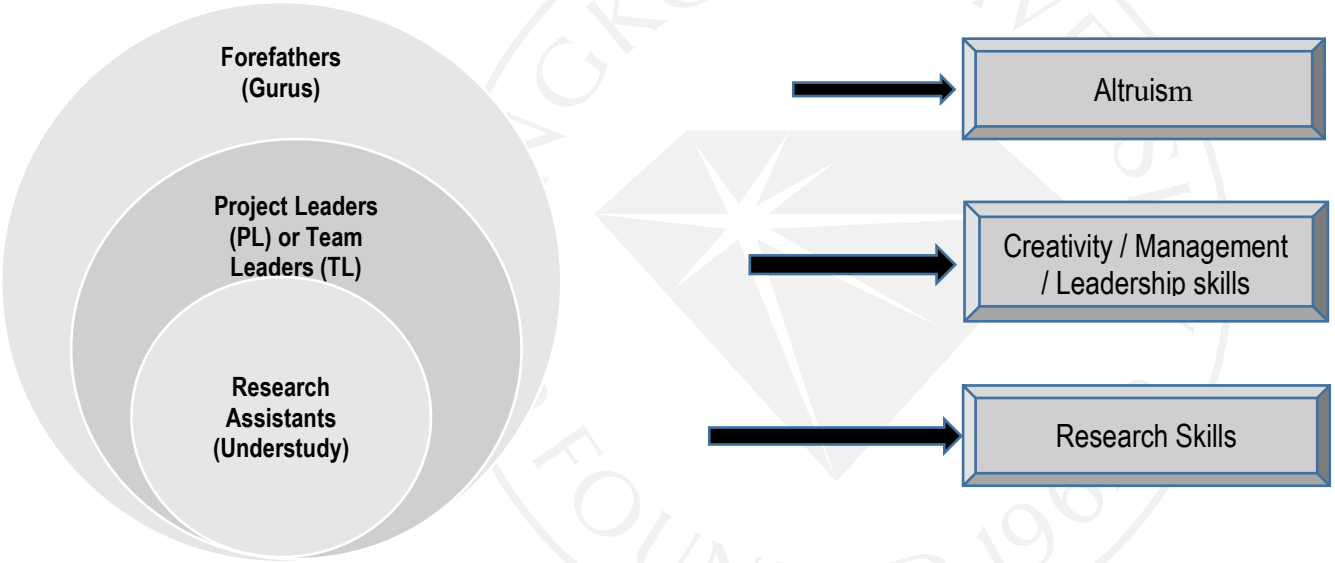
Figure 6.5

Innovators' Positional Development Cycle and Expansion of Specific Innovation Skills



At the beginning of this journey, innovators started as *Research Assistants* (RAs), serving as assistants to the project or team leader. In other words, they assist in matters about the task attached to research, honing *research skills* (see 4.2.3.2.3.1). Furthermore, RAs become understudies when they show interest or potential to lead the project. With this, RAs are allowed to have real-time exposure to the activities of the innovators. For instance, innovators tagged them during conferences, seminars, and exposition fairs. Most of all, they are directly involved in the conduct of research with responsibilities for procurement and preparing the technical report, and even join innovators in demonstrating the technologies to target users.

Innovators in this stage quickly become adept in research because it is the focus and baseline of their work. Their identified immediate concerns are the focus [*focusing skills*] of intensive research (see 4.2.1.1.1.1). Since their thrust may vary from time to time because of management change, they focus first on the problems brought about by different natural calamities, thus, considering their skills [*problem-solving*]. Finally, they find solutions on how to help the victims of calamities by producing useful technologies amidst disasters.

Those RAs or understudies who opted to stay may lead a specific project or continue with what the team leaders started. Moreover, since this is the *Team Leader or Project Leader's* stage, innovators are expected to develop novel products from the research results. It means enhancing the innovators' *creativity* through collaborative working relationships among teammates and significant others. As a result, innovators come up with a solid production innovation grounded on the needs of the society and working within the social context of the farmers and laborers. Braced with

their *critical thinking skills*, they can discern and look at things from different perspectives. Bestowed with *foresight*, they can predict more or less the outcome of their technologies.

Furthermore, technologies are well delivered because they are hands-on in handling product development. When things are out of their control, they know exactly how to source things to avoid delays in producing the product. In other words, being *resourceful*l is equally essential, significantly, as things can change abruptly. *Furthermore, constantly evaluating* the technology up-close and personal gives them insights on how to improve it further. In short, their *management skills* in dealing with colleagues and treating the technology are incomparable**.**

In addition, innovators are confident in their treatment of the technology because they are armed with good ***leadership skills*****,** meaning innovators have sufficient training skills in leadership aside from being a member of the team once. As a result, each team member's expertise is tapped and optimized. The innovators mentioned that the project leader they call forefather managed the team several times.

Forefather, the last individual advancement stage, is considered a legendary founder of the project who transferred knowledge of the technology to the innovators once they retired. Forefathers constantly and relentlessly mentored *[mentoring skills]* the current innovators. There is a strong manifestation of the mentor-mentee relationship vis-a-vis *collaborating skills*. *Collaborating* with various stakeholders led to forging partnerships for potential funding of their projects.

Finally, as the innovators reach the category of being called forefathers, altruism is achieved. For the innovators, ***altruism*** is thinking of others first over self. Their technology is a tool to respond to corporate social responsibility (CSR), thus

becoming part of their *advocacy*. In other words, they build the spirit of volunteerism – where they serve others without counting the cost. In other words, they can transcend their personal life to focus on community-based activities in particular and country-based in general, leading to the following insight.

In a nutshell, accompanying the forefathers' knowledge transfer to the innovators is through specific innovation skills to achieve successful product innovation. It means acquiring knowledge through competent individuals for one purpose in one context (Minciullo & Pedrini, 2015) and Thorisson and Talbot, 2018).

6.1.4 Innovation can be Described as Transcending Oneself for Social Justice.

Concerning innovation based on the standard definition of innovation, industries or the business sector innovate for their company's economic growth and gain competitive profit. In contrast, UPLB, and particularly its agricultural training institutes, innovate for social justice and to boost economic growth, achieve Sustainable Development Goals (SDG), and contribute to the attainment of Ambisyon 2040 and the Philippine Development Plan (APDP) 2017-2020, that is, for the benefit of society. For example, innovator C said: J*ust thinking of sharing the technology with the end-users.*

Therefore, one may understand transcendence elements with questions, "What motivates the innovators to create technologies beyond what is expected from them, pooling all their resources together and going out of their way to reach the masses?"

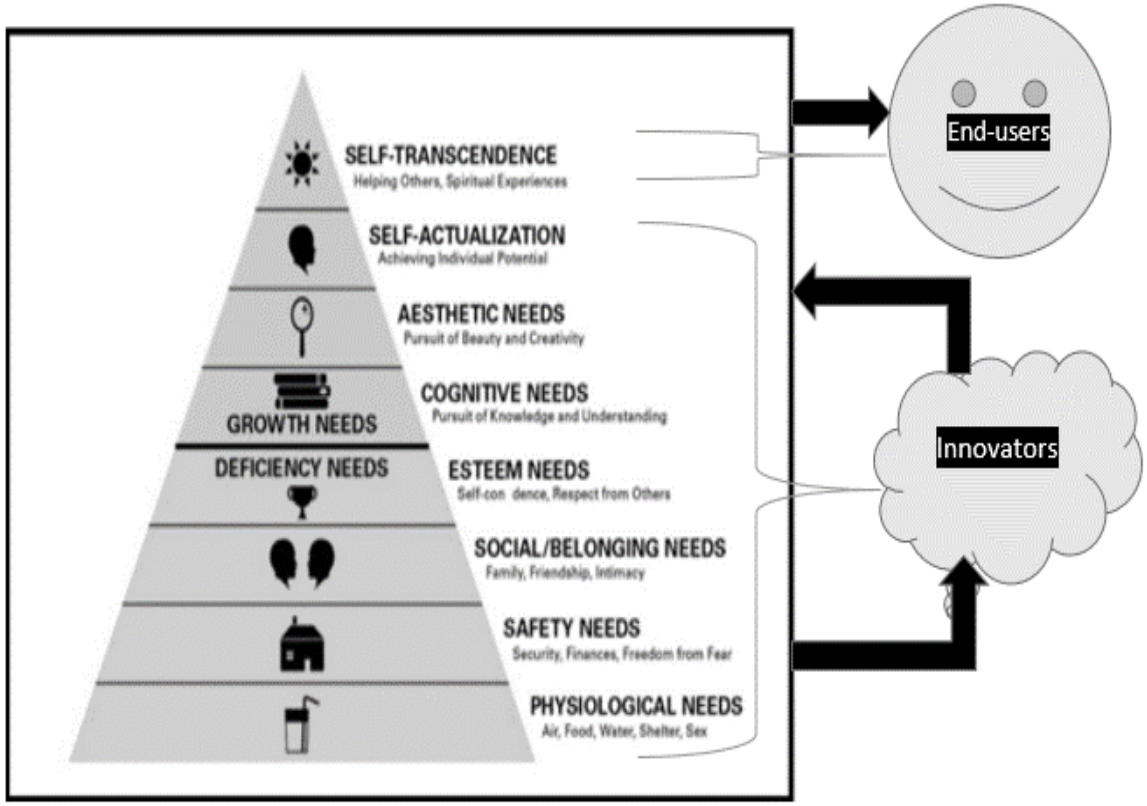
First, those findings offer an expanded understanding of *Maslow's Hierarchy of Needs*, used to study how humans intrinsically partake in behavioral motivation (see 2.7.5). Maslow used the terms "physiological," "safety," "belonging and love," "social needs" or "esteem," and "self-actualization" to describe

the pattern through which human motivations generally move. This theory is foundational to understanding how effort and motivation are correlated when discussing human behavior. Each of these individual levels contains a certain amount of internal sensation one must meet to move through and complete the hierarchy.

According to Webber (2019), Maslow furthered the research of his theory, recognizing that self-transcendence was a higher and different need. The current theoretical framework includes eight parts divided into deficiency needs (the lower four) and growth needs (the upper four), as shown in Figure 5-5. If individuals find that their first four needs are deficient, they cannot effectively pursue their growth needs for a sustained period.

Figure 6.6

Expanding Maslow's Hierarchy of Needs.



Note. Zhang and Dong as Adapted from Webber (2019)

From the in-depth interviews in this research, it is clear that innovators have crossed and surpassed the first four needs. Hence, they are not deficient in this area and can move through their growth needs to reach the top of the pinnacle and transcend themselves for others (the end-users).

As is evident in the research findings, after the innovators fulfill their own needs (physiological needs through self-actualization), they go the extra mile to reach out to others (end-users) to fulfill their needs without expecting anything in return, which Maslow termed as transcendence. In layman's terms, transcendence is the life force and desired result of "volunteerism," meaning forgetting oneself in the spirit of giving without expecting anything in return. In terms of this model, (1) for the end-users (the beneficiaries of technology), technologies directly offer the opportunity to address their functional needs; and (2) for practitioners (innovators), creating technologies and sharing them with the end-users ceaselessly enhances their growth needs.

Connecting to Maslow's Hierarchy of Needs, the innovators have reached the pinnacle of self-transcendence, helping people without expecting anything. Moreover, the advocacy of reaching out to the majority has become a habitual culture carried on from generation to generation as the Philippines strives to recover the agricultural sector fully.

Innovator A expressed this solid passion for help when he said: *I come from a family of farmers. My only intention in doing this technology is to help ordinary farmers and ordinary workers. I am not thinking of doing a business out of it. I want to help.* Furthermore, as Innovator H emphatically states: *This is for the end-users to benefit. I am happy to make a difference in their lives.*

There is also a strong relationship between these findings with ***Lawrence Kohlberg's Moral Development.*** The innovators in this study achieve the highest level of moral development, which contributes to the continuing support and expansion of their innovative technologies. According to Luenendon (2019), one thing that makes humans different from other species on Earth is our drive, not just our instincts but also our emotions. And not a tiny part of those emotions is our sense of morality.

Morality is learned and developed along the way, not given to us on a silver plate (see 2.7.6). Kohlberg (1969) defined *morality* as recognizing the distinction between good and evil or between right and wrong; respect for and obedience to the rules of proper conduct; the mental disposition or characteristics of behaving in a manner intended to produce good results. It is a progression.
As we grow of age, our moral reasoning is defined and refined, building on our cognitive development.

The concept of moral development emerges throughout this study and has much to do with the moral compass vis-à-vis the cognitive capability of the innovators. For example, building upon Kohlberg's last descriptive element of morality, the innovators vividly carry the disposition to go out of their way to produce technologies that help the farmers.

Furthermore, Kohlberg proposed that individuals form ways of thinking through their experiences, including understanding moral concepts such as justice, rights, equality, and human welfare. Kohlberg identified six stages of moral reasoning or the Progression of Morality Development (as shown in Table 2-7 in Appendix I),

grouping them into three primary levels, representing a fundamental shift in the social-moral perspective of the individual as they mature.

The pre-conventional level's first level characterizes a person's moral judgments from a concrete, individual perspective shaped by people around and faces the consequences of breaking the rules set by society. Individuals at the conventional level of reasoning have a basic understanding of conventional morality and reason with an understanding that norms and conventions are necessary to uphold society. They tend to be self-identified with these rules and uphold them consistently, viewing morality as acting following what society defines as right. Finally, the post-conventional level is characterized by reasoning based on principles, using a "prior to society" perspective. These individuals reason based on the principles which underlie rules and norms. There is an understanding that elements of morality, such as regard for life and human welfare, transcend particular cultures and societies and are to be upheld irrespective of other conventions or normative obligations (Power et al., 1989).

As has been shown repeatedly in the research findings, the innovators' level, and understanding, of morality achieve the highest level of Kohlberg's model, that of universal ethical principle orientation, meaning that along the journey of product development, they offered their entirety for the general welfare of the society, and even the country to some extent. As Innovator D consistently mentioned: *"We create products for the less fortunate, for the society's wellbeing and the country in general. We no longer think of the return of investment (ROI) as long as these are beneficial and make a difference in their lives. That is more than enough for us.* "Successful product innovation not just benefited the target end-users but led to advocacy that transformed, and continues to transform, the lives of the people, helping to change the

mindset of the general public in their approach to the agricultural sector and resulting in social justice

6.2 Recommendations

Based on the findings and insights emerging from this study, several opportunities to potentially improve the innovation process in HEIs came to light. Therefore, the following recommendations are offered:

6.2.1 Higher Education institutions should have a similar framework as built from this study, which will allow innovations to be utilized and enable the beneficiaries to embrace the innovation so that research outputs are not in vain.

6.2.2 It is clear from the findings that there is a need to review the procurement law in terms of funding research with agricultural technologies so that technologies may reach the beneficiaries before the calamities arise. Furthermore, although the government has recognized the impact of the innovators' technologies, the law on procurement processes is further studied and modified as necessary to fast track the release of funds for future projects.

6.2.3 It is evident from the findings that innovators perform multiple tasks; they carry full managerial roles and, at the same time, are responsible for administrative tasks and technical process work on top of their rigorous research work and, for some, teaching loads. As emerged in this study, this carries significant stress and the pushing of physical limits, which can cause delays in the development and delivery of technologies. Further, there appears to be a discrepancy between research support for part-time researchers/teachers and those who are full-time researchers, which devalues research critical to society. Therefore, full-time researchers are released from non-essential research-related responsibilities to concentrate and focus on product

development. This shift would contribute significantly to developing rich research culture and demonstrate the university's commitment to successful innovation for the larger society.

6.2.4 Enhanced collaborative R&D is necessary between innovators and interested private industries to improve R&D strengths in specific areas of agri-technology through forging a Memorandum of Agreement (MOA) to legitimize the activity.

6.2.5 Funding limitations and the tedious processes related to discovering funding channels are often cited as a block that slows down the delivery and adoption of environmentally sound technologies. Thus, there is a need to strengthen and streamline the government's existing financing mechanisms so as not to delay the release of funds to develop much-needed innovative products.

6.2.6 Universities possess a wealth of expertise in research that industries can tap into to level up the development of product innovation and optimize the academic research outputs. In addition, agriculture is the largest user of the Earth's ecosystems and has the most significant impact on the environment and its biodiversity that constitutes the foundation of food security (FAO, 2017). Therefore, it is imperative that all concerned bodies such as the university, industry, and government work together, collaborate in research and development, and share knowledge, providing the opportunity to become innovatively creative to meet future agricultural challenges. To facilitate collaboration and determine how to work together in the future, UPLB could host and convene a working group/forum of all concerned stakeholders (university, industry, government) on food security.

6.2.7 Higher Education Institutions need to seriously consider having an Intellectual Training Service Office (ITSO), also advocated by the Intellectual Property Office,

Philippines (IPO, Phil), saying that every HEI should have a stable Intellectual Training Service Office (ITSO) to protect the innovators' productive technologies, thus, consistent with their mission to assist potential innovators in licensing their products and building an innovation culture.

6.2.8 Although the concept of Intellectual Property (IP) has already reached the consciousness of Higher Education Institutions, there is still low awareness regarding the legalities of and processes involved with intellectual property. IPOPhl is currently partnering with agencies such as the university to help enforce IP. Higher Education Institutions need to pay close attention to IP and rigorously embed into the institution the observance and practice of IP processes to ensure originality and protection of technologies. This approach can also avoid monopoly and price increase of the said technologies.

6.2.9 It is critical that innovators who partner with international linkages ensure their mindset is people-oriented rather than profit-oriented. For example, the preferential option of practicing organic agriculture for healthy and just living is encouraged. It is a clear finding in this study that scientists-innovators produce technologies not for the economic growth of the university but for sustainable economic growth of the society and welfare of the people for a just and humane society. It is this approach that keeps the innovators innovating.

6.3 Future Research

The world in which we live has changed drastically as this research progressed. In the current challenging, complex environment, aggravated by a pandemic, an economic downfall, and continuing and perhaps even increasing environmental challenges, there is an even greater need and opportunity to build upon

existing technologies and create new technologies in service to humanity and to mitigate the occurrence of natural and artificial calamities. Nevertheless, more importantly, we need to choose technologies that will restore the natural vastness of the planet earth, where disenchanted creatures will no longer live in poverty and where there will be abundance in terms of organic food, breathing in the clean and fresh air, and bringing back the harmonious relationship of the ecosystem and biodiversity.

In Maslow's Hierarchy of Needs, food, which directly correlates with agriculture, tops the hierarchy of man's needs. It is because it has the largest share and serves as the base over other needs. Moreover, as forwarded in Chapter 2, agriculture is the basis of all civilization. It is part of everything from the food we eat to our clothing (see 2.9.1.1). Furthermore, it takes an ecosystem and several actors – including innovators – to work together to produce and deliver the food we need. Hence, there is a dire need and a call to create more reliable and cost-effective, and up-to-date technologies to address the challenges of addressing food safety and food security for sustainable development. This work is dedicated to future research in this area.

Finally, it would undoubtedly be worthwhile to explore the Innovation Model in terms of other domains of knowledge and, indeed, in terms of other cultures. However, there is a greater need for more focus on technologies to support food security and food safety in our volatile environment. The influencers that surfaced in this study affect innovation. There would be value in exploring those connections more deeply in future research.

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APPENDICE

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Appendix A

UPLB Vision-Mission

Vision

- A globally competitive graduate and research university contributing to national development

Mission

- To develop leaders committed to advancing inclusive growth through education, research, and public service.

Core Values

- Working together for excellence

Institutional Outcomes

- Lead in searching for knowledge in agriculture, forestry, biotechnology, veterinary medicine, mathematics, engineering, food and nutrition, the arts and humanities, and the social sciences.
- Conduct basic research and development, they contributing to the generation of the knowledge and products
- Undertake community, public and volunteer service, as well as scholarly and technical assistance to government, the private sector, and civil society.
- Demonstrate democratic values, practice responsible citizenship and nationalism while actively interacting with global community and helping address global issues, at the same time promoting Filipino identity.

Key Goals and Programs

- To sustain academic excellence and leadership
- To utilize knowledge and technologies towards inclusive growth
- To create an enabling environment for creativity and innovation

Appendix B

Survey Questions

1. _____ _____ _____

Surname Given Name M.I.

I. Background

1. Please tell me about your position.

2. What do you like most about your position? What do you like the least?

3. How long have you served in this capacity?

4. Have you been to other organizations before coming over?

5. What three experiences, if any, do you believe were the most important experiences you have encountered in your organization?

6. Is there any unique quality you feel you bring to this position? Why?

7. Is there any instances that you felt you were being antagonized because you have brought something new to this institution?

8. How did research and development contributed to your success?

9. How did you share knowledge to your team?

II. Innovation

8. What is knowledge? Information? Ideas?

9. What is knowledge in higher education institution?

10. What is creativity?

11. What is creativity in higher education institution?

12. What is innovation? What characterizes innovation?

13. What is innovation in higher education institution?

14. What is the relationship between knowledge and creativity? Between creativity and innovation?

15. How are these three constructs (knowledge, creativity and innovation), relate to one another?

16. What is the innovation you have introduced? How long did it take you to launch your innovation? What were the challenges / struggles you have encountered along the way?

17. What are the benefits of your innovation?

18. What are the conditions of the organizational system that help move knowledge and creativity to innovation?

19. How are knowledge and creativity engaged to promote innovation in a higher education institution?

20. Did you use any model to innovate?

21. Is there a model that can help determine the innovativeness of a higher education institution? May I know a bit of that information?

22. Do you believe innovation is mandated, created, self-initiated or regulated?

23. How would you characterize it?

24. What are the terms and conditions of innovation?

25. What is invention?

III. On Competencies

26. What does it take to be innovative?

27. Are there any specific skills or attitude or competencies needed to attain innovation?

28. What are the necessary competencies you have had to attain this innovative project?

29. What competencies contribute to successful innovation?

30. Why do some people struggle with innovation?

Appendix C

Interview Protocol

Place: _____ Date: _____

Time started: _____ Time finished: _____

_____

Participant's Brief Background:

1. _____ _____ _____

Surname Given Name M.I.

2. Date of Birth: _____ 3. Contact No. _____

4. Place of Birth: _____ 5. Nationality_____

6. Age: _____ 7. Gender: _____

8. Present Address: _____

9. Highest Degree Attained_____

10. Field of interest, expertise

11. Significant Awards received for the past three to five years (Local ____ / International _____)

12. Number of patents received: _____

13. What are the unique characteristics of to the R&D BIOTECH agricultural sector that influence innovation?

14. What innovator competencies and attributes that enable successful R&D BIOTECH innovation in HEIs?

15. How is innovator success in R&D BIOTECH supported and encouraged in HEIs?

_____

Thank you for your active participation in this interview!

God bless!

MLBAggarao

Researcher

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Appendix D

Research Instrument

1. _____ _____ _____

Surname Given Name M.I.

2. Date of Birth: _____ 3. Contact No. _____

4. Place of Birth: _____ 5. Nationality_____

6. Age: _____ 7. Gender: _____

8. Present Address: _____

9. Highest Degree Attained_____

10. Field of interest, expertise

11. Significant Awards received for the past three to five years (Local ____ / International _____)

12. Number of patents received: _____

13. What are the unique characteristics related to the R&D Biotech agricultural sector that influence innovation?

14. What are the innovator competencies and attributes that enable successful R&D Biotech innovation in HEIs?

15. How is innovator success in R&D Biotech supported and encouraged in HEIs?

_____

-- End of the interview –

Thank you and God bless!

MLBAggarao

Appendix E

Request Letter to Participants

23 January 2019

NELLY S. AGGANGAN, Ph.D.

Biotech, UPLB, College, Laguna

Dear Dr. Aggangan:

Greetings of peace and love!

With high spirits and humble in attire, I am reaching you through e-mail and at such an odd time. I hope you will not mind my way of approaching you.

I am a faculty member of Philippine Normal University, Manila and presently working on my dissertation entitled **"Exploring the Success of R&D Biotech Innovators in Higher Education Institutions: A Case Study of UPLB Agricultural Innovation".** This study is being conducted as part of the requirement for the Doctor of Philosophy in Innovation and Knowledge Management Program at Bangkok University, Bangkok, Thailand.

With my recent interview with Commission on Higher Education (CHED), your institution has been highly recommended as one of my respondents because of the innovation products your institution has excellently produced, thus, designated as Center of Excellence (COE) in Agriculture Education.

In line with this, may I ask for an appointment which is most convenient on your part to conduct an interview with you as prime mover of innovation and helped firmed up the innovation paradigm in your institution.

Thank you so much in advanced and I am looking forward for your preferential action to my request.

Should there be any questions, please feel free to reach me through my official email (aggarao.mlb@pnu.edu.ph) or through my mobile phone (0936-630-2306).

A joyous and A Prosperous New Year to you and your loved ones!

Very truly yours,

Marivilla Lydia B. Aggarao

Ph.D. Candidate

Bangkok University

Bangkok, Thailand

Appendix F

INFORMED CONSENT TO PARTICIPATE IN RESEARCH

Procedures:

[1] This study involves participants to be physically present for a one-on-one, face-to-face interview. The purpose of this interview is to share my views, experiences, description as the prime mover of our university-initiated innovation program. I am being asked to volunteer because I have the first-hand experience in materializing our innovations. My involvement in this study will begin when I agree to participate and will continue until the research is complete.

[2] Completion of these procedures will require approximately 45-minute to 1-hour interview followed by a 5-minute debriefing, for a total time of 1 hour and 5-minute maximum of participation. Eight individuals (8) individuals will be invited to participate in this study and the same procedure will be accorded.

[3] The procedure involves individual interviews that will take place between interviewer (the researcher) and interviewee (the participant). The discussion will be tape-recorded. It will be led by the researcher and will cover sets of questions on the topic of fostering innovation and competencies to promote innovation in higher education institutions to which my views, experiences and description on those of other participants are requested.

[4] I will try to answer every question asked to the best of my ability to serve the general purpose of this research.

[5] I will try not to withdraw from my participation as I understand that there is a limited sample size of the research and that we were purposely selected for this study.

[6] By signing this consent form, I allow the researcher/author to make my records available to my university, Commission on Higher Education (CHED), Higher Education Institutions (HEIs), Teacher Education Institutions (TEIs), Department of Science and Technology (DOST), Intellectual Property Office Philippines (IPOPhl), Department of Agriculture (DA), The United States Agency for International Development, Philippines (USAID), and other government and non-government agencies that may be of beneficial to their organizations.

[7] There is no involved monetary remuneration during the entire conduct of the research.

[8] I will receive a copy of this signed consent form for my records.

Possible Risks and Safeguards:

My participation in this study does not involve any significant risks and the potential advantages of my participation are:

[1] I may obtain a greater personal awareness, knowledge, and understanding of how innovation is fostered within an organization, explore how knowledge and creativity are engaged and explore organizational conditions to promote innovation in higher education institutions. Specifically, understand the innovators' core competencies as key elements for innovation.

[2] Through future communications and possible applications of the findings of the research, indirectly my participation may bring future benefits to others who are responsible for aligning, and navigating, several individuals around the process of innovating.

[3] My participation may enable the Principal Researcher and others working in the topic area to contribute to the body of knowledge on the factors that promote innovations in universities as perceived by the innovators; to identify innovators' core competencies as key elements for innovation and to build an innovation system model for SUCs to achieve innovation which is the lifeblood of a university. It will encourage all HEIs and other stakeholders to take a bolder step to further innovation.

Confidentiality

Since there is a limited sample size of universities and colleges involved in innovation, anonymity cannot be guaranteed. The information gathered from this study will be reviewed thoroughly between me and the researcher during the follow-up interview to ensure my views, descriptions and comments are recorded accurately and captured correctly before publishing. All information collected in this study will be stored in a locked file and will be kept in a secured room. Only the researcher will have an access to these records. Consenting to participate in this research indicates my agreement that all information collected from me individually may be used by current and future researchers.

Signature for both parties

The above mentioned researcher has explained to me in details the research, has answered my questions and clarified all my doubts and apprehensions. Therefore, willfully, I submit myself as principal participant in this study.

_____

Participant's Signature Over Printed Name

_____

Researcher's Signature Over Printed Name

Bangkok University, Bangkok, Thailand

Contact No: +63 -936-630-2306

_____

Date

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Appendix G

Interview Transcript Validation Form

NELLY S. AGGANGAN, Ph.D.

Biotech, UPLB, College, Laguna

April 2019

Dear Dr. Aggangan:

Greetings!

First, I would like to personally express my sincerest appreciation for participating in my study entitled: **"Exploring the Success of R&D Biotech Innovators in Higher Education Institutions: A Case Study of UPLB Agricultural Innovation"** last February 2019. I informed you during the orientation that your participation includes review of your transcript.

I am sending the copy of the transcript to you not only to uphold research ethics, but most importantly to validate what you have shared during the interview. The objective is to seek your approval on the printed version to discover and correct errors or inconsistencies that may be due to poor recording quality, to clarify thoughts, and add statements. Attached also is a copy of the ***Interview Transcript Validation Form*** where you can indicate and categorize all the changes you wish to consider in the original transcript. If you have additional comments or have no requested changes kindly indicate them on the ***Comments*** section.

Once again I would like to thank you for partaking in this study. If you have any questions or concerns please contact me through my mobile number 0936-6302306 or email me at aggarao.mlb@pnu.edu.ph

More power to you!

Very truly yours,

Marivilla Lydia B. Aggarao

Ph.D. Candidate

Bangkok University

Bangkok, Thailand

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Appendix H

Experts Validation Form

Name: _____ Signature: _____

Themes / Categories Code: _____

Direction: Kindly indicate the changes you want to consider in Patterns formed from the validated transcribed interviews including the Line Number and Category Number of the changes you made.

Category 1: Errors / omissions corrected

Category 2: Specific details added

Category 3: Specific details corrected / changed

Category 4: Grammatical changes made

Category 5: Themes / Categories removed

Category 6: Themes / Categories added

Category 7: Definitions removed

Category 8: Definitions added

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Page	Line No.	Changes	Category No.

Other comments:

_____
_____
_____
_____
_____

Page No. _____

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Appendix I

Progression of Morality Development (Adapted from Kohlberg, 1969)

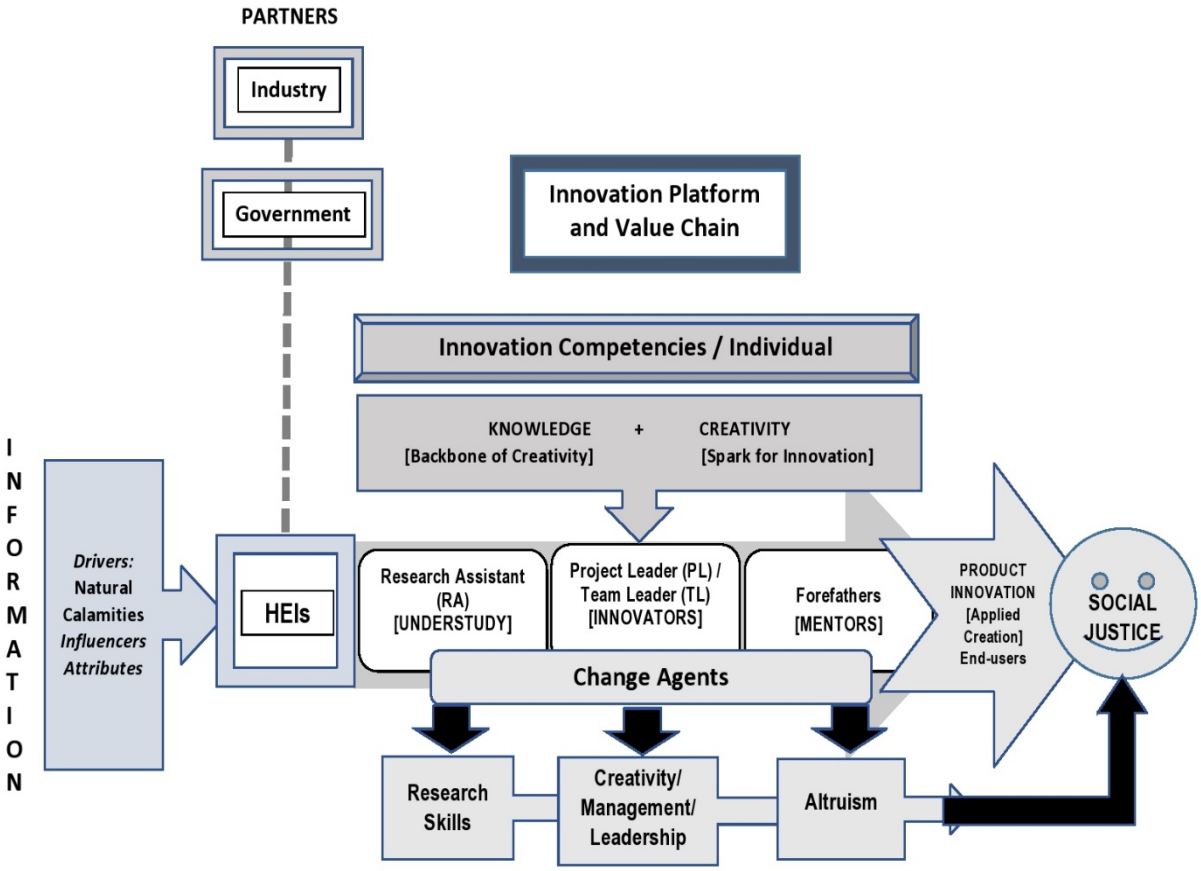
Levels	Stages	Focus	Concept of Morality
		Pre-conventional	
	• Individuals do not yet have a personal morality code. • Morality is shaped from people around and an individual faces the consequences of breaking the rules set by the society.		
I	1 **Obedience and Punishment Orientation**	Ego-centrism (self-centered)	Morality is defined by how society perceived to be right and wrong.
	2 ***Instrumental Orientation***	What's in there for me?" (self)	The right thing to do is defined by individual beliefs
		Conventional	
	• **Morality** accept general rules and moral standards of society and adults.		
	3 ***Good Boy, Nice Girl Orientation***	Gaining approval from others of one's actions (self).	Actions must be pleasing to others even if we are not comfortable with it.
II	4 **Law and Order Orientation**	Acceptance of moral code and rules of our society (community-direct involvement).	Actions and rules set up by the community are believed and followed in order to maintain peace and order.
		Post-Conventional	
	• Stand to live by our own moral code and ethical principles [example: liberty and justice] • Independent of one's own moral code or conduct.		
	5 ***Social Contract Orientation***	Share on opinions about the moral code and rules set by society and question certain laws and institutions and their work for the society (society-extended community).	Morality serves the common good. Majority wins.
III	6 ***Universal Ethical Principle Orientation***	Moral codes are based on social ideas such as respect, individual dignity, and equality among everyone. (universal)	Moral reasoning is defined by using certain universally accepted ethical principles that serve the people and the society in general.

Appendix J

An HEI Journey along the Path toward Agriculture Innovation

(an Addendum from the Researcher)

As forward in the introduction to this chapter, certain factors dominate the path of innovation exclusive to specific institutions, such as its vision-mission-goals and objectives and institutional culture that dominate the path of innovation. The example of culture was pointed out since this powerful force, relating specifically to the research culture in an HEI, set the table for the innovative technologies at the center of this research. Interlaced from the beginning to the end of the UPLB innovation path in support of Philippines agriculture is the atmosphere of legacy, a culture passed on to the innovators by the forefathers through their disruptive or incremental innovations that impacted the end-users led to lifetime advocacy..



An HEI
Journey on the Path toward Agriculture Innovation

Introduction

The Commission on Higher Education (CHED) is the key leader of the Philippine higher education system, effectively working in partnership with other major higher education stakeholders to build the country's human capital and innovation capacity toward developing the Filipino nation as a responsible member of the international community.

Under Republic Act 7722, An Act Creating the Commission on Higher Education (CHED), Philippines, at the university in a knowledge society or knowledge economy is characterized as

> … not just a generator of knowledge, an educator of young minds and a transmitter of culture but also as a significant agent of economic growth, through which the nation builds its human capital to and be at par in the global economy. It is, therefore, vital to encourage Philippine Higher Education Institutions to become platforms for innovation and drivers of competitiveness and economic growth (CMO, No. 52, Series of 2016).

To keep pace with a highly technological-knowledge society, Higher Education Institutions (HEIs) continuously advance their curricular programs, policies, procedures, processes, products, teaching strategies, structures, and human resources to capacitate every institution member to become innovative.

A preliminary survey of the literature reveals that innovation is most common in the corporate, industrial world, primarily driven by the need to respond to increasing demands while also taking advantage of the opportunities of technological advancements. Universities possess a wealth of expertise in research which industries can tap to level up their process or products, while standards for excellence also push institutions to innovate. Therefore, universities seem to innovate in response to external forces (providing service to the industry and responding to required excellence benchmarks). However, new studies also suggest that institutional culture may also affect the innovation path a university takes depending on the needs or demands of the society, whether in the agricultural, education, or industry sector.

Rationale

In the light of this study, the agricultural sector is the focus of product innovation. We consider product innovation to introduce a new good or service or have significantly improved characteristics or intended uses. Likewise, Hassan (2017) defined Product Innovation (PI) as goods, services, ideas, or processes perceived by the

customer as a new thing in life. A product or an idea becomes innovative when it is valid and used, and, in the case of this research, it stands out from the rest and truly makes the customers' lives easier.

Agriculture is the basis of all civilization upon which our traditions and values are built and shaped. It is part of everything, from the food we eat to our clothing. However, with the admission of economic industrialization with its irresistible benefits and challenges, an agriculture-based economy like the Philippines lags in enhancing its agricultural richness.

Based on the Philippine Statistics Authority (PSA), which reported the performance of Philippine agriculture from April-June 2019, agricultural output contracted by 1.27 percent in the second quarter of 2019 due to the decline in crops production. In addition, among the three [service, industry, and agriculture] major industry groups, according to De Guzman's (2018) observation, the agriculture sector continues to be the laggard, contributing only 0.03% to the third-quarter GDP growth.

It is an adverse effect of the decline in agricultural outputs; for instance, the massive increase in the price of sugar and tin cans, which caused the scarcity of necessities like food within the meager income of thousands of Filipino households. The devastating truth is that agriculture is dying and notes significantly with these realities.

There are many reasons this occurs—the conversion of agricultural land into industrial areas, shopping malls, and subdivisions. Many of our agricultural schools produce office-oriented workers who would much rather do the paperwork than help improve the country's agricultural sector. Furthermore, almost everyone would want to work in enticing air-conditioned offices or rooms, people want to work in the city, and workers are inclined to enjoy the advantages of industrialization. For these reasons alone, few would be interested in tilling the soil and investing in agriculture. As stated by Samar Rep. Edgar Sarmiento (de Carbon, 2019), there are a decreasing number of agricultural lands due to the gradual industrialization of the country.

Further, in these times of world shifts, there is a sporadic climate in the country due to climate change. Therefore, the Philippines tends to be devastated – especially the farmers – when any natural and manufactured are destroying crops, plants, or agricultural products and the adverse effects of the pandemic. Conde (2020) added that

farmers *are suffering the burden of the lockdown enforced since March to contain the COVID-19 epidemic.* For example, farmers do not know how to sustain their products when environmental problems attack.

Because of these callous reasons (Habito & Briones, 2005; Ravago & Balisacan, 2015), the Philippines lags in long-term total factor productivity in agriculture. Nevertheless, natural calamities are inevitable realities and are the identified need and a significant driver that stirred the innovators in this research to create product innovation. Over and above, this driver and other emerging influencers detailed in this research motivated them to produce the best and lowest-cost yet effective technologies.

The Interplay of HEIs, Government and Industry to Innovation

Cognizant of the crucial role of agriculture, it is befitting to focus attention on this sector. Therefore, all country sectors take initiative actions to restore the moral fiber and good image that agriculture has started. For instance, the Philippine government finds ways to develop agricultural policies and infrastructure aligned with the industry's expectations. Further, universities offering agricultural programs must be conscious enough to instill in their graduates the remarkable contributions of their technologies in the market. In line with this, the agriculture industry must be attractive enough to offer a lucrative income such that increasing numbers of young people will pursue a career in agriculture. Encourage more creative researchers and innovators to produce advanced technologies that are eco-friendly and affordable for the end-users and live a sustainable, natural, and organic lifestyle. "With closer ties and collaboration between the academe, the government, and industry, we hope to foster an inclusive innovation ecosystem wherein the University is in touch with the actual needs of the public and industry" (Glenn N. Baticados, Director, TTBDO, UPLB, 2018).

Furthermore, according to Etzkowitz (2003), the triple helix model postulates that the interaction between industry-university-government is the key to improving the conditions for innovation in a knowledge-based society. He describes the industry as the locus of interaction with the government as the source of contractual relations that guarantee stable interactions and exchange and the university as a source of new knowledge and technology. Mills (1958) notes that industry and government have always been significant institutions in modern society. The university is elevated to an

equivalent status in the knowledge-based society in contrast to previous institutional configurations in which it occupied a secondary status. In the case of the current example, the university serves as the technology provider (rooted in the indigenous knowledge passed on by the forefathers to the innovators), and the government provides the financial aspect to achieve successful product innovation. The industry's role is to adapt the product for mass production.

Innovation Platform and Value Chain

An innovation platform is a space for learning and change. It is a group of individuals (often representing organizations) with different backgrounds and interests: farmers, traders, food processors, researchers, stakeholders, and potential adopters. The members come together to diagnose problems, identify opportunities and find ways to achieve their goals. They may design and implement activities as a platform or coordinate activities by individual members. The university serves as the innovation platform whose focus is on agriculture, and researcher-innovators, farmers, university officials, government entities, and other significant others join forces in coming up with viable technologies or product innovations in response to their current thrust on food production as one of the societal concerns of Philippine government.

Value chains comprise an entire production, processing, and marketing system, from inception to the finished product. It consists of a series of value chain actors, including farmers, traders, processors, wholesalers, retailers, and consumers, linked together by flows of products, finance, information, and services. In this study, the value chain includes various members of the institution – top to bottom officials, the organizational system, the established framework, management style, innovators, experts, and beneficiaries of the technology. In addition, chain supporters such as government and private funding agencies, procurement law, extension, and transporters provide various services to the chain and enable it to function.

Scientists-Innovators as Key Agents to Successful Product Innovation

Change agents are transforming today's workplaces, allowing people in innovation leadership positions to take their seats at the table and top managers (Naughton, 2004) to address issues that beset the state of agriculture. Innovation results

from a complex set of processes, which also depends on the organization's marketing ability, strategy, resources, networks, and processes, together with the culture and leadership of the firm (Doyle & Bridgewater, 1988). The institution's highest governing body sets the university's strategic direction.

A successful change that can convert knowledge and ideas into a benefit – in the form of new or improved products/services – is the building capabilities and support for innovation. Innovation can be a perceived level of change for a product, service, or process that maybe be incremental, radical, or transformational (Mudrak et al., 2004). For purposes of this study, innovation is considered to occur through product innovation, likewise known as technology, which is new to an organization and eventually, in this study, makes a dramatic impact on the end-users, who are the community and society. The innovators themselves are the first and foremost change agents in academe who vehemently respond to the environmental problems surrounding the community.

EXPANDED DEFINITIONS IN THE CONTEXT OF THE INNOVATION PROCESS EMERGING FROM THIS STUDY

While this research began by defining and understanding core terms from the literature, as the study continued, there were unique contexts connected to the use of these terms, and references to related concepts and experiences, by the innovators. Thus, these emerging expanded descriptions of core terms in the context of this study become essential to the innovation process.

Commission on Higher Education Institution – referred to as **CHED,** as outlined by the Congressional Commission on Education (EDCOM) in 1992, looks into the tertiary and graduate education needs and was part of an extensive plan for developments in the country's education system.

Competencies – operationally, it refers to the skills or elements to achieve innovation, which eventually distinguishes from knowledge and creativity in higher education institutions. Competencies encompass a person's indispensable working habit and entirety in discharging his duties and tasks responsibly to satisfy one's terms of reference adequately.

Core competencies – operationally, core competencies are considered the indispensable working habit and entirety of the innovators in the discharge of their duties and tasks responsibly to satisfy one's terms of reference adequately for the people they serve.

Creativity – operationally refers to *the ability to produce novel technology of the acquired information and knowledge.*

Higher Education Institution - refers to **HEI,** vocational universities, community colleges, liberal arts colleges, institutes of technology, and other collegiate-level institutions, such as vocational schools, trade schools, and career colleges that award academic degrees or professional certifications. Hence, CMO, No. 52, Series of 2016, has encouraged Philippine Higher Education Institutions to become platforms for innovation, competitiveness, and economic growth drivers.

Innovation – operationally, it is applied creation that provides:

- Relevant influence.
- The impact of the change.

- The significance of its effects on the end-users.

Innovation Competencies (IC) – operationally, innovation competencies are the creative knowledge, skills, and attitude to contribute something novel and of value to society, making life more satisfying and grandeur.

Knowledge – operationally, it refers to the backbone of creativity and a gateway for potential and promising innovation output.

Developed Innovation Path Model (DIPM) – operationally, this refers to the developed model, which describes innovation product development with the intertwining relationships of knowledge, creativity, and innovation until technology transfers for social justice.

Knowledge Absorption - operationally, this refers to integrating the valuable part of experiential knowledge into existing knowledge and applying that knowledge in fulfilling the responsibility of creating innovation products.

Knowledge Sharing - operationally, this refers to capturing and optimizing knowledge, specifically that knowledge handed down by the forefathers.

Product Innovation (PI) – operationally, this refers to the product or technology produced by the scientists-innovators for the intended end-users.

State Universities and Colleges (SUCs) – refers to any public institution of higher learning created by an Act passed by the Congress of the Philippines. The national government fully subsidized these institutions and may be considered a corporate body.

Technology - operationally, this refers to the generic term for products or product innovation on agricultural products or other things that the university offers for commercialization.

On Drivers of Innovation

Natural Calamities. Refers to environmental problems which serve as the impetus for producing technology

Procedural Process of Technology Utilization (PPTU)

Societal Issues. Refers to the issues that hamper agricultural growth in attaining economic growth, achieving sustainable development, and mitigating climate change.

State-of-the-Art Facilities. Refers to the location of technology development. It has two kinds: (1) on-site (laboratory), the storage of specimens such as fungi and bacteria; (2) off-site (field) where root crops, grains, or fruit-bearing trees are grown

On Core Competencies

Social Skills. Refers to the ability to make extra efforts to learn on their own and learn from others (forefathers), the rigors of developing the technology, and negotiating for funds to run the project

Technical Skills. Refers to the ability to apply the expertise and training gained to develop a product that addresses societal issues

Transcendence. Refers to the ability to respond to the needs of the community to achieve social justice without expecting anything in return

On Competencies

Altruism. Refers to *the ability to forget oneself in favor of the much less fortunate who will benefit from the technology*

Creativity skills. Refers to the ability **to produce novel technology from the acquired information and knowledge.**

Leadership skills. Refers to the ability *to exemplify responsible leadership skills to maintain a mentor-mentee smooth interpersonal relationship in leading a transformative project*

Problem-solving skills. Refers to the ability to recognize prevalent problems and find a solution to overcome them

On Innovation Competencies

Advocacy. Refers to the the ability to inspire the local people to utilize the product and transform their lives.

Collaborating skills. Refers to the ability pool various resources or expertise and forge potential partnerships to fund the project

Commitment. Refers to the ability take charge and be responsible for the notable impact of technology in the community

Critical thinking skills. Refers to the ability to discern and make sound decisions in finding effective solutions to social problems.

Evaluating skills. Refers to the ability to assess the impact of product innovation in the community

Focusing skills. Refers to the ability to develop products one at a time to avoid mixed-up and shambolic output

Mentoring skills. Refers to the ability to mentor and guide the next generation of innovators in producing profitable products.

Resourcefulness. Refers to the ability to source knowledge, think outside the box, and the maturity to deal with the complexities of the technology.

On Individual Influencers

Concept of Resonance. It refers to the zealous character of enriching and amplifying clear direction to be involved in knowledge sharing.

Contentment over Royalty and Promotion. It refers to the innovators' fulfillment in helping others rather than seeking external rewards.

Family History. It refers to a previous family episode that triggered innovators to share their knowledge to produce technologies.

Humility. It refers to the innovators as individuals having an accurate view of themselves, knowing their strengths and weaknesses, and being other-focused rather than self-focused.

Innovation is Self-initiated [Skill of Transcendence]. It refers to the innovators' self-impelled intention to produce innovation.

Insignificance of Title. It refers to the titles [inventor, researcher, scientist instead of innovator], which are merely labels and do not define them or their work.

Prayers Matter. It refers to the innovators' trust in a more significant source. On one occasion, two of the innovators beseeched the guidance of the Almighty.

Role of Belief or Religion to Altruism. It refers to the innovators' conviction or creed, which led to being altruistic.

The Joy of Laughter. It refers to the jubilation of the innovators in sharing their insights, experiences, and knowledge in their journey towards product innovation.

Tolerance. It refers to the recognition that innovators exercise understanding when mistakes occur.

Trait of Persistence. It refers to the determination of the innovators to draw their attention to knowledge sharing to deliver the product to the end-users repeatedly and persistently demonstrating the skill.

Writing Skills. . It refers to the innovators' ability to inscribe or write correctly.

On Knowledge Sharing

Appreciative Inquiry. This refers to the positive recognition and reinforcement received when sharing and expanding knowledge from the gurus to the innovators and understudies.

Community of Practice. This refers to innovators who share a concern or a passion for creating technologies and learn how to do it better as they interact regularly.

Constant Search for Knowledge. This refers to the continuous exploration of traditional and scientific knowledge in creating remarkable technology

Demonstrating Skills. This refers to the ability to take their time out to teach and demonstrate how to use the technology to the end-users.

Emphatic Nature. This refers to the innovators' identifying with the situation of the beneficiaries of technology and the eagerness to share information in developing technologies.

Enriched Environment. This refers to the working atmosphere of the innovators as they continuously share and transfer knowledge in the completion of their journey to successful product innovation.

Feedback. This refers to the ability to clarify and point out missed things.

Foresight. This refers to looking beyond and becoming proactive in knowledge sharing to curate and design relevant product innovations.

Multiple Administrative Tasks. This refers to the increased workload that delays their duties to create technologies.

Research Skills. This refers to the ability to converting traditional knowledge into scientific knowledge to create sustainable product innovation.

Passion. This refers to the driving force, commitment, and a sense of urgency to respond to pressing environmental issues, hence the need to share the knowledge and coach one another in the team.

Trust. This refers to the team leaders showing trust and confidence towards the members and vice versa and never doubting their performance capacity.

Well-grounded background. This refers to the technical adeptness and preparedness of the innovators.

On Organizational Elements

Cohesive Teamwork. Refers to the teamwork demonstrated by the individuals in sharing their expertise to create substantial technology

Concern for Beneficiaries of Technology. Refers to the driving force to produce technology and leaves an extraordinary impact on people's lives.

Consistent Appreciation of Mentors. Refers to the behavior exhibited towards their mentors, such as appreciation and credit for the insights/ideas shared in starting the technology through community immersion, consultations, and formal training abroad.

Know-hows of Innovators. Refers to the technical and soft skills acquired through various exposures to produce the technologies responsibly for the people.

Management Style. Refers to the interplay of the institution, administration, and innovators in responding to the vision-mission to be a globally competitive graduate and research university contributing to national development through the produced technologies.

Procedural Process of Technology Utilization. It refers to the systematic function of gatekeepers who put a premium on the technology to serve its purpose to the fullest.

On Emerging Influencers

Appreciative Inquiry. This refers to the positive recognition and reinforcement given to innovators by the forefathers to continue the legacy handed on them.

Empathy. This refers to the innovators' identifying themselves with the situation of the beneficiaries of technology.

Enriched environment. This refers to the working atmosphere of the innovators in their journey toward successful product innovation.

Family History. This refers to a previous related family episode residing in the innovator's memory that triggers innovators to produce technologies.

Humility. This refers to the innovators' recognition of know who they are, their strengths and weaknesses, and are honest with others about who they are.

Joy of Laughter. This refers to the jubilation of the innovators in sharing their insights, experiences and knowledge in their journey towards product innovation.

Passion. This refers to an inner driving force, commitment, and sense of urgency to respond to pressing environmental issues.

Persistence. This refers to the trait of persistence refers to development of the technology as well as the determination of the innovators to ensure successful delivery of the product to the end-users by repeatedly and continuously demonstrating the product even if sometimes they are being ignored.

Resonance. This refers to the zealous character of connection tat enriches and amplifies clear direction.

Well-grounded background. This refers to the technical adeptness and preparedness of the innovators in terms of a solid grounding in their domain of focus.

General Terms

Commission on Higher Education Institution – referred to as **CHED.** The creation of CHED was part of a broad agenda for reforms in the country's education system, outlined by the Congressional Commission on Education (EDCOM) in 1992 that looks into the needs of the tertiary and graduate education.

Higher Education Institution - referred to as **HEI,** a level of education that is provided by universities, vocational universities, community colleges, liberal arts colleges, institutes of technology and other collegiate level institutions, such as vocational schools, trade schools and career colleges, that award academic degrees or professional certifications. Hence, CMO, No. 52, Series of 2016, has encouraged Philippine Higher Education Institutions to become platforms for innovation and drivers of competitiveness and economic growth. They will serve as respondents of the said research.

State Universities and Colleges (SUCs) – refers to any **public** institution of higher learning that was created by an Act passed by the Congress of the Philippines. These institutions are fully subsidized by the national government, and may be considered as a corporate body.

BIODATA

Name: AGGARAO, MARIVILLA LYDIA BULAN

Education Background:

She graduated Salutatorian at the Sabino Acorda Elementary and finished her secondary education at St. Louis University, Tuguegarao City. She finished her Bachelor of Arts in Psychology and Master of Arts in Education with a specialization in Guidance and Counseling at the Philippine Normal University. She has also completed the Ph.D. in Educational Management coursework at the same institution. She finished her Ph.D. in Innovation and Knowledge Management at Bangkok University, Bangkok, Thailand, and her dissertation marked 'Distinction'.

Work Experiences:

Before joining Philippine Normal University, she worked as a preschool, elementary, and high school teacher, a Psychometrician, and a Guidance Counsellor. At PNU, she was designated as a part-time Guidance Counselor at the Institute of Teaching and Learning (ITL), a faculty member and Extension Coordinator of the College of Education CED), former Director of the Alumni Relations Services Office (ARSO), Faculty Assistant of the Community Partnership and Extension Office (CPEO). At present, she is a faculty member of the School and Information and Knowledge Management (SIKM) and an adjunct faculty at the Faculty of Behavioral Sciences (FBeSS) and Faculty of Education Sciences FES). Currently, she is the Extension Coordinator of the Institute of Knowledge Management (IKM).

Contact Email (optional)

aggarao.mlb@pnu.edu.ph

Bangkok University

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Mr./ Mrs./ Ms. Ms. Marivilla Lydia Bulan Aggarao now living at Manila, Philippines

Soi 9D Lily Tower, Suntrust Parkview Residences Street Natividad Lopez St.

Sub-district _____ District District V

Province Ermita, Manila Postal Code 1000 being a Bangkok

University student, student ID 9580200161

Degree level ☐ Bachelor ☐ Master ■ Doctorate

Program Ph.D. KIM Department IKI-SEA School Graduate School

hereafter referred to as "the licensor"

Bangkok University
9/1 Moo 5 Phaholyothin Road, Klong 1, Klong Luang, Pathumthani 12120 hereafter referred to as "the licensee"

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