DYNAMIC CAPABILITIES OF RESEARCH UNIVERSITIES AND THE INNOVATION PERFORMANCE THROUGH TECHNOLOGY TRANSFER

by

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ABSTRACT

GHAZALA BIBI. Dynamic Capabilities of Research Universities and the Innovation Performance Through Technology Transfer.
(Under the direction of DR. FRANZ KELLERMANNS)

This research paper explores the relationship between dynamic capabilities and innovation performance in research universities in the United States, with a focus on technology transfer. The study draws on the dynamic capability's theory developed by Teece et al. (2007), which offers a valuable framework for understanding how organizations can adapt to changing environments and leverage their capabilities to achieve competitive advantage. Using a quantitative correlational research design, the study examines the impact of dynamic capabilities on innovation performance in research universities. Specifically, the study measures innovation performance using revenue, licenses and options executed, startups formed, patent applications, and invention disclosures. The results of the study indicate that dynamic capabilities have a positive and significant impact on innovation performance in research universities. In addition, the study examines the moderating effects of the Carnegie classification and the type of university (public or private) on the relationship between dynamic capabilities and innovation performance. This research offers important insights into the factors that contribute to research universities' innovation performance and provides implications for constructive social change in the areas of innovation, economic growth, and societal development. By employing the dynamic capabilities theory as a framework for analysis, this study contributes to a deeper understanding of how research universities can leverage their capabilities to drive innovation and economic growth, and offers practical recommendations for policymakers, university administrators, and researchers. Overall, this study provides a valuable contribution to the literature on dynamic capabilities and innovation performance in research universities.

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CHAPTER 1: INTRODUCTION

In recent years, research universities have been widely acknowledged as significant innovation and economic growth engines (Muneeb et al., 2022). The ability of these institutions to generate new information and ideas through research and development activities has been acknowledged as a crucial element in boosting innovation performance (Crisp et al., 2019; Green & Venkatachalam, 2005). The higher education institution has seen enormous changes and reforms, including the devastating COVID-19 epidemic that significantly impacted the higher education sector (Muneeb et al., 2022). While universities have contributed to economic development for centuries, advances in science and technology have elevated research universities' importance within metropolitan and regional innovation ecosystems (Crisp et al., 2019) and now merely producing new information is insufficient. Technology transfer and academic entrepreneurship have been seen as important ways to drive innovation and economic and societal development (Wang et al., 2022) and to fully exploit the potential of research institutions, it is essential to understand how universities can improve the transfer of their technology and expertise to industry partners better.

But what is innovation and how to measure the innovation performance? Innovation is something that can be defined as having something to do with novel developments and how they may be successfully disseminated (Knight, 1967). The process of identifying and creating intellectual property from scientific discoveries and bringing those findings into the commercial sector through licensing agreements and corporate collaborations is known as university technology transfer (Tojeiro-Rivero & Moreno, 2019). Innovation can also be characterized in terms of technology transfer initiatives and the success with which universities move their ideas into the business sector. The traditional university business model contributes indirectly to technology transfer by providing the industry with a more highly educated and trained workforce (Miller et al., 2014). The creation of new scientific knowledge and its commercialization to generate economic and social impact through new products, services, and processes are significant issues. Hence, researchers and policymakers actively debate universities' Third Mission and legislative approaches to facilitate knowledge transmission (Micozzi et al., 2021). Technology transfer is the transfer of university research results to the business sector (Carlsson & Fridh, 2002); It is the method by which ideas and products are transferred from research institutes to the marketplace (Castillo et al., 2018). Research and development are one of the primary goals of research universities, however, it must be absorbed and infused into the industry to generate a financial return on investment for the institution and the business. Universities speak of their capabilities to transform research into life-improving products that strengthen the economy and promote innovation. Gatorade, Google, plasma screens, web browsers, and Allegra, the allergy medication, were all invented at different universities. If higher education institutes are to provide high-quality education and research with limited resources, their funding must be sustainable for the sake of the nation's future (Katzman & Azziz, 2021). Many university administrations view the technology transfer program as a support function for academics and not to generate a profit (Trune & Goslin, 1998). Research universities' ability to transfer technology to the business sector is necessary. No matter how much we invest in research and development, without universities, faculty, and society recognizing quantitative and economic outcomes, society will not benefit at the maximum capacity it has to offer. The COVID-19 pandemic impacted our life, work, and operations, but not in our direction. If anything, it proved how technology transfer helped us fight it better. Scientists and researchers at the forefront of their fields devised licensing requirements to facilitate rapid and broad access to life-saving technologies such as ventilators and immunizations from laboratories, hospitals, and businesses (AUTM, 2020). This is where the concept of dynamic capabilities comes into play. The leaders of universities should assess the existing capabilities and resources available to institutions and develop the skills necessary to employ and improve them.

Since the Bayh-Dole Act in 1980, university research commercialization has steadily increased in popularity (Aksoy & Beaudry, 2021; Castillo et al., 2018). Many universities welcomed the Bayh-Dole Act because it enabled formal technology transfer to generate revenue, thus building relationships with external stakeholders and promoting economic growth and development in local regions (Link et al., 2007). The Bayh-Dole Act (P.L. 96-517, Patent and Trademark Act Amendments of 1980), enacted on December 12, 1980, established a uniform patent policy among the numerous federal agencies that fund research, allowing small businesses and nonprofit organizations, such as universities, to retain title to inventions made under federally funded research programs (AUTM). Before the enactment of Bayh-Dole in 1980, university discoveries were infrequently commercialized for the public good. Instead, many technologies languished because the federal government lacked the time, motivation, and money to ensure they were brought from the lab to the marketplace for the public good (Woodell & Smith, 2017). In 1980, universities received less than 250 patents; by 1993, this number had increased to more than 1,500 (Woodell & Smith, 2017). According to the Association of University Technology Managers (AUTM) 's 2020 survey report, since its adoption more than four decades ago, the Bayh-Dole Act has spawned approximately 300 new pharmaceuticals and discoveries that have propelled the innovation economy, contributing $1.7 trillion to the gross domestic product and creating more than $5.9

million in employment (AUTM, 2020). Universities like MIT and Stanford were the first to develop the idea of the entrepreneurial university (Etzkowitz & Leydesdorff, 2000). Using a university-wide patent policy, a technology transfer policy, partnerships between universities and industries, and policies that make it simpler to launch new enterprises, state officials push campuses to speed up innovation, job creation, and economic growth (Bok, 2003; Dalmarco et al., 2018). Universities in the UK, Scandinavia, Belgium, the Netherlands, and other nations underwent a wave of development, becoming centers that assisted academic entrepreneurs in starting their own businesses and collaborating more closely with industry (Dalmarco et al., 2018). According to the 2020 AUTM survey, faculty researchers created 1,117 startups, executed over 10,050 licenses and options, and 933 new commercial products were taken to the market (AUTM, 2020). However, Federal resources 'rate of return is low, despite $83.1 billion AUTM (2020) going to higher education institutions to fund faculty research projects and the education of graduate students and post-doctoral researchers. Given the billions of dollars the government invests in higher education research, institutions should realize a better return on their R&D expenditure.

Universities have adopted the concepts of technology transfer, research commercialization, and entrepreneurship, but they have not yet implemented them to the extent that they can earn financial benefits (Katzman & Azziz, 2021). Universities are encouraged to increase innovation, job development, and economic growth through increased collaboration with industry. Companies expect colleges to do more to teach their executives and work strategically in ways that will result in the development of valuable new products. Citizens everywhere want educational programs that qualify them for better employment and more promising careers (Bok, 2003). Influential products derived from academic research include the HIV drug Emtricitabine from Emory University, the anti-inflammatory Remicade from New York University, and the CAR-T immunotherapy from the University of Pennsylvania. University-based breakthroughs have been made in a variety of fields, not simply the biological sciences, including computers, the RSA encryption technique, autonomous driving technologies, and others (Hsu et al., 2021). In other words, in any economic climate, the innovation performance from the technology transfer would support expanding the university's economic role beyond patenting and licensing. Universities can achieve a return on their academic investment through technology transfer, which can then be reinvested in the institution's continued growth and development. To bring discoveries to market, technology transfer can occur in practically every field of research or expertise (Katzman & Azziz, 2021).

This dissertation investigates the role of dynamic capabilities in achieving innovation performance through technology transfer activities at research institutions. Dynamic capabilities (D.C.s) are independent variables in this study. Dynamic capabilities are defined as an organization's (or institution's) ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments (Leih & Teece, 2016; Teece et al., 1997). It is also defined as an institution's capability to sense, seize opportunities, and reconfigure assets and business models to meet the demands of the evolving environment (Bejinaru, 2017; Heaton et al., 2019; Leih & Teece, 2016; Teece, 2007). Teaching and research are fundamental components of a research university's business strategy, making basic research an ordinary capability. According to Winter (2003) ordinary capabilities enable a business to survive. The loss of basic research in the corporate sector has increased the relative significance of research universities within the total scientific activity of the

United States (Leih & Teece, 2016). Expanding on Leih and Teece (2016), I propose that by sensing, seizing, and reconfiguring resources and strategies, research universities can establish robust dynamic capabilities that enable them to achieve innovation performance through technology transfer activities for potential financial benefit. For research universities to efficiently transfer their knowledge and technology to industry partners, dynamic capabilities are required. This necessitates a variety of skills, such as the capacity to recognize and evaluate prospective commercial prospects, negotiate, and manage collaborations with industry, and protect and license intellectual property.

Research universities may want to establish priorities and allocate their resources in a manner that is consistent with and supportive of the challenges and opportunities. Furthermore, new campus business models or new revenue stream activities involving the commercialization of academic research must become a significant component of a universities' activities, as opposed to being just tagged onto the existing research and teaching streams (Leih & Teece, 2016). The institutions continuously need to reconfigure their talents and resources to adapt to a rapidly changing environment (Katzman & Azziz, 2021; Teece et al., 1997). The reconfiguration entails identifying new opportunities, seizing, and investing in them, and modifying old patterns to maximize the advantage (Heaton et al., 2019; Teece, 2007). This study applies Teece's (2007)'s three dimensions of dynamic capabilities (sensing, seizing, and reconfiguring) Teece (2007) by equating "sensing" with exploration, "seizing" with exploitation, and "reconfiguring" as a higher-order capability that involves selecting a mode of adaptation, number of publications by human capital employed by universities. I utilize secondary data from (AUTM), and IPEDS to measure the two dimensions of dynamic capabilities'; sensing and seizing. The total research and development (R&D) investment, also referred as the research investment, from the federal government, industry sponsors, and other sources is utilized to quantify the sensing dimension. I leverage R&D investment that has a positive correlation with university innovation performance as government research funding increases. The second dimension of dynamic capabilities is measured by the number of technology transfer staff (size) and the date the office was formed (age) to seize the opportunity. The age and size of the Transfer Technology Office are anticipated to have a positive correlation with innovation performance. For many institutions, the official university technology transfer procedure is still in its infancy. Through its technology transfer office, a university can also offer guidance to potential purchasers of patented technology (Heaton et al., 2019). Innovation performance, the dependent variable, is measured by the gross Licensing income received by all Technology Transfer activities, Startups formed, new patent applications, invention disclosures, and number of Licenses and Options.

According to (AUTM) licensing of scientific discoveries is the one of the important method of generating revenue. Creating research-based enterprises, industry-specific workforce courses, industry-sponsored research, and in some cases, technology consulting are all possibilities for attracting new revenue streams. Patenting and licensing only work for a restricted number of technology categories, which is why so few institutions are successful with these strategies. Most universities have two fundamental missions: knowledge transmission: teaching and training, and knowledge production: research and scholarship (Katzman & Azziz, 2021). One of the biggest resources universities has been intellectual capital, knowledgeable human capital. Human capital’s underlying knowledge enables institutions to identify innovative opportunities (Lepori et al., 2019). By reorganizing their resources, universities align the skills of their essential human assets with the vision for technology transfer. The issue of measuring the intellectual capital of individuals presents a challenge. Since the human capital refers to the individual capabilities of researchers in this case; therefore, the number of publications is used to quantify the variable in this study, which is adapted from (McClure & Titus, 2018). Universities that aspire to innovate and have economic effect should measure innovation performance using licensing income, startups formed, new patent applications, invention disclosures, and the number of licenses and options. The dependent variables of innovation performance measured by multiple activities of technology transfer provides a comprehensive view of open innovation capabilities and the capacity to convert research and development efforts into viable business opportunities.

The present study used two moderators: Carnegie classifications and type of institute. R1 is Doctoral Universities define as higher education institutions with very high research activity, and R2 as doctoral universities with high research activity (Education, 2022). The second moderator is the type of institute, with the values of public or private. Private colleges can differ from public research institutions. Thus, private research institutes in the United States evaluate their R&D and innovation performance differently than public institutions, resulting in a more diverse performance. In addition, I use control variables such as institution size, locale, age, region, ranking, and admission rate when evaluating innovation performance via technology transfer activities. By incorporating these control variables, we can gain a deeper understanding of the effect of other variables on innovation success and ensure that our findings are robust and relevant.

My research is based on the Association of University Technology Managers' Licensing Annual Survey data collection (AUTM), and IPEDS data. More than thirty variables related to technology transfer are represented in the (AUTM) data. I choose to investigate only the factors that are to explain the universities' technology transfer process using the dynamic capabilities theory. In addition, I collect data on aggregated faculty publications for universities in AUTM data to supplement the study. No previous transfer technology research has utilized the dynamic capabilities methodology with AUTM data and constructs suggested in this paper, with the exception of Yuan et al. (2018)'s published article. Where the researchers examine how universities can create and capture value from their technology creation and technology commercialization efforts by utilizing a dynamic capabilities perspective using 829 universities from China over six years; however, they utilized different measures (Yuan et al., 2018). A college or university's assets include everything it owns, manages, and exerts influence over, including its human capital and policymakers (Katzman & Azziz, 2021). Moreover, with universities and policymakers attempting to understand how to contribute to both the traditional functions of institutions and the role of fostering regional economic development, this research provides a better understanding of viewing transfer technology through the lens of dynamic capabilities; sensing seizing, and reconfiguring (Teece, 2007).

The notion of dynamic capabilities has been frequently utilized in the business sector to explain how organizations may adapt to changing market conditions and innovate to acquire a competitive advantage. However, research on the application of dynamic capabilities in the context of technology transfer in higher education has been limited. This research suggests the application of dynamic capabilities to investigate how universities might increase their capacity to boost innovation performance via technology transfer operations for higher financial advantage by utilizing dynamic capabilities. This is first paper to propose the application of dynamic capabilities within the notion of technology transfer in higher education, examining that US universities can enhance the capacity to improve innovation performance via technology transfers operations. My research benefit both theory and practice. Theoretically, the results shows research institutions that firms have sensing and seizing capabilities and the precise reconfiguration capability needed to adapt to improve innovation performance through technology transfer operations. The conceptualization of dynamic capability theory extends empirical research and contribute to strategic theories' Dynamic Capabilities.

These dynamic capabilities are specific to innovative performance through technology transfer projects; they are not a general compilation of dynamic capabilities that apply in all situations. My research offers useful insights into the critical choices management must make when carrying out technology transfer activities in their universities, namely, which method of transformation to pursue and what capabilities to develop in various organizational areas and at different times, to successfully encourage innovation performance by transforming fundamental research capabilities into dynamic capabilities. The study’s findings shed important light on how a firm’s skills, ability to seize opportunities, and rate of deployment of reconfiguration capabilities affect changes in its performance in innovation. By leveraging critical capabilities, such as innovation, managers are likely to create useful application implications while building strategies to improve and sustain business performance. Notably, this is a good strategy for gathering resources and choosing the business competences and capabilities that would efficiently and effectively deliver desired results through innovation. This research can be seen as the first step toward universities realizing a new model of technology transfer that entails universities converting standard capabilities into dynamic capabilities by creating the organizational capacity and incentives within universities to support the entrepreneurial effort of their faculty by allocating resources to campus' human capital.

This study's utilization of secondary data from IPEDS and AUTM is a limitation. While these databases contain a great deal of data about universities and their technology transfer operations, they may not capture all pertinent facts or subtleties. In addition, the accuracy and completeness of the data may vary across universities and over time, which may affect the results' reliability. Not all research universities with a technology transfer offices report to AUTM (2020), nor all reporting declare their opening date. Another limitation of this study is the proxies used to quantify the dimensions of dynamic capabilities were developed or proxied from outside the higher education industry, rather than measuring them directly. While these proxies are frequently used in the literature and some of them have been validated in other contexts, they may not adequately capture the specific characteristics of dynamic capabilities in the context of technology transfer in higher education.

1.1 - Research Objective and Research Questions

Research universities have played a critical role in driving innovation and contributing to economic development. The dynamic capabilities theory provides a framework to examine how organizations develop, integrate, and reconfigure resources and competences to respond to rapidly changing environments. In this context, this dissertation aims to investigate the relationship between research universities' dynamic capabilities and their innovation performance. I address the following research questions:

1. *How do research universities' sensing capabilities influence their innovation performance?*
2. *How do research universities' seizing capabilities influence their innovation performance?*
3. *How do research universities' reconfiguring capabilities influence their innovation performance?*
4. *How does the Carnegie classification moderate the relationship between dynamic capabilities' dimensions and innovation performance among research universities?*
5. *How does the type of university (public or private) moderate the relationship between dynamic capabilities' dimensions and innovation performance?*

Based on the research questions, the objectives of this study are to:

Objective 1: Investigate the influence of sensing capabilities on research universities' innovation performance.

Objective 2: Examine the impact of seizing capabilities on research universities' innovation performance.

Objective 3: Assess the role of reconfiguring capabilities on research universities' innovation performance.

Objective 4: Determine the moderating effect of the Carnegie classification on the relationship between dynamic capabilities' dimensions and innovation performance.

Objective 5: Analyze the moderating role of the type of university (public or private) in the relationship between dynamic capabilities' dimensions and innovation performance.

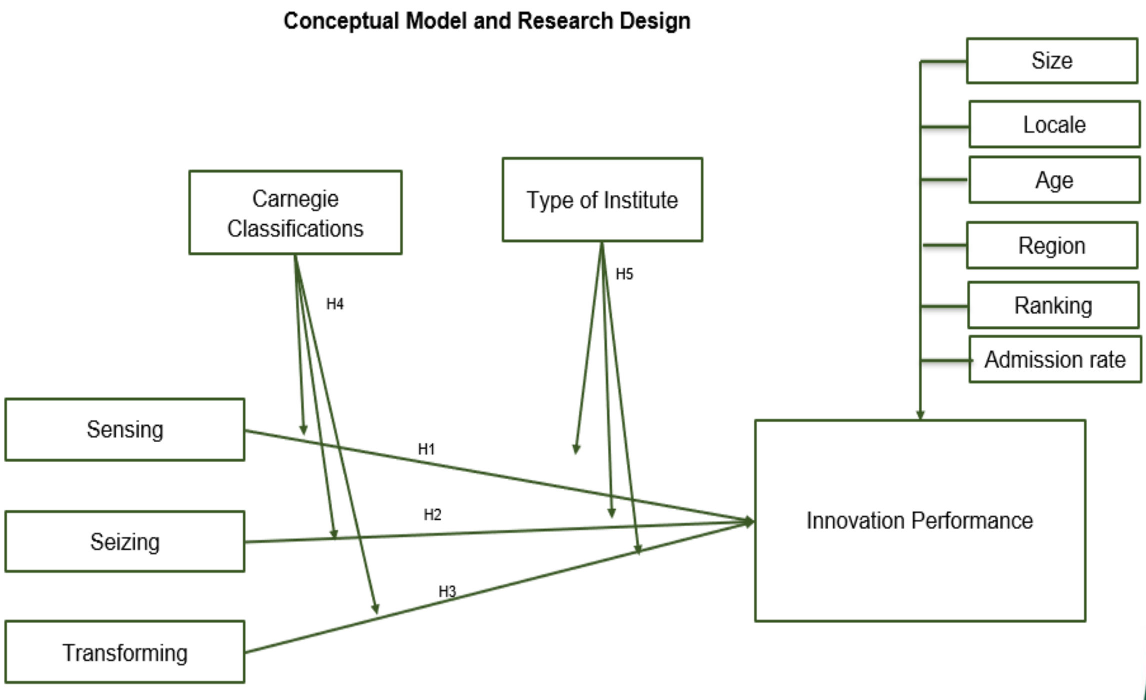
1.2 - Organization of the Dissertation

Chapter 1 introduces the research topic, which explores the role of dynamic capabilities in achieving innovation performance through technology transfer in higher education. Chapter 2 presents a comprehensive literature review on innovation and firm performance through dynamic capabilities theory, which provides the theoretical framework for this study. Chapter 3,outlines the methods of quantitative data collection and analysis. This chapter also details the research design and methodology, including the research questions, participants, and data collection procedures. Chapter 4 describes the data analysis procedures used to analyze the collected data, including the software and techniques used. Finally, in Chapter 5, I present the findings of the data analysis and draw conclusions based on the research questions posed in Chapter 3. This chapter also discusses the implications of the findings for theory, practice, and future research directions.

CHAPTER 2: LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

This study analyzes empirically the effects of research institutions developing dynamic capabilities through technology transfer activities to contribute to or attain innovation performance. The concept model being investigated in this research article is depicted in Figure 1 below.

Figure 1 – Conceptual Model



Multiple sections of this chapter give a review of the relevant literature. The first section provides a summary of the theory of dynamic capabilities. The next section then gives the innovation performance as measured by literature-based technology transfer activities. I also explore the literature on technology transfer, its origin, and government policy action. Then, I end the literature assessment by noting the gaps and developing the argument for literature-based hypotheses.

2.1 - Theoretical Framework – Dynamic Capabilities

In recent years, the dynamic capabilities view has gained increasing attention in the management literature, not only in the concept's original domain (strategic management) but also in many other areas of business administration, as it addresses the question of how firms can adapt to changing environments (Barreto, 2010). When introducing the concept of dynamic capabilities, (Leih & Teece, 2016); Teece et al. (2016); (Teece et al., 1997) emphasized their significance for organizational performance's ultimate success. The definition of capability is "a high-level routine (or collection of routines) that, together with its implementing input flows, confers upon an organization's management a set of decision options for producing significant outputs of a certain type" (Winter, 2003) P. 99). According to Teece, dynamic capabilities indicate the firm's ability to distinctively align and realign idiosyncratic resources/competencies to respond to changing market requirements; therefore, firm characteristics such as sensing, seizing, and transforming the business strategy are essential for the firm to react dynamically to the business environment (Leih & Teece, 2016). The institution's capabilities can be classified into three characteristics: sensing, seizing, and transforming or reconfiguring opportunities (Heaton et al., 2019; Leih & Teece, 2016; Teece et al., 2016; Teece, 2007; Teece et al., 1997). Dynamic capabilities enable organizations to generate, deploy, and safeguard the intangible assets that drive better long-term business performance. The distinct skills, processes, procedures, organizational structures, decision rules, and disciplines underpin enterprise-level sensing, seizing, and reconfiguring capabilities are difficult to develop and deploy (Bejinaru, 2017; Teece, 2007). These micro-foundations of dynamic capabilities reinforce enterprise-level sensing, seizing, and reconfiguring capacities(Teece, 2007). In addition to adjusting to their circumstances, firms with robust dynamic capacities are highly entrepreneurial and can influence business environments through innovation and collaboration with other industries, organizations, and institutions. The expanding body of research on dynamic capabilities has produced consecutive and unique definitions of the construct and resulted in a rich, complicated, and somewhat disjointed body of research pointing in various directions (Barreto, 2010; Helfat & Peteraf, 2015; Teece, 2007; Winter, 2003). The dynamic capability perspective extends the resource-based view Barreto (2010), argument by addressing how valuable, rare, difficult to imitate, and imperfectly substitutable resources can be created, as well as how the current stock of valuable resources can be replenished in environments that are constantly changing (Ambrosini & Bowman, 2009). Since the introduction of dynamic capabilities in the 1990s, the area has advanced significantly. The resource based view (RBV) is fundamentally static and unable to explain enterprises' competitive advantage in changing contexts (Barreto, 2010). As a result, Teece et al. presented the framework for dynamic capabilities to fill the need. Although they had earlier attempted to establish the concept of dynamic capabilities Teece and Pisano (1994), it was their 1997 work that brought the new concept to the attention of the management literature (Barreto, 2010). In 1994, dynamic capabilities were defined as the subset of the competencies and capabilities that allow the firm to create new products and processes and respond to changing market circumstances (Teece & Pisano, 1994). In 1997, it was revised to the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments (Teece et al., 1997). In 2000, Teece described dynamic capabilities as the ability to sense and seize opportunities quickly and proficiently (Barreto, 2010). Later Zollo and Winter defined dynamic capability as a learned and stable pattern of collective activity through which the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness, making the argument that dynamic capabilities are shaped by the coevolution of these learning mechanisms (Barreto, 2010; Zollo & Winter, 2002). Winter (2003) added capabilities that operate to extend, modify or create ordinary capabilities. In 2007, Helfat et al. attempted to link the resource-based view by suggesting that the capacity of an organization to create purposefully, extend or modify its resource base and Teece enhanced that Dynamic capabilities can be disaggregated into the capacity to (a) sense and shape opportunities and threats, (b) seize opportunities, and (c) sustain competitiveness by augmenting, integrating, protecting, and, when necessary, reconfiguring the firm enterprise's intangible and tangible assets (Barreto, 2010; Bejinaru, 2017; Heaton et al., 2019; Helfat & Peteraf, 2015; Li & Tang, 2021; Teece, 2007). Dynamic capabilities have value, although some organizations are more adept at adjusting to rapid changes in their environments regardless of a substantial disagreement concerning how dynamic capabilities manifest in practice (Birkinshaw et al., 2016). This study follows (Teece, 2007)'s three types of dynamic capabilities (sensing, seizing, and reconfiguring) by equating a "sensing" capability with exploration and a "seizing" capability with exploitation and "reconfiguring" as a higher-order capability that involves choosing a mode of adaptation (Birkinshaw et al., 2016).

Majority of the literature agrees that dynamic capabilities are processes that modify the resource base and that dynamic capability as an aggregate multidimensional construct, thus, has measurement inconsistencies (Ambrosini & Bowman, 2009; Barreto, 2010). Dynamic Capabilities are multidimensional and expressed in various forms depending on the company's organization and industry (Helfat, 2007). As each organization's ability to build its product and adapt technology to its needs differs, so do the criteria used to evaluate its capacity for innovation (Leih & Teece, 2016; Teece, 2007). The strategic dynamic capabilities process typology focuses on the unique firm capabilities for sensing and seizing new opportunities and threats in the business environment, making strategic choices for growth and innovation, and reconfiguring firm resources, structure, and capabilities to gain a competitive advantage (Teece, 2007). There is currently no standard scale for testing dynamic capacities. Kump et al. (2019) has recently attempted to develop a 14-item scale based on Teece's 2007 D.C framework assessing, sensing, seizing and transforming capacities by describing the rigorous empirical scale development procedures to demonstrate high reliability and validity as predictors of business and innovation performance (Kump et al., 2019). According to Kump et al. (2019), the following literature research findings on scales for evaluating DC as conceptualized by Teece exist between January 1997 and December 2015: 1. By Pavlou and El Sawy (2011) where he tried to operationalize DC to measure new product development performance, 2. By Protogerou et al. (2012), where he established the measure to determine firm performance, 3. By Hamid Hawass (2010) where he examine the determinants of the reconfiguration capability from a multilevel organizational perspective, 4) by Naldi et al. (2014), where Teece (2007) conceptualization of dynamic capabilities was studies in the context of small and medium-size firms' innovative performance (Kump et al., 2019). Additionally Kump et al., (2019) also listed the literature reviews between January 2016 to January 2018 where the firm or innovation performance was main outcome 1. Pandit et al. (2017) discussed the disruptive innovation performance, 2. Babelytė-Labanauskė and Nedzinskas (2017) discussed the innovation performance in respect to R&D using Teece (2007)'s dynamic capabilities model.

There are several scholarly articles that address the nature and origins of dynamic capabilities (Ambrosini & Bowman, 2009; Breznik & D. Hisrich, 2014; Easterby-Smith et al., 2009; Helfat, 2007). Majority of this research cite Teece et al. (1997) as the original notion of dynamic capabilities. Table 1 below provides the four different definitions of dynamic capabilities in the literature Strønen et al. (2017) in addition here are some notable studies from top journals on Dynamic Capabilities in table below.

Table 1: Notable studies from top journals on Dynamic Capabilities

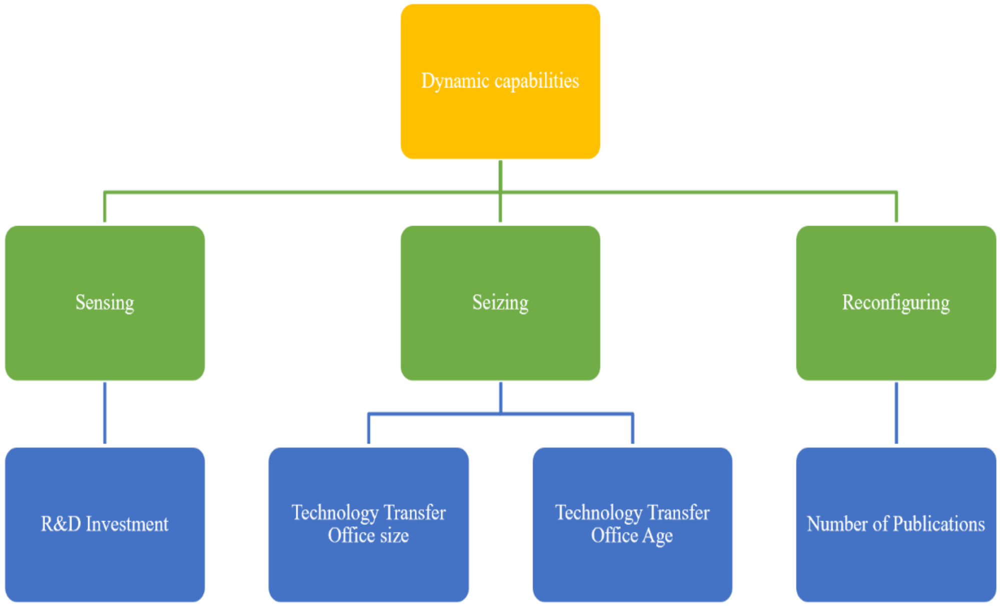
Study	Journal	Citation
Dynamic Capabilities and Strategic Management	Strategic Management Journal	Teece, D.J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. Strategic Management Journal, 18(7), 509-533.
Dynamic Capabilities: What Are They?	Strategic Management Journal	Eisenhardt, K.M., & Martin, J.A. (2000). Dynamic capabilities: What are they? Strategic Management Journal, 21(10/11), 1105-1121.
Managerial Cognitive Capabilities and the Micro foundations of Dynamic Capabilities	Strategic Management Journal	Helfat, C.E., & Peteraf, M.A. (2015). Managerial cognitive capabilities and the microfoundations of dynamic capabilities. Strategic Management Journal, 36(6), 831-850.
Dynamic Capabilities and Strategic Management	Academy of Management Journal	Helfat, C.E., & Peteraf, M.A. (2003). The dynamic resource-based view: Capability lifecycles. Academy of Management Journal, 46(3), 568-577.
Dynamic Capabilities and Strategic Management	Journal of Management	Helfat, C.E., Finkelstein, S., Mitchell, W., Peteraf, M.A., Singh, H., Teece, D.J., & Winter, S.G. (2007). Dynamic capabilities: Understanding strategic change in organizations. Journal of Management, 33(6), 807-819.
Dynamic Capabilities: A Review and Research Agenda	Journal of Management	Teece, D.J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. Journal of Management, 34(5), 1291-1311.
Dynamic Capabilities: A Review and Research Agenda	Harvard Business Review	Teece, D.J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. Harvard Business Review, 95(7/8), 92-101.

Table 2: Four definitions of Dynamic Capabilities

Definition	Source	Page Number
"Dynamic capabilities are the firm’s processes that use resources to generate and reconfigure product-market positions"	(Teece et al., 1997)	516
"Dynamic capabilities are the firm’s ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments"	(Helfat & Peteraf, 2003)	1000
"Dynamic capabilities are the firm’s ability to create, extend, or modify its resource base in ways that permit it to create and sustain competitive advantage in a constantly changing environment"	(Winter, 2003)	994
"Dynamic capabilities are the firm’s ability to sense and shape opportunities and threats, and to build and reconfigure internal and external competencies to enable the firm to adapt its resources to the changing environment"	Teece (2007)	1319

As an operationalization for analytical purposes, Teece (2007) asserts that "dynamic capabilities can be disaggregated into the capacity (1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness by enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise’s intangible and tangible assets.(Strønen et al., 2017; Teece, 2007)" Due to varying conceptualizations, variables, and measurements, the applications of dynamic capabilities are unclear, making it difficult to assess the impact of dynamic capabilities on innovation performance and necessitating the development of dimensions. In this study, the dimensions of sensing, seizing, and transforming dimensions serve as analytical dimensions as depicted in the following figure.

Figure 2 – Dynamic Capabilities Dimensions



In summation, overall, these studies indicate that dynamic capabilities are essential for achieving innovation performance. It is important for firms to build ability for sensing, seizing, and reconfiguring in order to uncover and exploit new opportunities for innovation. As a result of the accelerated change in the business environment, businesses are realigning their structures to keep up, remain competitive, and develop the capabilities necessary to seize opportunities associated with innovative performance (Robertson et al., 2021). Literature on dynamic capabilities and innovative performance in the higher education industry is still in the formation stage. Next, I define through literature review the innovation performance, dependent variable, through technology transfer operations, mainly in academia settings.

2.2 - Context

Innovation is an elusive, dynamic, and broad concept that is difficult to define considering the nature of its activities (Abdulai et al., 2022). Due to the value judgements associated to the term innovation, defining innovation inside an organization is highly complex (Knight, 1967). Never the less, innovation is considered a key factor in the better performance and economic growth of organizations and the prosperity of nations (Robertson et al., 2021). The definition of innovation is debated among scholars, and its unresolved conceptual definition poses a difficulty to empirical research (Abdulai et al., 2022). MingJi et al. (2014) defined "innovation as the development of new values through solutions that meet new requirements, inarticulate needs, or old customer and market requirements through the implementation of new means or methods of adding value to a product or service" MingJi and Ping (2014, p. 65) Knight (1967) on page 478 defined innovation as "the adoption of a change which is new to an organization to the relevant environment" (Knight, 1967). Innovation performance has long been a focus of interest in current business areas because to its link with economic growth (Chen & Huang, 2009; Robertson et al., 2021). The best indicator of a company's innovation performance is the extent to which it achieves commercial success through the selling of technologically innovative products Kobarg et al. (2018), which can be open and closed source innovation. Open innovation involves collaborating with external partners and stakeholders to create new ideas and bring them market. A concentrated emphasis on technology transfer can boost innovation performance Rybnicek and Königsgruber (2019) as each organization's ability to build its product and adapt technology to its needs differs, so do the criteria used to evaluate its capacity for innovation (Leih & Teece, 2016; Teece, 2007). The process of recognizing and developing promising intellectual property from scientific discoveries and directing those discoveries into the commercial marketplace through licensing agreements and business partnerships is known as university technology transfer Tojeiro-Rivero and Moreno (2019), Thus, for the purpose of this study I define innovation in terms of technology transfer efforts and the success with which universities move their ideas to the corporate sector (Etzkowitz, 2003). Innovation is the adoption of new techniques by an organization, whereas innovation performance is an evaluation of the effectiveness of a newly adopted strategy (Colyvas et al., 2002). Despite the fact that effective technology transfer can have a substantial financial impact on universities, the benefits extend far beyond the financial sphere (Castillo et al., 2018). Over the past few decades, there have been several literature reviews related to university technology transfer, where hundreds of articles in many academic journals were studied. Most reviews focused on the productivity of technology transfer offices; others focused on academic spinoffs and entrepreneurs (Bayuo et al., 2020). Zhang and Tang (2018) evaluated the degree to which technological breakthroughs in various industries were based on current academic research and the time gaps between the investment in recent academic research programs and the commercialization of their discoveries. The findings indicate that one-tenth of the newly commercialized items and processes in the computer processing, electrical equipment, chemicals, and instruments, medicines (Zhang & Tang, 2018). Just like innovation, the term technology transfer is also difficult to describe and illusive. Technology transfer is a commonly used term with multiple definitions for different individuals and organizations (Katzman & Azziz, 2021). Technology transfer refers to the process through which research organizations and universities translate discoveries or findings into products such as technologies, drugs, or services that would benefit the public. Evidence of technology transfer in the United States was reported by Amry et al. (2021), who investigated the roles of universities in technology transfer in a systematic review of 96 published studies. The outcome of the review demonstrated that the significant roles of universities in socioeconomic development necessitate the need for universities to diversify their technology transfers. Engaging in social innovation would shift focus from the formal technology transfer process allowing universities to make more direct and significant socioeconomic influences. Similar results were reported by Katzman and Azziz (2021), who found that universities anchor their technology transfers on two actions: the generation of knowledge through research and scholarship and the transmission of knowledge through training and education. Given the significance of knowledge transfers, this section reviews the literature on factors that influence such technology transfers.

Researchers have identified different factors influencing technology transfer in higher education. Jin and Lee (2021) used a sample of 48 universities to investigate the factors influencing universities' technology transfer in the LINC program. The analysis of the collected data revealed that the capabilities of the organization, characterized by financial support, the number of assigned projects, and cooperation with other companies, influenced the university's decision to participate in technology transfer. Zmuidzinaite et al. (2021), while investigating the factors that influenced the performance of technology transfer offices, revealed that relationships with investors, patents, and networking influenced technology transfer. The process of technology transfer cannot be specified because there are too many parallel operations, necessitating a comprehensive toolkit for academics to measure the implications of transferring technology, which is often difficult to distinguish from other organizational characteristics (Kobarg et al., 2018). There are multiple modes and activities to stimulate technology transfer, establishing and relying on the Technology Transfer Offices (TTO) within universities as the most common (Harris, 2020). All those modes reflect innovation performance in one way or another. One of the key facilitator of technology transfer activity is the business incubator with the main objective of economic development, technology commercialization, real estate development, and entrepreneurship (Borden & McCormick, 2020). As per Harris (2019), the other modes to promote technology commercialization entail university research parks, regional clusters, academic spinoffs, startups, licensing, contract research and consultancy, joint venture spinoffs, alliances and collaborations, corporate venture capital, and open science and innovation. Agrawal's literature review established a general framework for the research in technology transfer by providing an overview of the various related research streams and how they interact, delivering a summary of the literature associated with each of these research streams, including prominent studies (Agrawal, 2001; Borden & McCormick, 2020). One of the mode, for instance, the number of patent applications can indicate innovations that are considered to have commercial potential and gives an indication of the rate at which ideas with commercial potential are presented (AUTM). Ferraris et al. (2019) published an academic literature review of the university spinoff, a small component of technology transfer by defining the six primary research groups or domains of it. These include (1) the attributes and personality traits of academic entrepreneurs, (2) the resource endowments and capabilities of the institution, (3) university structures and regulations that facilitate commercialization, and (4) environmental factors that affect academic entrepreneurship. (5) the development and performance of spinoffs; and (6) research measuring the economic impact of spinoffs on regional economies. The business literature refers to technology transfer as the diffusion of technology from the place of its introduction the other markets (Ferraris et al., 2019). The number of licenses granted (including option agreements) is an additional technology transfer activity that can indicate the demand for university-generated innovations (AUTM, 2020). Governments are important actors in the innovation process since they can not only promote innovative activities but also develop their own inventions to create more efficient procedures and improve the quality and accessibility of public services. Even while internationally accepted concepts and criteria exist for measuring innovation in the commercial sector, no comparable framework exists for the public sector OECD (2010) or for higher education sector in terms of technology transfer. The increased recognition of technology transfer started with the emphasis on licensing and patenting; then, scholars examined the policy issues related to university licensing (Harris, 2020). Research supports the merits of open innovation. For instance, Chesbrough and Crowther (2006) concluded that open innovation related to greater innovation performance, as assessed by patent counts and new product launches. There are several ways to measure innovation performance, but the dependent variables that are often used are licensing income, startups formed, new patent applications, invention disclosures, and the number of licenses and options. In the next section, I conduct a literature study on the topic of innovation performance in higher education, which has attracted the attention of academics from a wide variety of fields. One of the most important forces behind economic expansion and development is universities' ability to foster innovation and disseminate the knowledge and technologies they have acquired to the wider public.

2.2.1 - Innovation Performance in Higher Education

Institutional innovation produces intelligent institutions that thrive in a world of exponential change in a distinct way (AlMalki & Durugbo, 2022). The characteristics of innovative higher education are anchored on current innovations aimed at improving governance and policymaking in organizations and advocating for innovations that improve equity, diversity, and inclusion in higher education (Schot & Steinmueller, 2018). Investigating the future of innovation and technology in higher education, Visvizi et al. found that institutions of higher education have placed an emphasis on equipping their students with knowledge of technology and how they may use it to advance their academics and careers in infotech (Visvizi et al., 2020). There is still a distinct gap between academic research and its development into useful products, tools, and resources for citizens and society, despite the efforts to promote innovation. This gap is known as the Valley of Death in the United States (Arciénaga Morales et al., 2018). Next section provides a literature review of the organizational processes and dynamic capabilities that enable the higher education sector to benefit from research capabilities. I also conduct a literature review on the various predictors of innovation performance in higher education using technology transfer as a means for the successful diffusion of new innovations.

Most universities have two fundamental missions: knowledge transmission (education and training) and knowledge creation (research and scholarship) (Katzman & Azziz, 2021). Entrepreneurship, technology transfer, and the commercialization of knowledge are becoming major factors in the education, research, and extension/outreach areas (Dalmarco et al., 2018). Transfer of technology to an academic entrepreneur's startup, a non-academic entrepreneur's startup, and a well-established commercial entity are the three most common forms of technology transfer (Bayuo et al., 2020). According to Rothaermel's literature review of technology transfer in 2007, very few theory-only papers (four or two percent) and literature reviews (nine or five percent) have been published in the technology transfer field. Notably, the few past literature reviews on university entrepreneurship concentrated on a single topic, such as spinoffs Ferraris et al. (2019) and incubators or science parks as opposed to presenting a thorough synthesis of the literature on technology transfer from universities (Dalmarco et al., 2018). More recently, scholars have examined university technology commercialization and entrepreneurship to the performance of technology transfer offices, which is not the focus of this study. There is a substantial amount of literature on the factors and settings that facilitate the commercialization of technology, such as industry closeness, innovation culture, intermediaries' support, management techniques, networking activities, property rights, researcher's characteristics, resource availability, team structure, technology application value, technology suitability for commercialization, transfer strategy, university policies and university structure (Dalmarco et al., 2018; Hayter et al., 2018). In addition to the scattered literature review and lack of a cohesive definition, another fundamental challenge for the universities is that their mission frequently entails difficult-to-cover expenses, resulting in substantial financial burdens (Ferraris et al., 2019). In the higher education sector, in general, neither teaching nor research operates under a business model that allows for generating a significant revenue surplus over expenditures (Katzman & Azziz, 2021). While the Bayh-Dole Act seems to have successfully increased the propensity to patent, it has not resulted in a shift in the underlying generation rate of commercially important inventions at universities. A significant amount of the literature examines performance across university licensing offices and explores why some universities are better with transfer technology than others (Harris, 2020).

This study concentrates mostly on technology transfer strategy through the university structure of the technology transfer office and resource availability as a measure of innovation performance according to dynamic capabilities theory. In recent years, there has been a rise in public support for the commercialization of university-based research occurring at the national policy level across nations (Lepori et al., 2019). The knowledge economy makes universities compete more with each other worldwide because they are directly involved in making, sharing, and processing new information and knowledge for society (Crisp et al., 2019). The extent to which universities promote and successfully commercialize academic research varies widely, making it difficult to identify clear forms of governance for university–industry partnerships and knowledge transfer procedures (Geuna & Muscio, 2009). The dynamic capabilities framework has been widely applied to enhance enterprise performance, but it is relatively limited in the higher education sector (Muneeb et al., 2022). Universities are critical components in innovation ecosystems. They are increasingly expected to serve as economic development partners with industry and local, state, and national governments, in addition to producing human resources and improving technology. Models such as the "Triple Helix" have been developed to examine relationships between academia, industry, and governments that may promote economic progress (Heaton et al., 2019). University technology transfer offices have been extensively researched, and best practices are generally understood, but not always followed (Phan & Siegel, 2006). Universities function as ecosystem orchestrators, strategically employing their intellectual, reputational, and financial capital to establish and sustain a robust ecosystem Hayter et al. (2018); (Heaton et al., 2019) to achieve this, universities must know how to translate their fundamental capabilities into dynamic ones. Strong dynamic capabilities take time to develop and must be maintained and frequently updated because routines lose their adaptability as circumstances change (Heaton et al., 2019). On campus, dynamic capabilities are typically underappreciated (Leih & Teece, 2016). According to Teece(2007), a key managerial function in the Dynamic Capabilities framework is "asset orchestration" (Heaton et al., 2019). Seizing demands universities to capture value by combining assets and developing new competencies (Yuan et al., 2018). Decentralizing authority, establishing a collaborative organizational culture, and spreading a shared vision are typical steps in developing robust capabilities. These qualities apply to the university setting, where faculty and administration authority is divided by nature (Heaton et al., 2019). The size of current university research and the growing reliance on the information in the production process have created enormous incentives to develop a more efficient technique of communicating academic breakthroughs to the business world (Visvizi et al., 2020). University activities, roles within national innovation frameworks, and regulation of technology transfer operations have evolved.

Moreover, institutions' missions have evolved to include a greater emphasis on the industry (Heaton et al., 2019). Increased competition between research institutes and universities for public and private contracts has prompted a shift in knowledge development between universities, industry, and applied research institutes. Universities continuously enhance their socioeconomically relevant instruction and research. Despite governments' and institutions' efforts, research suggests insufficient internal support structures, the infancy and complexity of the technology transfer process, and a lack of commercial skills among those in charge of commercialization within technology transfer offices (Tseng et al., 2020). Other factors include insufficient faculty incentives to disclose and use intellectual property beyond legal requirements, pay scales in the public sector that makes it difficult to hire qualified technology transfer employees, and limited dissemination of institutional-level policies among researchers (Borden & McCormick, 2019). Universities have adopted the concepts of technology transfer, research commercialization, and entrepreneurship, but they have not yet implemented them to the extent that they can earn financial benefits (Katzman & Azziz(2021), hence the need to assess the ability to develop dynamic capabilities in this study through dynamic capabilities theory (Visvizi et al., 2020). One of the possible explanations for universities to have not generate financial gain include that university-developed technologies are too fundamental, and the academic organization is too removed from the market to successfully commercialize the technology (Tseng et al., 2020). Another hindrance can be the conflict of interest, and cultural bias, a rigorous separation of academic and commercial research operations is necessary to avoid conflicts of interest and cultural bias (Visvizi et al., 2020). However, according to Thursby and Thursby (2002)'s research, results indicate that increased licensing is mostly attributable to an increased readiness of professors and administrators to license and an increased reliance on external R&D by businesses (Thursby & Thursby, 2002; Tojeiro-Rivero & Moreno, 2019).

Technology transfer could be a success at universities to bring innovation performance by properly designed inventive systems that address both researchers and technology transfer staff (Borden & McCormick, 2019). The research necessary to determine that universities must develop and implement cohesive and feasible technology transfer/commercialization strategies stands out as a major gap in the existing literature (Peng-Yu & Kuo-Feng, 2019). The tensions between academic and commercial research outputs may be controlled at the university level by establishing dual structures such as technology transfer offices (Tseng et al., 2020). It is suggested that as a result of these changes, universities, particularly in industrialized nations, have grown more entrepreneurial and a global perspective is growing (Apa et al., 2021). At the center of the entrepreneurial university, the concept is the function of higher education institutions as a source of technology and knowledge directly applicable to industry (Apa et al., 2021; Popp Berman, 2008). Moreover, as such, it is a rather contested concept (Harris, 2020; Tyler, 2011). Although research on the creativity of higher education institutions is thriving, the topic is still somewhat fragmented, encompassing numerous subfields, such as technology transfer, the study of university licensing, scientific parks, incubators, and spin-offs Lepori et al. (2019) evaluated 176 articles on innovation in higher education and established that 45% of the articles revealed the significance of innovation and technology transfer in higher education in solving social problems (Lepori et al., 2019). Federal government agencies provide nearly $33 billion yearly to higher education institutions to conduct scientific research (Apa et al., 2021; AUTM, 2020). This ongoing commitment contributes to the expansion of human knowledge and the education of the next generation of science and technology leaders (Klofsten et al., 2019). In addition to providing the foundation for several new products and processes that benefit the nation and its residents, university research also yields a wealth of novel discoveries. However, these resources are not designed to produce commercial applications immediately. It pertains to basic knowledge. The foundational research conducted in universities is the foundation for discoveries that take years, if ever, to reach the marketplace. Now, however, the government and higher education frequently establish a connection between their research and financial returns, as they did in December after Congress increased annual funding for research by $2.6 billion (APLU, 2019). In a knowledge-based economy, technological innovation and the scientific research upon which it is founded are essential for a significant portion of national productivity development (Cunningham et al., 2019). Basic research conducted at universities does not spontaneously generate new goods and procedures. They necessitate discoveries or innovative concepts, as well as more development, funding, manufacturing capacity, and marketing. Universities and other institutions employ the technology transfer process to transmit scientific discoveries to the business sector for further research and commercialization (Cunningham et al., 2019; Findler et al., 2019; Klofsten et al., 2019). Students and faculty are typically the most successful means of converting research results into new technologies, but this part of technology transfer is sometimes neglected. Many of the most effective university-industry contacts are based on the education and training of students with industry-relevant knowledge and skills, or on the ties that faculty members have formed with specific companies (AlMalki & Durugbo, 2022). The review in this section discusses how an application for licenses and patents, formation of new startups, and disclosures of inventions influence technology transfer in higher education. Ebersberger and Herstad (2017) investigated the effect of public funding on academic R&D and research priorities. The authors found that public funding has a positive impact on innovation performance in higher education, particularly when it is targeted towards research areas that are aligned with societal challenges and industry needs (Ebersberger, 2004). Zheng Cheng (2020) investigated how university-industry collaboration affects innovation performance in China's national manufacturing industry. The authors found that collaboration between universities and industry has a positive impact on innovation performance in higher education, particularly when there is a high level of knowledge sharing and co-creation(Cheng et al., 2020). Overall, these studies highlight the significance of innovation performance in higher education, as well as the numerous aspects that contribute to its success. In this study I measure the dependent variable, innovation performance, by technology transfer activities such as the Licensing income, Startups formed, new patent applications, invention disclosures, and number of Licenses and Options in higher education setting. The next section presents the literature review on the Licensing income, Startups formed, new patent applications, invention disclosures, and number of Licenses and Options.

2.2.2 - Measures of Dependent Variable, Innovation Performance

Innovation performance, the dependent variable in this study, is a crucial aspect of research universities' contributions to economic development and technological advancements. Several studies have investigated different metrics to assess innovation performance within these institutions. In this dissertation, innovation performance is measured as a composite of various indicators, including licensing income, number of startups formed, number of new patent applications, number of invention disclosures, and the number of licenses and options.

One of the most prevalent metrics of innovation performance is **Licensing income**. This measure indicates the revenue made by licensing technologies to third parties. It is a clear indicator of how an organization can develop and promote its technology. Assessing license revenue is especially beneficial for research universities with a strong emphasis on technology transfer, as it provides a clear indication of their effectiveness in commercializing their research and producing economic impact. Licensing is an arrangement where a company or a business temporarily authorizes the other to access or use its products. Nambisan et al. (2018) reviewed the literature on open innovation, entrepreneurship, and platforms in the United States. The review's outcome revealed that open innovation created opportunities for entrepreneurs and firms to use their innovations to promote technological developments. Nambisan et al. (2018) were extended by Huggins et al. (2020), who studied open innovation in universities using a sample of 158 universities in the United Kingdom. The analysis of the collection revealed that universities licensed their research projects to protect their inventions and participate in open innovations. Thus, licensing influenced technology transfer positively. Besides extending a particular field of research, universities licensed their inventions as a source of revenue and a license to participate in open innovation practices and engagement. According to Thursby and Thursby (2002)'s research, results reveal that the majority of the rise in licensing is attributed to the greater willingness of professors and administrators to license and the rising reliance of businesses on external R&D (Thursby & Thursby, 2002; Tojeiro-Rivero & Moreno, 2019). Licensing allows universities to prioritize research projects and inventions to commercialize and publicize. Holgersson and Aaboen (2019) conducted a systematic review of the literature to investigate the significance of intellectual property management in technology transfer offices. Analyzing the outcome of 112 peer-reviewed articles, the results revealed that transfer technology offices facilitated the transfer of knowledge and sharing of their research after licensing. As per the findings, the patenting and licensing of inventions and research projects maintained the value of the research. Consistent results were reported by Belitski et al. (2019), who investigated the commercialization of university research in transition economies. Using data drawn from a sample of 272 scientists, the findings indicated that though commercialization of research was not associated with the existence of transfer technology offices, licensing, like patenting, was a source of income and funding for university projects. Though research is limited to total number of licenses and options, researchers have demonstrated that licensing influences university participation in open innovation besides the commercialization of the research projects.

Patent applications are a direct reflection of the innovation capabilities of an organization, and they are a useful metric for assessing the impact of research and development activities. Measuring new patent applications is particularly useful for research universities that seek to generate new knowledge and ideas through their research activities. Patents are crucial in actualizing and transforming university discoveries and projects into marketable products. Businesses and organizations seeking to transform university discoveries must receive permission and authorization from the university to actualize the project and discoveries into marketable products (Baglieri et al., 2018). Studying technology transfers in universities, Baglieri et al. (2018) analyzed qualitative and quantitative data from 60 universities in the United States between 2002-2012. The results revealed that leveraging high-quality research and startup creations recorded higher economic performance. Understanding that commercialization of university projects is beneficial, universities patented and copyrighted their projects to mitigate fraudulent activities. Extending Baglieri et al. (2018) research, Hayter et al. (2018) Hayter et al. (2020) reported that the prioritization of revenue and maximization of profits influenced technology transfer in the United States. While investigating innovative pathways for knowledge exchange, Hayter et al. (2020) stated that patenting innovation allowed universities to protect and commercialize their inventions. Patenting allowed the disclosure of inventions to specific businesses. The patentability of inventions allowed institutions of higher learning to commercialize their projects to organizations based on the number of profits the new invention would bring the university.

Hayter et al. (2020) noted that universities only transferred technological knowledge based on possible returns. Agreeing with Hayter et al. (2020), Katzman and Azziz (2021) stated that patents, besides earning the universities revenue, allowed them to maintain ownership of the project or discoveries while allowing its actualization. Brantnell and Baraldi (2022) sought to understand university commercialization of research by investigating the involvement of technology transfer offices. Supporting the research by Katzman and Azziz (2021), Branteli and Baraldi (2022) found that technology transfer offices protected university research during commercialization. Patent application has influenced the transfer of university research positively and negatively. Positively, the patent application allowed universities to share research based on the expected revenue and profits while maintaining ownership. Patenting only allowed the commercialization of projects that could be actualized to improve the lives of common citizens. Negatively, focusing on revenue and maximization of profits from projects, universities neglected the need for quality research and their fundamental role of improving communities' social and economic lives around learning institutions.

Startups are another innovation indicator; it shows how well an organization converts technology into business potential. Research universities that generate spin-off firms to commercialize their technology and achieve economic impact can benefit from measuring startup formation. Research has demonstrated that many universities seeking to commercialize their research projects and inventions partner with new ventures and startups. Baglieri et al. (2018), while investigating university technology transfer office business, reported that institutions of learning used new startups to commercialize their projects and incorporate business models in university evaluation programs. Baglieri et al. (2018)

demonstrated that universities utilized startup creations and high-quality research as catalysts for commercialization. Similar findings were reported by Omelyanenko et al. (2018), who investigated the management of technology transfer in education, specifically using startup methodology to improve technology transfer efficiency and skills. The results indicated that new startups provided universities with new inventions, which they leveraged to transfer knowledge and possibly develop research projects through commercialization. Other research also reiterated that incubators and new ventures provided researchers and institutions with learning alternatives to enhance, manage and commercialize their projects and inventions. Overall, new startups are important tools for researchers to make public their inventions at a fee. Startups in the United States are important critical, innovative tools for universities technology transfers in the United States. Schaeffer et al. (2020) studied the convergence and divergence between informal and formal knowledge transfer channels in higher education institutions. Adopting a quantitative longitudinal study, the results indicated that positive interactions at both team and individual levels were critical in developing a strong cumulative effect during knowledge transfer. However, the success of knowledge transfer by institutions of learning is anchored on researchers acquiring and using different university-industry knowledge transfers to increase the entrepreneurial success of their research projects and inventions. Different from Schaeffer et al. (2020) research, Miranda Oliveira et al. (2019) conducted quantitative research with a sample of 461 startups incubated in technology-based incubators (TBIs) to examine the impacts of new startups on knowledge transfer from universities to research centers. The analysis of the collected data revealed that universities that worked closely with new startups launched new products often when compared to universities lacking such relationships. Across the reviewed literature, technology transfer from universities and the transfer frequency is influenced by the relationship between higher education and new ventures. As a factor influencing technology transfer, new startups affect the frequency with which universities launch new projects, commercialize their inventions, and generate revenue from such projects through licensing and patents.

Prior to the 1980s, the concept of technology transfer in higher education institutions has existed for some time. However, the strong emergence of technology transfer in higher education institutions has been linked to establishing the Bayh-Dole Act in the US and facilitating interactions between universities and industry (Mowery & Sampat, 2004). Following the establishment of the Bayh-Dole Act, public and private universities in the United States began to establish technology transfer offices in their institutions and started spin-offs (the founding of new firms) and commercialization of university research through licensing (Apa et al., 2021; AUTM). In conclusion, organizations seeking to innovate to have an economic effect must measure innovation performance using licensing income, startups launched, new patent applications, **Invention disclosures**, and the number of licenses and options. Innovation performance measured by these activities offer a thorough understanding of an organization's capacity for innovation and its capacity to convert R&D efforts into commercially viable prospects. The next section examines technology transfer advocacy and legislative initiatives in the United States.

2.2.3 - Technology Transfer Advocacy & Legislation

When it comes to the process of commercialization and the transfer of technology, policymakers and practitioners place a significant emphasis on the idea of societal impact (Fini et al., 2018; Fini et al., 2019). Before 1980, the federal government claimed all royalties or other income from federally funded patents (Visvizi et al., 2020). Federally financed researchers might apply for patents and assign them to universities, but the government owned the invention whether a patent was awarded or not. A university could only profit from federally produced patents by requesting a title rights waiver. Since 70% of academic research during this time was federally financed, patenting was difficult (Saltmarsh & Johnson, 2020). Since 1980, the United States Congress has passed no fewer than eight major policy initiatives about technology transfer and means of fostering it (Visvizi et al., 2020). (Mansfield, 1998)'s findings were released at the height of the competitiveness argument of the 1980s and early 1990s in the United States, which centered on topics such as the purported inability of U.S. companies to leverage university research for commercial advantage. These considerations influenced the 1980 enactment of the Bayh-Dole Act (Harris, 2020). The Bayh-Dole Act (P.L. 96-517, Patent and Trademark Act Amendments of 1980), which went into effect on December 12, 1980, established a uniform patent policy among the numerous federal agencies that finance research, allowing small businesses and nonprofit organizations, including universities, to keep ownership of inventions created as part of federally funded research programs (AUTM). Bayh-Dole was a competitiveness and economic development initiative. Universities have embraced it since formal technology transfer can produce revenue, foster relationships with external stakeholders, and stimulate regional economic growth and development (Saltmarsh & Johnson, 2020). This legislation was co-sponsored by Senators Birch Bayh (D-IN) and Robert Dole (R-KS). The Bayh-Dole Act was instrumental in encouraging universities to participate in technology transfer activities (AUTM; Tojeiro-Rivero & Moreno, 2019). Research has poured in due to the expanding commercial interaction between academia and industry, and it was thought that the B.D. The act would deliver the fruits of academic inventions in an effective, efficient, and socially desirable way (Saltmarsh & Johnson, 2020). There was also the belief that the university could be the source of inventions that would boost the economic strength of the United States; therefore, the passing of the Bayh-Dole Act has been deemed a watershed point in the university's commercialization (Borden & McCormick, 2020).

The significant involvement of universities in industrial innovation, particularly after 1945, relied on institutions external to universities, such as venture capitalists, equity-based funding of new enterprises, and considerable labor mobility between academics and industry (Tojeiro-Rivero & Moreno, 2019). Even though research-intensive universities get external financing for innovation, performance might vary considerably. For example, universities can have strategic advantages that place them in a better position to increase technology transfer performance. Furthermore, heterogeneity in techniques can be large and include the size of the technology transfer Office (Coupet & Ba, 2022). The number of organized university "technology" offices has increased Since the Bayh-Dole Act was passed, the scope and importance of universities' patenting and technology licensing operations have dramatically increased (Tojeiro-Rivero & Moreno, 2019). The Association of University Technology Administrators (AUTM) was established, and numerous universities in the United States and Canada joined. AUTM has begun conducting an annual survey of its members to collect information on transfer technology initiatives (AUTM, 2020). In the research paper, (AUTM) serves as the primary data source for research technology transfer activities to improve innovation performance through the lens of dynamic capabilities.

2.3 – Research Model and Hypothesis Development

My research model seeks to examine the relationship between dynamic capabilities (DCs) and innovation performance in research universities. The research model encompasses three independent variables, namely sensing capabilities (R&D investment), seizing capabilities (institutional environment/management strategy), and reconfiguring capabilities (intellectual capital). Additionally, the model includes control variables such as institution size, age, location, region, rank, and admission rate. The dependent variable, innovation performance, is measured as a composite of licensing income, number of startups formed, number of new patent applications, number of invention disclosures, and the number of licenses and options.

Based on the assessment of the relevant literature, little is known about the measurement of successful technology transfer of innovations and the capability to compare these metrics across the various modes of engagement. Furthermore, a scale of technological transfer success is not present in much of the literature. Much of a literature is focused on either the one or two components of technology transfer, or the performance of technology transfer office with a lot of entrepreneurship advice. However, relatively little research focuses on how universities may enhance the core strategic dynamic capabilities processes on revenue generation sensor to identify, seize, and configure the resources to boost the likelihood of financial gain and economic expansion.

The only other study that comes close to this paper is the one that has adopted Teece's (1997) concept of dynamic capabilities and operationalized matrix of key performance indicators in the area of R&D and innovation, which allowed the construction of the strategic management model for research organizations, which was then statistically validated (Babelytė-Labanauskė & Nedzinskas, 2017). However, the research by Babelyte et al. (2017) has several drawbacks, including the fact that the study was limited to the Lithuanian R&D and innovation ecosystem, which inhibits competitiveness on the local level due to its small size; hence, the scale is quite modest. The primary findings of this study highlight the favorable influence of research organizations' dynamic capabilities on their R&D and performance outcomes. Therefore, the study was concluded that effective utilization of dynamic skills within a research organization can create advantageous R&D and innovation performance in an environment that is subject to rapid change, with a suggestion that further research in other countries, with more data should be conducted (Babelytė-Labanauskė & Nedzinskas, 2017). Based on the literature review on innovation performance, dependent variable, revenue, number of new product created, number of new patent filed, Cordero (1990) among others is used. This research model seeks to provide a comprehensive understanding of how the different dimensions of dynamic capabilities contribute to research universities' innovation performance. By analyzing the relationships between these variables, the study aims to offer valuable insights into the factors that drive innovation performance within these institutions, as well as identify potential areas for improvement and policy implications.

The following section discussed the development of the five hypotheses of the study: The hypotheses are listed in the table below along with their justifications, limitations, and sources. The institution size, age, location, region, rank, and admission rate served as controls for all hypotheses. Moreover, the dependent variable, innovation performance, is measured by licensing income, number of startups formed, number of new patent applications, number invention disclosures, and the number of licenses and options.

Hypothesis	Justification	Limitations
H1: Research universities' sensing capabilities have a positive relationship with innovation performance.	R&D investment, as a component of sensing capabilities, can stimulate innovation performance in higher education institutions. R&D investment is considered as a critical driver of innovation performance in higher education sector through technology transfer activities	The use of self-reported data may lead to potential social desirability bias. There might be other factors beyond the control variables that can influence innovation performance
H2: Research universities' seizing capabilities have a positive relationship with innovation performance.	Seizing capabilities can facilitate the conversion of research output into innovation performance in the form of licensing income, startups launched, new patent applications, invention disclosures, and the number of licenses and options	The lack of a standardized definition of seizing capabilities may limit the comparability of results It may be challenging to directly measure seizing capabilities, and the data available may be subject to measurement errors.
H3: Universities' reconfiguring capabilities have a positive relationship with innovation performance.	Reconfiguring capabilities allow universities to effectively utilize their intellectual capital and optimize their internal operations, leading to higher levels of innovation performance.	The measurement of reconfiguring capabilities is subjective and may not capture the full extent of the construct. As a metric of research output, the number of publications has limits since it does not include the effect of such articles. The quantity of publications is not always indicative of the relevance or quality of the study.
H4: The relationship between the dynamic capabilities' dimensions and innovation performance is be moderated by the Carnegie classification.	R1 universities have a greater research focus and receive more federal funding, which may allow them to leverage their dynamic capabilities more effectively for innovation performance	The generalizability of results may be limited to universities within the US Carnegie classification system. The classification may not capture all relevant institutional differences and nuances that may influence innovation performance in technology transfer activities.
H5: The relationship between the dynamic capabilities' dimensions and innovation performance is be moderated by the type of universities.	Public universities may have greater incentives to generate innovation performance due to their mission to serve the public good and potential impact on local economic development	The definition of "public universities" may vary across different countries and regions, limiting comparability. The type of institute may not capture all the relevant factors that may influence technology transfer activities and innovation performance of research institutions

Regarding the first hypothesis, multiple regression was deemed the appropriate approach since the purpose of this hypothesis was to investigate the relationship between independent variable R&D investment (sensing) measured at interval level of measurement, and the dependent variable innovation performance of technology transfer measured at the interval level of method. Multiple regression is acceptable when the goal is to measure the relationship between an independent variable (either nominal or interval) and a dependent variable measured at the interval level (Hair et al., 2011). There was concern that this approach would not work if there were violation of parametric assumptions, however, all assumptions were met as detailed in chapter 4. Multiple regression was also the best technique to address the second and third hypotheses. The fourth and fifth hypothesis includes moderation analysis. Moderation analysis involves introducing an interaction term into the multiple regression model to determine if the interaction term is significant. Thus, multiple regression was the best technique for these hypotheses.

2.3.1 - Hypothesis One

IV-Sensing- Research and Development (R&D) Investment

How higher education R&D investments (research expenditure) may foretell the innovation and technological performance of institutions of higher education. Peng-Yu and Kuo-Feng (2019) quantitatively investigated R&D investments and diversification using a sample of 283 manufacturing firms from the Taiwan information and technology industry. The data analysis revealed that the technological investments made by these manufacturing firms in information technology in learning institutions fostered innovation. Particularly, investments in training and resource developed both the intellectual capital needed by university faculty to diversify their relationship and thus improved innovation performance. Unlike Li and Huang (2019), Tojeiro-Rivero and Moreno (2019) used data from the Spanish

Survey on Business Strategies to investigate the impacts of R&D outsourcing and technological cooperation on firm performance. While Tojeiro-Rivero and Moreno (2019) did not focus on university innovation performance, their findings indicated that R&D outsourcing improved innovation performance for firms in areas with a low knowledge pool. However, technological cooperation was found effective in firms operating in areas with high knowledge pools, such as around institutions of higher learning. Overall, R&D investments can improve the technological performance of universities located in areas with limited technological knowledge. R&D investments avail the resources in terms of skilled human resources, technological software, and hardware needed to improve the innovation performance of higher education institutions. Tojeiro-Rivero and Moreno (2019) found that cooperating in innovation activities is critical to improving innovation performance, similar to technology firms. In previous research, Bednář and Halásková (2018) investigated R&D expenditures and innovation performance of firms and learning institutions in Western Europe. Despite limited investments in innovation activities, R&D expenditures have proved critical in improving innovation performance and technological cooperation between firms and institutions of higher learning across western Europe. Comparable findings were reported by Zhang and Tang (2018) and 2019, who investigated the impacts of R&D diversity investments on innovation performance with a focus on the nano-biopharmaceutical field. Using a sample of 554 innovative organizations, the findings revealed that organizational diversity positively influenced technological and innovation diversification. Diversifying R&D partnerships improves knowledge sharing that, in turn, positively influences innovation performance. Though research examining the impacts of R&D investment on innovation performance in higher education, extant research has demonstrated that increasing R&D

investment in learning institutions fosters the positive technological development and innovation performance. To illustrate, Kobarg et al. (2018) investigated the impacts of university-industry collaborations on product innovation performance. Using a sample of 2061 companies, Kobarg et al. (2018) demonstrated that though university-industry collaborations spurred technological application in learning and innovation performance institutions, students and faculty were at risk of being absorbed by industries. Despite fueling radical innovation, substitution risks somewhat minimize the institution of learning innovation performance. Consistent results were reported by Ferraris et al. (2019), who investigated whether global R&D partnerships increased the innovation performance of companies using a sample of 112 medium-sized tech firms engaged in R&D global partnerships. Contrary to Kobarg et al. (2018) findings, Ferraris et al. (2019) found that global R&D partnerships enhanced companies' innovative processes and performance. Regarding higher education institutions, R&D global partnerships and investments indirectly stimulated innovation performance. Other researchers in the current literature have evidenced the impacts of R&D investment on firm and university innovation performance. Extending the research conducted by Ferraris et al. (2019), Apa et al. (2021) investigated the impacts of university-SME collaboration on innovation performance in Italy and the United States. Analyzing data collected from 179 SMEs and universities, the collaboration between SMEs and universities has increased the institutions of learning technology and innovation performance. Apa et al. (2021) established that as a result of partnerships, universities increased their financial and resource investments in innovation and technology research. Apa et al. (2021) findings were reiterated by Gimenez-Fernandez et al. (2020), who investigated the differences in innovation performance between old and new firms. Though not clearly illustrated, Gimenez-Fernandez et al. (2020) reported that new startups partnering with universities reported improved innovation performance compared to old startups. Thus, across the reviewed literature, limited studies have evidenced that though universities risk being absorbed by R&D investments, partnering with R&D has improved their innovation and technological performance though more research is warranted. According to Chen et al. (2022) the relationship between R&D expenditures and innovation performance has been carefully examined based on empirical evidence, Hall et al. (2013); (Huňady & Orviská) reported R&D is strongly correlated with innovation Savrul and Incekara (2015) also indicated R&D expenditure is a significant promoter of innovation performance; Pegkas et al. (2019) that higher education R&D has a positive and significant effect on innovation as well, thus there are strong empirical support from the literature for the **First hypothesis** that there is a significant positive relationship between R&D investment (sensing) and innovation performance of technology transfer in the research universities. Outside of research universities, a variety of studies on knowledge and innovation have focused on micro, meso, or macro levels of innovation performance. As hypothesized by Frenz et al (2009), spending on internal research and development is favorably correlated with innovation performance. Frenz summed up his findings by claiming that internal R&D expenditure, purchased R&D, and intra-company knowledge transfers are significant in understanding innovation performance, he utilized the data which consisted of 786 enterprises in the panel (Frenz & Ietto-Gillies, 2009). This study examined 206 Korean biotechnology companies and their strategic affiliations for a total of 292 research and development efforts. Similar to Frenz et al. (2009), Zhu (2022) discovers that increasing government investment in research and development (R&D) can boost innovation performance during this period, and that organizational proximity and geographic proximity have a moderately positive effect on the relationship between R&D investment and innovation performance (Zhu & Xu, 2022). Bednář and Halásková (2018) also investigated R&D expenditures and innovation performance of firms and learning institutions in Western Europe. Despite limited investments in innovation activities, R&D expenditures have proved critical in improving innovation performance and technological cooperation between firms and institutions of higher learning across western Europe. Comparable findings were reported by Zhang and Tang (2018) and 2019, who investigated the impacts of R&D diversity investments on innovation performance with a focus on the nano-biopharmaceutical field. However, the relationship between R&D investment and performance innovation of technology transfer within research institutions of USA utilizing AUTM (2020) longitudinal data of more than a decade has not been explored prior to this study. Using longitudinal data to build an R&D plan with the requisite clarity, agility, and commitment to achieve the university's objectives, I anticipate identifying a positive relationship that is clear and backed by the literature. Instead of serving as the innovation engine of the institution, R&D becomes disconnected from the corporate world, detachable from market trends, and out of sync with commercial speed, resulting in very little return on investment for the university.

In summary, hypothesis one states there is a significant relationship between R&D investment (sensing) and performance of technology transfer in the universities, while controlling for size, locale, age, region, ranking and admission rate. It is justified based on the literature review above indicating R&D investment is considered as a critical driver of innovation performance in higher education sector through technology transfer activities. However, there might be other factors beyond the control variables that can influence the innovation performance, which is measured by the Licensing income, Startups formed, new patent applications, invention disclosures, and number of Licenses and Options.

H1: Research universities' sensing capabilities have a positive relationship with innovation performance.

2.3.2 - Hypothesis Two

IV- Seizing - Institutional Environment and Management Strategy

The management's strategy and the environment within the institution of higher learning influence the innovation performance of the learning institution. Researchers have demonstrated that institutional support promotes innovation performance (Cunningham et al., 2019; Findler et al., 2019; Klofsten et al., 2019). Cunningham et al. (2019) investigated how university policies on technology influenced regional innovation and entrepreneurship. The results indicated that institutional policies that advocated for technology transfers and technology sharing improved the innovative performance of the institution. Reviewing the findings of 32 studies published between 2005 and 2017 on the impacts of higher education on sustainable development, Findler et al. (2019) reiterated that supporting sustainable development improved the university's investments in technology and innovative performance. Sustainable development is achieved through improved innovation performance proliferated by favorable institutional policies and effective management strategies. As illustrated, institutional policies characterized by the internal and external environment impact innovation performance, Klofsten et al. (2019) extended Findler et al. (2019) research by investigating entrepreneurship as an economic driver and social change for universities. However, Klofsten et al. (2019) found that entrepreneurial policies to empower and influence innovation and technological performance, poor leadership, and strategic challenges negatively influenced the university's innovation performance and entrepreneurial action. Systematically reviewing and reporting the outcome of 485 peer-reviewed studies on institutional innovation, AlMalki and Durugbo (2022) found that policy-driven interventions and experiential learning led to the development of a multi-level management model that improves innovation performance. Thus, research has evidenced that favorable institutional policies and effective strategic management foster technology and innovative performance. Similarly, poor institutional policies and strategic management challenges, as illustrated by Klofsten et al. (2019), negatively influence innovation performance. Universities are granted funds to conduct R&D from various resources, therefore need the ability to build the dynamic capabilities to be able to effectively utilize the resources to promote the innovation performance through technology transfer. in 1908. The University of Wisconsin–Madison established a technology-transfer office in 1925 in order to publicize the finding of scientist Harry Steenbock that irradiating food to boost vitamin D could treat rickets. Steenbock paid his own patent expenses of $300. When Quaker Oats offered him $1 million for his innovation, Steenbock collaborated with university administration to establish a revenue-generating office for the university. The office licensed Steenbock's invention to Quaker Oats in 1927, resulting in the creation of vitamin D-enriched breakfast cereal (Wapner, 2016). Much of the literature focuses on the TTO's role, assessment measurement and performance, organizational structure, and model. However, there is scant evidence in the literature for TTO as a measurement of institutional environment and management strategy for innovative performance in technology transfer. According to Pujotomo (2020), the authors who were active in the TTO articles between 2000 and May 2020 are shown in figure below (Pujotomo, 2020)

Figure 3 – Articles related to Technology Transfer Office published between 2000

Since the University management decides on the structure of Technology Transfer

No	Topic/group	Article	Total Article
1	Role of TTO	(Abbas et al., 2018; Beltran et al., 2020; Berbegal-Mirabent et al., 2012; Bolzani et al., 2020; A Huyghe et al., 2014; Link, 2000; (Macho-Stadler et al., 2007); Martín-Rubio & Andina, 2016; Mohammed et al., 2018; Villani et al., 2017; Bigliardi et al., 2015; Chapple et al., 2005; Chugh, 2013; De Beer et al., 2017; Holgersson & Aaboen, 2019; Lafuente & Berbegal-Mirabent, 2019; Olaya-Escobar et al., 2020; Rahim et al., 2019; G Secundo et al., 2019; Giustina Secundo et al., 2017; Stephan, 2001; Ustundag et al., 2011; Weckowska, 2015)	23
2	Assessment, Measurement, and Performance of TTO	(Cartaxo & Godinho, 2017; Chapple et al., 2005; De Beer et al., 2017; Lafuente & Berbegal-Mirabent, 2019; Olaya-Escobar et al., 2020; G Secundo et al., 2019; Battaglia et al., 2017; Chakroun, 2017; Curi et al., 2015; Haney & Cohn, 2004; Link & Siegel, 2005; Marques et al., 2019; D S Siegel et al., 2003; Silva et al., 2018; Stuart J. Smyth et al., 2016; Soares et al., 2020; Stankevičienė et al., 2017; Tornatzky, 2001; Troshani et al., 2011; Tseng & Raudensky, 2014)	20
3	Organizational Structure of TTO	(Alexander & Martin, 2013; Battaglia et al., 2017; Brescia et al., 2016; Chakroun, 2017; Hülsbeck et al., 2013; Link & Siegel, 2005; Sengupta & Ray, 2017; Troshani et al., 2011; Zheng et al., 2013)	9
4	Collaboration Form	(Anderson, 2007; Blankesteijn et al., 2020; Fadeyi et al., 2019; Lissoni, 2012; Mowery & Sampat, 2004; Sellenthin, 2009; Senoo et al., 2009; Shane et al., 2015)	8
5	Model of TTO	(Andrade et al., 2017; Andreev et al., 2016; Baglieri et al., 2018; Feng et al., 2012; Olcay & Bulu, 2016; Poyago-Theotoky, 2009; Sierra et al., 2017)	7
6	Commercializat ion	(Bengtsson, 2017; Geoghegan et al., 2015; Hoye & Pries, 2009; Pitsakis & Giachetti, 2019; Donald S Siegel et al., 2007; Viana et al., 2018)	6
7	Knowledge Transfer	(Alavi & Habek, 2016; Cesaroni & Piccaluga, 2016; Hidalgo & Albors, 2011; Pinto & Fernández-Esquinas, 2018; Sharifi et al., 2014; D S Siegel et al., 2001)	6
8	Others	(Closs et al., 2012; Derrick, 2015; Fai et al., 2018; Fitzgerald & Cunningham, 2016; Annelore Huyghe et al., 2016; Meysman et al., 2019; Muscio, 2010; Xu et al., 2011)	8

Office, and the size of the office, I propose **second hypothesis** in this study that there is a significant relationship between the seizing dynamic capabilities and innovation performance of technology transfer in research universities. The literature study reveals that age and size of technology transfer offices (TTOs) have been utilized to evaluate the success of TTOs, but not the innovation performance of research universities. Since creating and staffing a technology transfer office to promote commercialization activities for innovation performance is dependent of the management strategy and institutional environment as mentioned in Wapner (2016), I anticipate discovering a correlation between the office's size and its age with innovation performance.

In summary, H2: Research universities' seizing capabilities have a positive relationship with innovation performance. Seizing capabilities can facilitate the conversion of research output into innovation performance in the form of licensing income, startups launched, new patent applications, invention disclosures, and the number of licenses and options. However, it may be challenging to directly measure seizing capabilities, and the data available may be subject to measurement errors. In addition, independent variable innovation performance is being measured by the Licensing income, Startups formed, new patent applications, invention disclosures, and number of Licenses and Options provide a comprehensive view of an organization's innovation capabilities and its ability to translate research and development activities into viable business opportunities.

H2: Research universities' seizing capabilities have a positive relationship with innovation performance.

2.3.3 - Hypothesis Three

IV – Reconfiguration- Intellectual Capital

Human capital, a critical asset in research universities is used interchangeably as intellectual capital in this paper. The capacity of a company's dynamic capabilities to reconfigure and modify organizational processes, as well as its capacity to successfully generate and build positioning assets and guard them against imitation, are the factors that determine the strategic posture of the company (Teece et al., 1997; Tushman & O'Reilly, 1996). In higher education, intellectual capital has enhanced innovation development and performance. Cricelli et al. (2018) investigated intellectual capital and university performance in developing countries. Employing quantitative research, Cricelli et al. (2018) analyzed five variables evidencing the relationship between intellectual performance and innovation performance, including innovation, research, and education. The results indicated that intellectual capital positively correlates with the university's performance, especially in research and innovation. Tseng et al. (2020) reported consistent results and investigated the factors influencing collaboration between intellectual capital and university innovation performance using a sample of three universities in Taiwan. The results revealed that universities that partnered with the government and other technology industries received funding and human resources training that furthered their innovative capabilities. In a systematic review of 45 publications, Alvino et al. (2021) investigated intellectual capital and sustainable development. The analysis of the 45 publications revealed that intellectual capital stimulated the university's sustainable development, especially with innovation and technological development. Thus, researchers have evidence that universities and organizations with intellectual capital recorded improved performance in technology and innovation. In the literature, human capital and intellectual are used interchangeably. Reviewing the research on the relationship between intellectual capital and innovation performance revealed that the availability of intellectual capital favorably impacted the innovation performance of higher education. Alrowwad et al. (2020) demonstrated that intellectual capital encouraged innovation and mediated between transformational and transactional leadership, noting that institutions with well-developed intellectual capital recorded improved innovation performance. Additional evidence was reported by Visvizi et al. (2020), who demonstrated that the future of innovation in institutions of learning was dependent on the institution's intellectual capital. Investment in intellectual capital positively relates to innovation performance. Besides the relationship, researchers have also sought to investigate how intellectual capital impacts innovation performance.

The impacts of intellectual capital on innovation performance in universities have received limited attention, with existing findings demonstrating that intellectual capital positively impacts institutions' innovation performance. Wendra et al. (2019) used a sample of 297 SMEs operating near learning institutions to investigate the relationship between intellectual capital, dynamic capabilities, and innovation performance. The analysis of the collected data revealed that it partially mediated the impacts of dynamic capabilities on innovation performance. Secundo et al. (2020) reviewed the outcome of 51 peer-reviewed articles on technology policies, sustainable development, and intellectual capital. In organizations and institutions of learning, intellectual capital is critical in innovation performance and sustainable development. Thus, with developed intellectual capital, institutions developed policies that support innovation. Ali et al. (2021), using a sample of 364 participants, investigated dynamic capabilities, innovation performance, and intellectual capital. Ali et al. (2021) reiterated that intellectual capital enhanced innovativeness and innovation performance. Researchers have shown that intellectual capital has an impact on innovation performance by influencing the integration, development, and re-alignment of policies to support innovativeness and, as a result, improve the innovation and technology performance of institutions. Research has demonstrated that intellectual capital, defined as intangible assets, including human capital that an organization can use to generate income and improve its economic performance, influences higher education innovation performance. Hejazi et al. (2018) quantitatively investigated the role of intellectual capital in creating innovation in computer units and health information technology. Using questionnaire data completed by staff and members of 10 medical centers, intellectual capital was found to predict the levels of innovation and medical centers' embrace and incorporation of health information technology and computer units in their care delivery. Moreover, besides encouraging the digitization of health records, intellectual capital helped identify factors influencing innovation in organizations. In quantitative research, Allwood (2012) used data from 298 participants to investigate the relationship between intellectual performance and innovation performance. The results indicated that intellectual capital positively influenced organizational innovation and performance This evidence was found across all the studies that were reviewed. Since the human capital refers to the individual capabilities of researchers in this case; therefore, the number of publications is used to quantify the variable in this study, which is adapted from (McClure & Titus, 2018). In the development of this hypothesis I use the (Teodorescu, 2000)'s definition of research productivity, provided on page 206, however, instead of self-reported number of journal articles, I use Web of Science data. The **third hypothesis** states that there is significant relations between reconfiguring and innovation performance of technology transfer in the universities. The effects of intellectual capital on the innovation performance of universities have received scant attention, even though existing research indicates that intellectual capital has a beneficial effect on the innovation performance of institutions, it isn't measured by the faculty publications. The publications by universities' skilled staff, research faculty, is used as a measure of intellectual capital or human capital, with the expectation that they serve as an indicator of future innovative performance. To make it an organization level analysis I use number of publications by the university as a measure. The number of publications represents a university's research output, which can have far-reaching effects on the scientific community and society. While citation metrics indicate the effect of individual articles, they may not convey a university's full research contribution. Citation metrics may not adequately reflect the importance of early-stage research, which may not have had sufficient time to accumulate citations. By emphasizing the quantity of publications, colleges can demonstrate their dedication to cutting-edge research and innovation. Reconfiguring capabilities allow universities to effectively utilize their intellectual capital and optimize their internal operations, leading to higher levels of innovation performance, thus it justifies being able to use number of publications as a measure as a measure of innovation performance resulting in

H3: Universities' reconfiguring capabilities have a positive relationship with innovation performance.

2.3.4 - Hypothesis Four

MV - Carnegie Classification

The Carnegie classification, also known as the Carnegie classification of higher education institutions, describes a classification framework used in the United States to classify colleges and universities. The classification framework was developed in 1970 to advance teaching. Primarily, the Carnegie classification is designed for research and educational purposes to identify important groups in learning institutions that can be compared easily. Borden and McCormick (2020) stated that the basic classification of learning institutions included all academic centers recognized by the National Center for Education Statistics and all colleges and universities that have been accredited to offer degree programs in the United States. Though tedious and controversial, ranking universities in the United States has often adhered to the guidelines presented by Carnegie classification systems. Kosar and Scott (2018) examined the application of the Carnegie classification framework to classify research universities in the United States. The Carnegie classification only uses publicly available data to assign universities one of three classes, R1, R2, and R3, illustrating the extent of research activities engaged by institutions, with R1 demonstrating the highest research activities, R2 representing higher research activities, and R3 accounting for moderate research activities Education (2022) . Additional findings were reported by Saltmarsh and Johnson (2020), who investigated elective Carnegie classification for community engagement. Analyzing data collected from 359 campuses in the United States, Saltmarsh and Johnson (2020) found that besides helping campuses to change, Carnegie classification helped campuses engage with community members and academic design cultures, structures, policies, and practices that would improve the ranking and performance of universities Saltmarsh and Johnson (2020). Carnegie classification classifies universities in the United States based on the levels of research activities and thus its important application in understanding innovation performance in higher education. Borden and McCormick (2020); (Education, 2022) classified the performance of institutions using Carnegie classification systems. Borden et al. (2018) agreed that the classification of tertiary institutions is highly dynamic and as such, institutions pursue diversity and different objectives; different classification systems, including the Carnegie system, have been crucial in the multifaceted assessment of the performance of tertiary institutions based on the quality of research outcomes and flexibility. Comparable results were reported by other researchers Toldson (2018) who investigated why historically black universities and colleges graduated more black baccalaureate students who further earned doctorate degrees in science. Like Borden et al. (2018), Toldson (2018) demonstrated that admission flexibility and diversity influenced the high graduation rates from historically black universities and colleges. The decision to pursue STEM courses after baccalaureate impacted research activities in schools of choice. Thus, Carnegie's classification influences the choice of learning institution based on diversity and levels of research activities that characterize innovation performance.

Carnegie's classification by assessing the research activity of different institutions allows the researcher to use the same criteria in assessing the institution's performance. Borden and McCormick (2020) investigated whether classification systems could be used to assess the performance of an institution meaningfully. The review of 32 peer-reviewed articles revealed that diversity in the missions of different classification systems is crucial in broadening societal goals to enhance learners' diversity at particular teaching institutions. Borden and McCormick (2020) asserted that a diverse population of learners enhanced scientific growth, and professional and technological development was critical in addressing different societal issues. Concerning innovation performance, Borden and McCormick (2020) suggested that stimulating professional and technological developments through diversity positively influenced the institution's innovation performance. Extending the research conducted by Borden and McCormick (2019), Harris (2020) studied institutional diversity in universities and colleges in the United States, analyzing qualitative data from six institutions, it was established that diversifying the higher education population enhances the classification of learning institutions and innovation performance and administrative decision-making in higher education. Crisp et al. (2019) reported consistent results and investigated how to differentiate four-year broad institutions in the United States. A descriptive analysis of the collected data revealed that four-year broad-access institutions positively influence post-secondary education opportunities. The descriptive analysis results revealed that Carnegie's classification framework advocated for inclusivity, which influenced heterogeneity and performance. Across the reviewed studies, researchers have demonstrated that Carnegie classification promotes diversity during classification, which influences the performance of classified institutions technologically and professionally. Carnegie classification influences institutional performance, and thus the intention of researchers to investigate how Carnegie classification influences innovation performance in higher education. While published literature on Carnegie classification and innovation performance in higher education is scarce, McClure and Titus (2018) investigated whether shifting the ranks of universities in the Carnegie classification system influenced administrative costs and performance. Collecting and analyzing quantitative data from a sample of 164 public research institutions, the results revealed that shifting the status of a university to a research status shifted its administrative spending and public financing. McClure and Titus (2018) did not investigate performance, but the results suggest that increased spending for research institutions would also influence technological development and innovation performance. Researchers have demonstrated that increased spending for research universities positively influenced innovation investments and performance.

Funding for universities influences their performance. Supporting the research conducted by (Lepori et al., 2019); McClure and Titus (2018) compared university performance in Europe and the U.S. Using data retrieved from 564 universities from Europe and 366 universities in the U.S. The analysis of the collection revealed that universities in the United States received more resources that positively influenced their technological investments and, thus, innovation performance. Consistent results were reported Lancho-Barrantes and Cantu-Ortiz (2021), who investigated quantifying publications of leading research universities. Adopting a quantitative research methodology, the results indicated that universities with the highest publications were considered innovative and technologically advanced. Comparing the results reported by Lancho-Barrantes and Cantu-Ortiz (2021) and Lepori et al. (2019), it was evident that resource availability and classification of universities as research institutions enhanced their innovation performance to meet the demands for scientific innovations. Moreover, the number of top publications by the universities could also be used to measure the levels of innovation performance. Carnegie's classification has impacted the university's preparation of students. McCormick and Borden (2018) demonstrated that classifying higher institutions as research institutions allowed stakeholders to develop a curriculum that prepared students for the labor market. Extending the research conducted by Borden and McCormick (2020), Ter Beek et al. (2022) investigated the need to prepare students for the labor market as the principal role of higher education. Using a sample of 29 information technology lecturers, the results indicated that developing the student's innovation competencies, knowledge, skills, and experience with information technology prepared them for the highly digitized labor market. Similar results were reported by (Gulden et al., 2020). In previous research, Gulden et al. (2020) conducted an exploratory review of the literature on the quality management of universities and the role of innovation on institutionalism. The results indicated that quality management led to quality education while institutionalism and diversity positively influenced innovation and technological performance. Overall, quality education and innovation performance equip students with the knowledge needed for the labor market. The **fourth hypothesis** is Carnegie classification significantly moderate the relationship between the independent variable of sensing, seizing, reconfiguring and the dependent variable of innovation performance of technology transfer. The Carnegie classification assigns universities to one of three classifications, R1, R2, or R3, based only on publicly accessible data, with R1 reflecting the greatest level of research activity, R2 representing greater research activities, and R3 representing moderate research activities (Education, 2022). One of the main reason I chose the Carnegie classification as a measure because of the suitability ranking for research performic improvement in (Vernon et al., 2018)'s literature review. According to his published article on page 11 Carnegie classification had more transparency in the calculation methodology, and raw institutional data availability. The process of ranking is replicable, and it there is an empirical data supporting it (Vernon et al., 2018). It is vital to consider the various types of institutions of higher education. There are numerous classifications by which scientists organize institutions of higher education. The Carnegie categorization of higher education institutions is one of the classifications. I apply the R1 and R2 categories in the assumption that the higher the study ranking, the stronger the moderation between independent and dependent variables. According to the Carnegie Classification, their rankings are not meant to measure research performance (Vernon et al., 2018). The objective is to determine if the ranking/type of Carnegie classification successfully moderates innovation performance to dynamic capability dimensions.

In summary, H4 states that the relationship between the dynamic capabilities' dimensions and innovation performance is moderated by the Carnegie classification. Specifically, with the R1 universities' innovation performance is higher. The justification being R1 universities have a greater research focus and receive more federal funding, which may allow them to leverage their dynamic capabilities more effectively for innovation performance. Research focus, R1 universities place a strong emphasis on research and innovation as part of their mission (Ranga & Etzkowitz, 2013); Rothaermel et al. (2007) In a study published in the Journal of Business Venturing, Etzkowitz (2003) suggests that the Triple Helix model of university-industry-government relations drives innovation in R1 universities by creating a synergistic environment Etzkowitz (2003). Additionally, Rothaermel (2015), in a study published in the Strategic Management Journal, highlights the importance of an institution's research orientation and entrepreneurial culture in driving innovation performance. Overall, the evidence implies that R1 universities are better placed to leverage their dynamic capabilities for innovative performance as a result of their increased emphasis on research and federal funding. This demonstrates the significance of institutional criteria, such as Carnegie classification, when analyzing the relationship between dynamic capabilities and innovation success in the context of universities, thus,

H4: The relationship between the dynamic capabilities' dimensions and innovation performance is be moderated by the Carnegie classification. Specifically, universities with R1 research classification, the innovation performance is higher. .

2.3.5 - Hypothesis Five

MV - Type of Institution

The majority of research universities in the United States can be divided into two categories based on their financing sources. Regional and local governments establish, operate, and provide financial support for public institutions. The other institution is a private university supported by private funds and controlled by trustees (Fischer et al., 2004). Public universities have played a crucial role in the creation of several regional businesses and technical competences, despite the erroneous historical perception that academic research is primarily fundamental and unaffected by regional imperatives(Hegde, 2005). The **fifth hypothesis** asserts that private and public institution types affect the relationship between the independent variables of sensing, seizing, and reconfiguring and the dependent variable of innovative performance in technology transfer. Private universities are indeed distinct from public research universities. In the United States, private research institutes evaluate their R&D and innovation performance differently than public institutions, resulting in a more diverse performance, Consequently, it intriguing to investigate the moderating effect on the dependent and independent variables. State governments have long had some influence over the resources and research of public universities. This is apparent in the public colleges' customary sensitivity to local industry and technological missions. However, among other changes during the past three decades, the governments' concentration on technology-based economic growth has led to a renewed commitment of public university research to regional objectives (Feller, 1997; Hegde, 2005). According to Hegde (2005), public universities tend to engage in poorer quality research and develop inventions with less effect than private universities on average (Hegde, 2005). There is very little research as to why one should use type of institution as a moderator, however, Perry et al., 2022 used Carnegie Classification and institutional ownership as control variables. Other than the research, there are other differences based on the institutional ownership, public vs private, such as graduate rates tend to be higher in private compared to public universities, and for the annual cost of attendance as well as public vs private funding business model (Perry et al., 2022). Another study unrelated to performance innovation, mentioned in (Montgomery & Montgomery, 2012)'s published article found evidence of use of institution type of private vs. public while evaluating graduate rate between black and white students. H5: The relationship between the dynamic capabilities' dimensions and innovation performance is moderated by the type of universities. There are numerous reasons why the type of university might successfully moderate the relationship between dynamic capability dimensions and innovation performance. Public and private universities have diverse objectives, resources, and institutional environments that influence their innovation activities and the impact of dynamic capabilities on their innovation performance. The following considerations justify the role of university type as a moderator, deciding whether each dynamic capability is strengthened or weakened:

Public universities receive significantly greater government financing than private universities, allowing them to invest in long-term R&D projects (Zhou & Etzkowitz, 2017). This resource availability could increase the correlation between public university R&D spending and innovation performance. Another reason could be that the Public universities typically engage in a greater number of collaborations with other universities, research institutes, and enterprises, thereby increasing the institutional climate for innovation (Ranga & Etzkowitz, 2013). This larger network may increase the impact of management strategy on innovation performance at public universities. In conclusion, the type of university, notably public versus private, can effectively moderate the relationship between the characteristics of dynamic capabilities and innovation performance. Public universities frequently have diverse resources, aims, and institutional contexts, which might influence the degree and direction of the correlation between dynamic capabilities and innovative success thus I propose the following hypothesis

H5: The relationship between the dynamic capabilities' dimensions and innovation performance is moderated by the type of universities. Specifically, public universities, the innovation performance will be higher.

CHAPTER 3: METHODOLOGY

This dissertation investigates the role of dynamic capabilities in achieving innovation performance through technology transfer. Dynamic capabilities (DCs) are independent variables in this study which include R&D investment (sensing), institutional environment/management strategy (seizing), and intellectual capital (reconfigure). Dynamic capabilities are an organization's (or institution's) ability to integrate, construct, and reconfigure internal and external skills in response to quickly changing circumstances (Leih & Teece, 2016; Teece et al., 1997). The institution size, age, location, region, rank, and admission rate served as controls for all hypotheses. Moreover, the dependent variable, innovation performance, is measured composite of licensing income, number of startups formed, number of new patent applications, number invention disclosures, and the number of licenses and options. The third chapter provides an overview of the study's methodology. This summary covers the study's design, population, sampling process, sample size, instruments, and data analysis strategies. Also described are ethical considerations and study constraints.

3.1 - Research Design

The study proposes using a quantitative research methodology for analyzing data obtained from (AUTM, 2020)'s annual survey. Further, the unit of analysis for the model to be tested is organization-level. I conduct a non-experimental quantitative study with a correlational design to see if there are any relationships between the dynamic capabilities variables of R&D investment (sensing), institutional environment/management strategy (seizing), and intellectual capital (reconfigure) and the innovation performance variables, composite of revenue, total number of licenses and options executed, number of startups formed, number of patent applications, and total number of patent applications.

A nonexperimental quantitative methodology with a correlational design is best suitable for this study because it begins with the analysis of numerical data to test theories (McCusker (McCusker & Gunaydin, 2015). Second, the choice of a nonexperimental quantitative approach with a correlational design assures research objectivity by separating the researcher from the research subjects (McCusker & Gunaydin, 2015). Third, there is no manipulation of independent variables; hence, this study employs a correlational quantitative method that is nonexperimental (McCusker & Gunaydin, 2015). In addition, a nonexperimental quantitative method with a correlational design is appropriate for this study because the purpose is to find and analyze the link between the dependent and independent variables.

A quantitative research approach employs numerical data that enables statistical analysis, reduces biases, and is founded on the paradigm of objectivity (Bowers, 2017). Multiple regression analysis is used to predict a continuous dependent variable, innovation performance, based on independent variables, R&D investment (sensing), institutional environment/management strategy measured by the Technology Transfer Office Size & Age (sizing), and intellectual capital (reconfiguring) (Field, 2018). In addition, multiple regression analysis determines the overall fit and the contribution of each predictor to the total variance explained (Field, 2013). Quantitative research measures consist of statistical, mathematical, or numerical assessments of data acquired by questionnaires and surveys, or by manipulating pre-existing statistical data using computing techniques. The lack of a focus on examining a phenomenon or developing a theory, model, or definition precludes the use of a qualitative methodology in this study(Allwood, 2012). Due to the nature of the hypotheses, multiple regression was the most appropriate method for analyzing the data in this study. In summary, the study design used in this research is a quantitative correlational study that involves the use of regression analysis to examine the relationship between dynamic capabilities and innovation performance in technology transfer. The research design aims to identify the factors that affect innovation performance and their impact on the dependent variable, innovation performance.

3.2 – Variable Description

In this section, I describe and operationalize the variables used in the non-experimental quantitative study with a correlational design to investigate the relationships between dynamic capabilities variables and innovation performance variables. The study's control variables, dependent variables, independent variables, and moderators are described , and operationalized as follows.

3.2.1 - Dependent Variable

The dependent variable is innovation performance. This study measures it by the composite of licensing income, number of startups formed, number of new patent applications, number invention disclosures, and the number of licenses and options, which is unique to this study The data for innovation performance is sourced from the Association of University Technology Managers (AUTM). Innovation performance, the dependent variable, is evaluated using a composite measure that comprises five essential dimensions: licensing income, number of new patent applications, number of invention disclosures, and number of licenses and options (Aksoy & Beaudry, 2021). Several studies published in leading business journals have used comparable technology transfer measures to evaluate innovation performance, so this comprehensive method is grounded in the existing literature as discussed in chapter 2. For instance, Siegel et al. (2003 & 2007) utilized licensing money as a metric of technology transfer performance Siegel et al. (2007), whereas Shane (2004) highlighted the importance of entrepreneurs in commercializing academic research (Shane & Duberley, 2004). In addition, Grimaldi et al. (2011) emphasized the significance of patents Grimaldi et al. (2011), Friedman and Silberman (2003) analyzed the factors that influence the frequency of invention disclosures Friedman and Silberman (2003), and Thursby and Thursby (2002) examined the relationship between university policies and licensing activities(Thursby & Thursby, 2002). The Association of University Technology Managers (AUTM), a recognized and reputable source of information on university technology transfer operations, provides data for the innovation performance measures. Using the composite of all the measures is unique to this study.

To operationalize the innovation performance variable, I used the AUTM data for licensing income, number of startups formed, number of new patent applications, number invention disclosures, and the number of licenses and options. These variables are combined to form a composite measure of innovation performance as mentioned above.

3.2.2 - Independent Variables

The study's independent variables are R&D investment (sensing), institutional environment/management strategy (seizing), and intellectual capital (reconfigure). R&D investment refers to the amount of money spent on research and development. Institutional environment/management strategy refers to the university's ability to seize opportunities and manage resources effectively. Intellectual capital refers to the university's knowledge and expertise.

To operationalize R&D investment (sensing), I used the research expenditures reported by The Integrated Postsecondary Education Data System (IPEDS, 2023)). Institutional environment/management strategy (seizing) is operationalized by using the composite of Technology Transfer Office Full-Time Equivalent (TTO FTE) and Technology

Transfer Office Age (TTO AGE) from AUTM. Intellectual capital (reconfigure) is operationalized by using the number of publications sourced from the Web of Science.

3.2.3 - Moderators

There are two moderators in this study. The first moderator is the type of institution, which refers to whether the university is public or private. This variable is sourced from IPEDS. The second moderator variable is the Carnegie classification, focused on R1 and R2. This variable also sourced from the Carnegie Classification.

To operationalize the type of institution variable, I used the IPEDS data that classifies universities as public or private. The Carnegie classification variable is operationalized by using the Carnegie Classification’s data that classifies universities as R1 or R2.

3.2.4 - Control Variables

The study’s control variables are locality, region, admission rate, ranking of universities, age, and size. Locality refers to the size of the city, suburb, town, or rural area in which the university is located. Region refers to the geographical area in which the university is situated. Admission rate refers to the percentage of applicants who are admitted to the university. Ranking of universities is a measure of the quality and reputation of the university. Age is the number of years since the university was founded, and size is the enrollment of the university. It is commonly acknowledged that innovation is a fundamental engine of economic growth, competitiveness, and social progress. By producing new information, teaching talented people, and partnering with business and government, higher education institutions play a vital role in supporting innovation (Etzkowitz & Leydesdorff, 2000). However, not all universities have the same capacity for innovation, and their performance in this area can be affected by a variety of circumstances. Using institutional controls as variables in empirical research that evaluate the relationship between innovation performance and other variables, such as dynamic capabilities, is one method I decided to study in paper. The institution's size is the first institutional control I utilize in this research paper. Larger institutions have a tendency to have more resources, research capabilities, and human capital, which can lead to greater innovation performance (Kim and Yoon, 2017; Li and Tao, 2018). For instance, a study of Chinese universities found that larger institutions had higher patenting activity and research output than smaller ones, suggesting that they have better innovation capabilities (Li and Tao, 2018). Similarly, a study of South Korean universities found that larger institutions had more research collaborations, higher funding, and more internationalization, which were positively related to innovation performance (Kim and Yoon, 2017).

Another institutional control that can influence innovation performance is the age of the HEI. Older universities tend to have more established research networks, prestige, and reputation, which can attract more funding, talented researchers, and partners, and improve innovation performance (Hsu et al., 2017; Lee and Kim, 2019). For instance, a study of Taiwanese universities found that older institutions had higher patenting activity and citation impact than younger ones, suggesting that they have stronger innovation capabilities (Lee and Kim, 2019). Similarly, a study of US universities found that older institutions had more research funding, higher quality research, and more technology transfer activity, which were positively related to innovation performance (Hsu et al., 2017).

Location and region are also important institutional controls that can affect innovation performance. HEIs located in regions with a high density of high-tech firms, or a strong entrepreneurial ecosystem tend to have more opportunities for collaboration and knowledge transfer, which can improve innovation performance (Chou et al., 2015; Gong and Liao, 2019). For example, a study of Taiwanese universities found that those located in regions with more high-tech firms had higher patenting activity, suggesting that they have better innovation capabilities (Chou et al., 2015). Similarly, a study of Chinese universities found that those located in regions with a stronger entrepreneurial ecosystem had more research collaborations and more patents, which were positively related to innovation performance (Gong and Liao, 2019).

Ranking and admission rate are additional institutional controls that can affect innovation performance. Higher-ranked universities tend to have more established research networks and resources, which can positively impact innovation performance (Chen et al., 2016; Wu and Chen, 2019). For example, a study of Taiwanese universities found that higher-ranked institutions had more research funding, more internationalization, and more patents, suggesting that they have better innovation capabilities (Chen et al., 2016). Similarly, a study of Chinese universities found that those ranked in the top 100 had more patents and higher citation impact than those ranked lower, which were positively related to innovation performance (Wu and Chen, 2019). Universities with more selective admissions tend to attract more high-achieving students and produce higher research output, which are indicators of innovation performance (Cheng and Lin, 2015; Lai and Lu, 2017). For instance, a study of Taiwanese universities found that those with.

To operationalize the locality variable, I used the Integrated Postsecondary Education Data System (IPEDS) codes for city size, suburb size, town size, and rural area size. For the region variable, I used the IPEDS codes for geographical areas of North, South, East and West. Admission rate is operationalized by using the admission rates reported by IPEDS. The ranking of universities is operationalized by using the Business Weeks' ranking of universities. Age and size is operationalized by using the data reported by IPEDS.

3.3 - Data Description

The data for this dissertation were collected from multiple sources to ensure a comprehensive analysis of the research model. Association of University Technology Managers, Inc (AUTM)'s data is one of the main sources, being utilized to measure the study variables and test the hypotheses. The Association of University Technology Managers is a nonprofit organization dedicated to bringing research to life by supporting and enhancing the global academic technology transfer profession through education, professional development, partnering and advocacy (AUTM). An online tool, STAT, was used to filter through a plethora of data on licensing activity and income, start-ups, funding, staff size, legal fees, patent applications filed, and royalties received. The data was extracted from license survey data using the criteria in Figure 3 and converted to a spreadsheet for further review. Second set, total university articles are gathered from Web of Sciences. Adopted from Aksoy and Beaudry (2021), I only use the observations that included all our variables. The data collection contains US Universities (5U) with survey years ranging from 2020 and a total of 160 universities. According to the survey of the year 2020, total research expenditures increased to $83.1 billion, a rise over 2019 and a nearly 22.8% increase over the previous five years. With nearly three-fourths of licenses and options conducted by startups and small businesses, universities are driving the innovation economy through small, entrepreneurial businesses (AUTM).

There are three independent variables which include R&D investment (sensing), institutional environment/management strategy measured through the Technology Transfer

Office Size & Age (seizing), and intellectual capital (reconfigure). R&D investment is research funding that is received from the federal government, industrial sponsors, and other sources. This variable is measured at the interval level of measurement utilizing total research expenditures variable. Institutional environment/management strategy is the University's TTO staff (size) and the age. This is measured at the interval level of measurement utilizing the TTO staff size (FTEs variable). Intellectual capital is the number of publications by university professors. I use the (Teodorescu, 2000)'s definition of research productivity, provided on page 206, however, instead of self-reported number of journal articles, I use Web of Science data.

This variable is measured at the interval level of measurement. The dependent variable of the study is innovation performance through technology transfer construct. This is measured by five indicators: Revenue, and composite of the following: total number

of licenses and options executed, number of startups formed, number of patent applications, and number if invention disclosures. These variables are measured at the interval level of measurement. In this study, there are two moderators. The Carnegie classifications R1 and R2 are employed as a moderator in this research. R1instittuions are defined by Doctoral Universities with very high research activity, and R2 as doctoral universities with high research activity (Education, 2022). The second moderator is the type of institute, with the values of public or private. Both moderators are categorical variables. Additionally, size, locale, age, region, ranking, and admission rate are the control variables.

The proposed study employ purposive sampling. Purposive sampling is a non-probability sampling technique in which the researcher relies on his or her judgment when choosing members of the population to participate in the study based on the characteristics of a population and the objective of the study (Yang & Banamah, 2014). A purposive sampling strategy was chosen for the study because participants needed to meet a specific set of inclusion criteria to be eligible to be able to participate in the study (Yang & Banamah, 2014). For this study, multiple regression with moderation analysis appears to be the most effective based on the current design. The analysis of the resulting quantitative data is conducted using the SPSS. The table below provides an overview of the variables, their definitions, and the data sources used in this study:

Variable	Description	Data Source
Independent Variables		
1. Sensing (R&D Investment)	Research expenditure for a university	AUTM Survey (2020)
2. Seizing (Institutional Environment/Management Strategy)	Institutional environment and management strategy	AUTM Survey (2020)
3. Reconfiguring (Intellectual Capital)	University publications	Web of Sciences
Control Variables		
1. Institution Size	Total number of enrolled students	IPEDS
2. Institution Age	The number of years since the university's establishment	IPEDS
3. Institution Location	The geographical location of the university	IPEDS
4. Institution Region	The region where the university is located	IPEDS
5. Institution Rank	The university's ranking	IPEDS
6. Admission Rate	The percentage of applicants admitted to the university	IPEDS
Dependent Variable		
Innovation Performance	Composite of licensing income, number of startups formed, number of new patent applications, number of invention disclosures, and the number of licenses and options	AUTM Survey (2020)
Moderators		
1. Carnegie Classification (R1/R2)	Classification of the university according to Carnegie classification (R1/R2)	Carnegie's Website
2. Type of Institution (Public/Private)	The type of university, either public or private	IPEDS

The study used regression analysis to investigate the relationship between dynamic capabilities and innovation performance in technology transfer. The data used for the analysis would be the average values of all variables for the year 2020 from the AUTM dataset. The second data set is from IPEDS providing all other variables that are not related to transfer technology activities, including control variables. The regression model would include the three dynamic capabilities (R&D investment, institutional environment/management strategy, and intellectual capital) as independent variables and the measures of innovation performance (licensing income, the number of startups formed, number of new patent applications, the number of invention disclosures, and the number of licenses and options) as dependent variables. The regression coefficients would be used to test the hypotheses and determine the strength and direction of the relationship between the independent and dependent variables. Additionally, the model includes control variables such as institution size, age, location, region, rank, and admission rate. The data for the independent variables were collected from the AUTM Survey of 2020 and the Web of Sciences. The control variables were sourced from IPEDS, while the dependent variable, innovation performance, was measured using data from the AUTM Survey of 2020. The two moderators in this study, Carnegie Classification (R1/R2) and Type of Institution (Public/Private), were obtained from Carnegie's website and IPEDS, respectively. This comprehensive dataset enables a robust analysis of the relationships between dynamic capabilities and innovation performance in research universities.

3.4 - Summary

This dissertation investigates the role of dynamic capabilities in achieving innovation performance through technology transfer. Dynamic capabilities (DCs) are independent variables in this stud which include R&D investment (sensing), institutional environment/management strategy (seizing), and intellectual capital (reconfigure). Dynamic capabilities are defined as an organization's (or institution's) ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments (Leih & Teece, 2016; Teece et al., 1997). The dependent variable of this study is innovation performance which is measured by the variable's revenue, total number licenses and options executed, number of startups formed, number of patent applications, and number if invention disclosures.

This chapter offered a thorough discussion of the quantitative correlational research design employed in this investigation. In Chapter 4, the results and conclusions of the data analysis are presented, together with tables and figures containing descriptive results and judgments regarding the underlying relationship between the research variables. The findings are then interpreted in Chapter 5, along with the limitations of the study, suggestions for further research, and implications for constructive social change.

CHAPTER 4: RESULTS

This study analyzed empirically the effects of research institutions developing dynamic capabilities through technology transfer activities to contribute to or attain innovation performance. The concept model investigated in this research article is depicted in Figure 1 below.

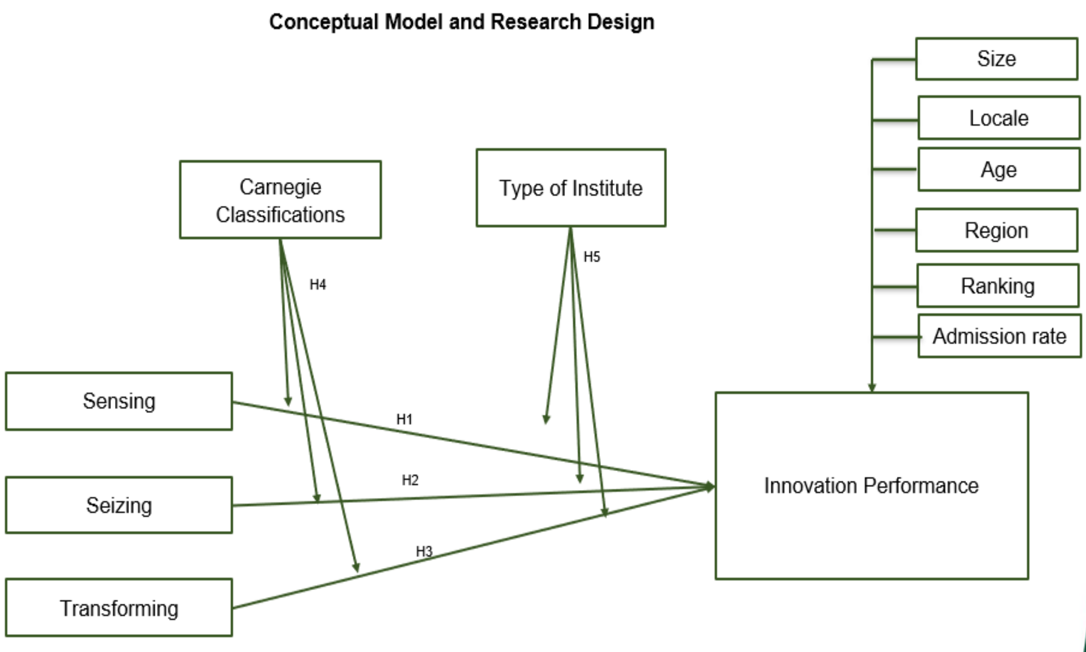


Figure 1 – Conceptual Model

The following hypotheses were tested in the study: This chapter presents the results and analysis of the quantitative research on the relationship between dynamic capabilities and innovation performance in research universities. The chapter is organized into five sections, each of which corresponds to a research hypothesis listed below.

Hypothesis
H1: Research universities' sensing capabilities have a positive relationship with innovation performance.
H2: Research universities' seizing capabilities have a positive relationship with innovation performance.
H3: Universities' reconfiguring capabilities have a positive relationship with innovation performance.
H4: The relationship between the dynamic capabilities' dimensions and innovation performance is be moderated by the Carnegie classification.
H5: The relationship between the dynamic capabilities' dimensions and innovation performance is moderated by the type of universities.

The following is a discussion of the study's population and sample as well as a demographic description of the sample. The institution size, age, location, region, rank, and admission rate served as controls for all hypotheses. Moreover, the dependent variable, innovation performance, is measured by composite of licensing income, number of startups formed, number of new patent applications, number invention disclosures, and the number of licenses and options. Also presented are the testing of parametric assumptions for the statistical analysis and the results of statistical testing. This chapter presents the results of the study that aimed to examine the relationship between research universities' dynamic capabilities and innovation performance. In particular, the study tested five hypotheses that investigated the role of sensing, seizing, and reconfiguring capabilities in promoting innovation performance, as well as the moderating effects of university type and Carnegie classification on these relationships. The analyses were conducted using SPSS, and the data collected from a sample of 160 US research universities were used to test the hypotheses.

4.1 - Data Analysis

This section describes the statistical analyses used to test the hypothesized relationships in my research model. It contains description of preliminary analysis, diagnostics tests, and necessary tests of biases. All tests were performed using SPSS statistics version 28.

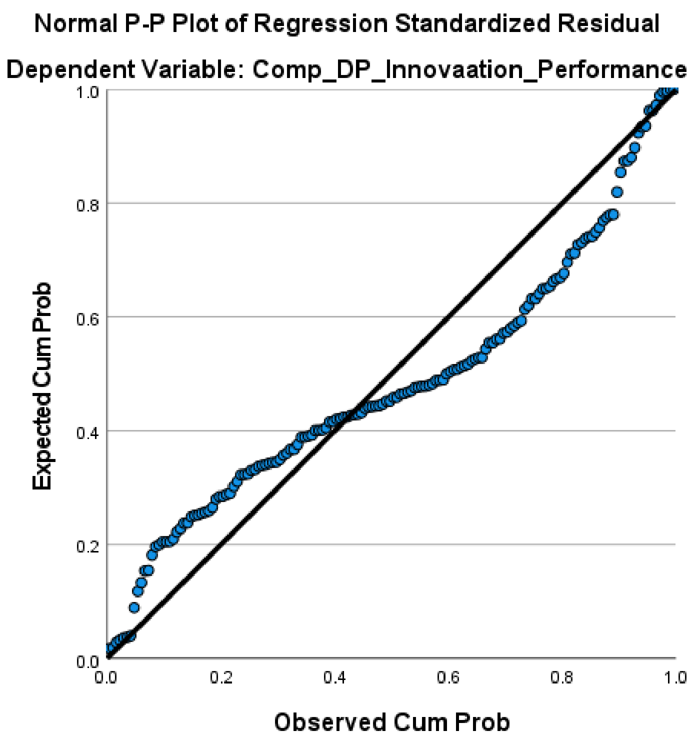
4.1.1 – Preliminary Analysis

I began importing data from multiple sources. During the data compilation process merging data from multiple sources posed several challenges. Data for independent and dependent variables was obtained from the 2020 AUTM Survey and Web of Sciences, while control variables were sourced from IPEDS. The two moderators, Carnegie Classification (R1/R2) and Type of Institution (Public/Private), were collected from Carnegie's website and IPEDS, respectively. One challenge was reconciling differences in university names across these various sources, which sometimes varied slightly. To ensure data integrity, additional research was conducted to confirm the correct alignment of universities in the dataset. Ultimately, data from 160 US-based universities was compiled for the year 2020. I examined the dataset for missing values. If missing values were present, I decided how to handle them. Options included removing rows with missing values, imputing the missing values with a suitable technique (mean, median, or mode imputation), or using advanced techniques like multiple imputation. In cases where data for 2020 was missing, previous year data (2019) was used as a substitute to maintain consistency across the dataset. This data cleaning process was essential in preparing the data for analysis and ensuring the reliability of the research findings. By addressing these challenges and replacing missing values, the final dataset allowed for a robust analysis of the relationships between dynamic capabilities and innovation performance in research universities. The dataset consisted of N = 160 educational institutions of which 110 (68.8%) were public and 50 (30.0%) were private. Two (1.3%) institutions did not have this information; thus 2019 data was used as mentioned above. Regarding Carnegie classifications, there were 104 (65.0%) R1 and 36 (22.5%) R2 types. There was no classification provided for 20 (12.5%) institutions, thus I sued the value 'Other' for these. Regarding the independent variables of the study (prior to forming a composite), the number of publications ranged from 519 to 759543 (M = 56,090.50 SD = 82,544.57); Technology Transfer Office Size ranged from 0 to 185.25 (M = 14.79, SD = 21.05); and total expenditures ranged from 0 to 7,291,419,000.00 (M = 463,528,153.48, SD = 733,198,130.82). These independent variables were standardized and combined and used in the multiple regression performed to address the study's research question. Regarding the five dimensions that comprised the dependent variable of innovation performance, gross revenue ranged from 0 to 362,712,828 (*M* = 11,953,429.77, *SD* = 34,736,219.51); the number of licenses /options ranged from 0 to 1110.09 (*M* = 54.36, *SD* = 107.65); the number of startups formed ranged from 0 to 98.0 (*M* = 6.38, *SD* = 10.01); the number of patent applications ranged from 0 to 590.0 (*M* = 47.16, *SD* = 73.90); and the number of inventions/disclosures ranged from 0 to 925.0 (*M* = 60.04, *SD* = 104.59). Table 2 provides this information. As mentioned earlier, these five dimensions were standardized, combined to form one variable, and then the mean was calculated to the single composite variable. This served as an overall measure of innovation performance.

There was no apparent pattern in the plot (non-curvilinear) which indicated no violation of the assumptions (Figure 2)

Figure 3.

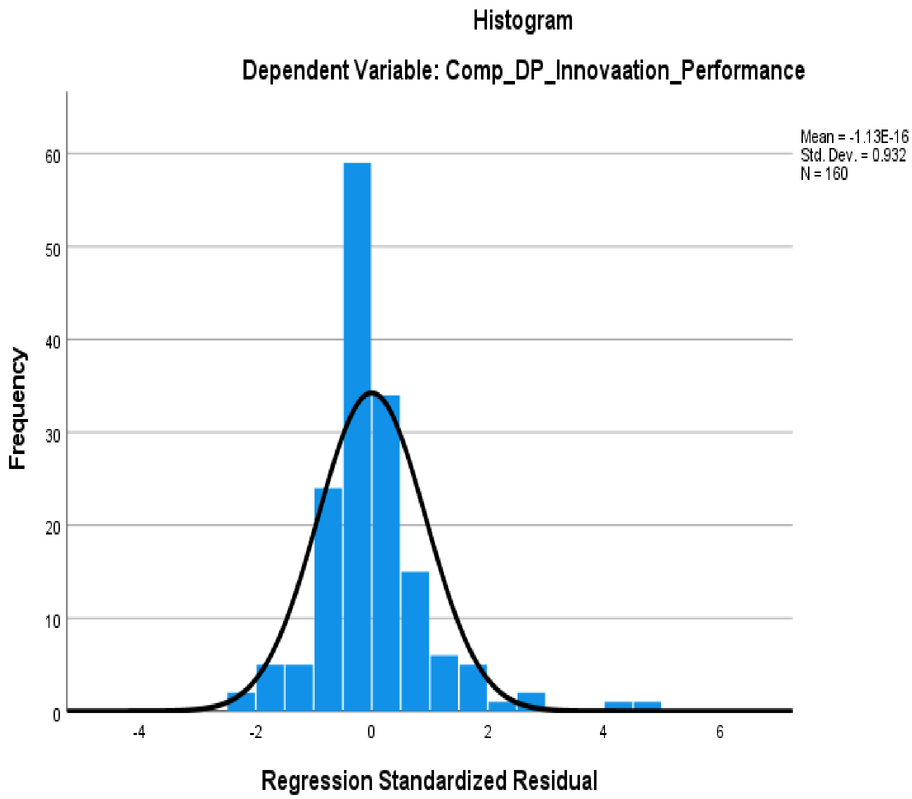
Scatter Plot of Regression Predicted Residuals versus Regression Residuals



There were no standardized residuals greater than ±3 standard deviations, thus no outliers. There was approximate normality of regression residuals as assessed through visual inspection of histograms (Figure 3).

Figure 4

Histogram of Regression Residuals



4.1.2 - Correlation Results:

After the preliminary results above, this section presents the results from testing the hypothesized relationships in my research models. It first summarizes the significant and non-significant findings from the SPSS analysis, with p-values representing the significance of the coefficients, and β (beta) representing the standardized coefficients in the table below.

Table: Summary of Significant and Non-Significant Findings

Variable	Model	Significance	Standardized Coefficient (β)
Significant Findings			
Institution size (CON_SIZE)	1	p < .001	0.384
	2	p = .040	0.109
Admission rate (CON_ADM_RATE)	1	p < .001	-0.332
No. of publications	2	p = .021	0.228
	3	p = .027	0.222
R&D investment	2	p = .002	0.328
	3	p = .002	0.329
TTO FTE age	2	p < .001	0.265
	3	p < .001	0.259
Interaction: Sensing x CC	4	p = .002	-1.025
Interaction: Reconfiguring x CC	4	p = .011	0.678
Non-Significant Findings			
Institution age (CON_AGE)	1	p = .229	0.088
Institution rank (CON_RANK)	1	p = .567	-0.046
Admission rate (CON_ADM_RATE)	2	p = .212	-0.075
Institution age (CON_AGE)	2	p = .577	0.028
Institution rank (CON_RANK)	2	p = .628	0.026
All coded variables	All	Non-Significant	N/A

4.2 - Results

A single hierarchical multiple regression was used in order to address the five hypotheses presented earlier. The independent variables can be entered into the regression equation using hierarchical multiple regression in any order the researcher chooses. This has several benefits, including (a) allowing for the control of covariate effects on the results and (b) allowing for the consideration of potential causal effects of independent variables when predicting a dependent variable. The amount of additional variation in the dependent variable that can be explained by the addition of one or more independent variables can be calculated using this procedure.

In the SPSS procedure for multiple regression, the variables were entered into four steps/blocks. The first block consisted of the pertinent control variables of size, age, ranking, admission rate, locale and region. The second block added the single independent variable of the composite of TTO office and Age. The third block then introduced the two moderators of university type public/private) and Carnegie classification (R1/R2). The fourth block introduced the two interaction terms of the two moderators with the independent variable.

Based on the regression coefficients data from SPSS below, the following analysis can be given for each model:

Model 1 (Controls Only):

The results from Model 1 suggest that institution size and admission rate are significantly associated with innovation performance, as indicated by their respective standardized coefficients of 0.384 and -0.332. Locale and region also show some association with innovation performance, with Locale 0 having the highest coefficient of 0.347 and Region 3 having the lowest coefficient of -0.224. Overall, the collinearity statistics suggest that there is low collinearity among the control variables in this model.

Model 2 (Controls + Independent Variable):

In addition to the control variables, Model 2 includes the independent variable of technological innovation capabilities, measured by Reconfiguring, Sensing, and Seizing. The results suggest that Sensing and Seizing are significantly associated with innovation performance, with standardized coefficients of 0.328 and 0.265, respectively. Reconfiguring also shows a positive association with innovation performance, although it is only marginally significant ($p = 0.021$). Notably, the inclusion of the independent variable in this model improves the overall model fit compared to Model 1.

Model 3 (Controls + Independent Variable + Moderators):

Model 3 includes all the variables in Model 2 and adds Type of Institute (Mod) and Carnegie Classification (Mod) as moderators. None of the moderators show a significant association with innovation performance. However, the inclusion of the moderators improves the overall model fit compared to Model 2.

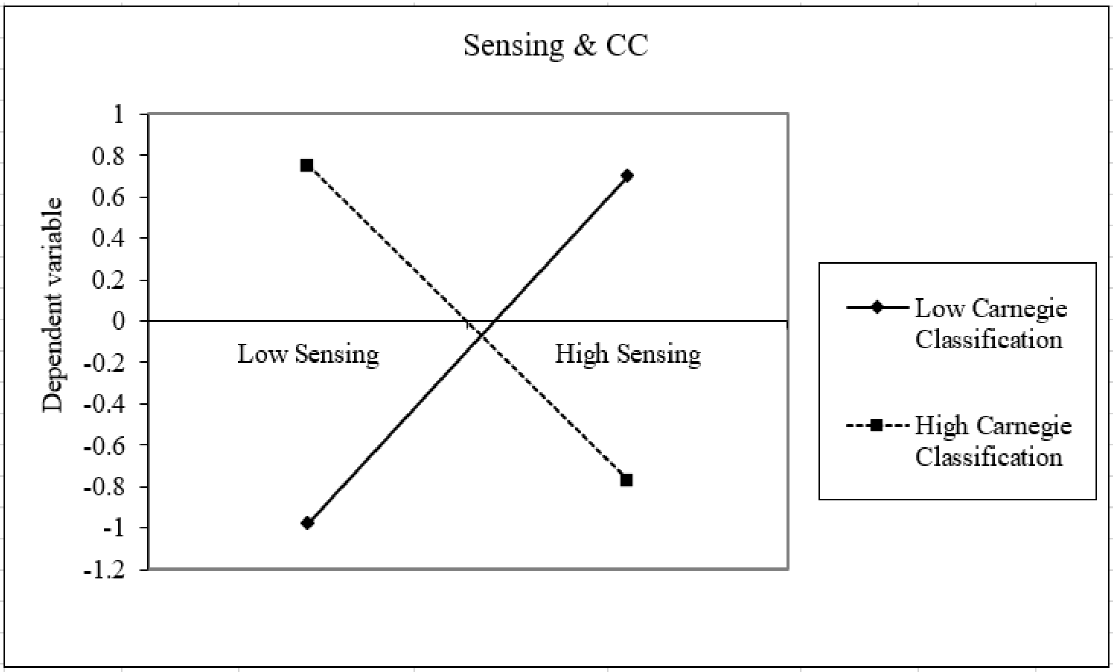
Model 4 (Controls + Independent Variable + Moderators + Interaction Terms):

Model 4 includes all the variables in Model 3 and adds interaction terms between the independent variable and each moderator variable. The results suggest that there are several significant interaction terms. Notably, the interaction between Type of Institute (Mod) and Reconfiguring is negative and significant ($p = 0.011$), indicating that the relationship between Reconfiguring and innovation performance is weaker for private institutions than for public institutions. Similarly, the interaction between Carnegie Classification (Mod) and Sensing is negative and significant ($p = 0.002$), suggesting that the relationship between Sensing and innovation performance is weaker for institutions classified as Doctoral/Research Universities compared to those classified as Master's Colleges and Universities.

Table 3 – Correlations

	Correlations																					
	Comp_DP_Innovation_Performance	Locale - 0 is coded 1	Locale 1 is coded 1	Locale 2 is coded 1	Region - 0 and 1 are coded 1	Region - 2 is coded 1	Region - 3 is coded 1	Size	Admission Rate	Age	Rank	Reconfiguring	Sensing	Seizing	Type of Institutre - Mod (PP)	Carnegie Classification - Mod (CC)	INT_PPXReconfigurining	INT_PPXSeizing	INT_PPXSensing	INT_CCXSensing	INT_CCXSeizing	INT_CCXReconfiguring
Comp_DP_Innovaation_Performance	1.000	0.149	-0.113	-0.060	0.177	-0.040	-0.137	0.303	-0.292	0.204	-0.228	0.759	0.778	0.715	0.058	0.137	0.334	0.402	0.403	0.716	0.662	0.719
Locale - 0 is coded 1	0.149	1.000	-0.835	-0.401	0.078	-0.002	-0.021	0.005	-0.197	-0.013	-0.144	0.119	0.106	0.061	0.191	-0.037	0.049	0.021	0.045	0.080	0.070	0.084
Locale 1 is coded 1	-0.113	-0.835	1.000	-0.053	-0.046	-0.030	0.096	0.036	0.246	0.034	0.150	-0.088	-0.097	-0.015	-0.225	-0.014	-0.021	-0.017	-0.021	-0.095	-0.017	-0.051
Locale 2 is coded 1	-0.060	-0.401	-0.053	1.000	-0.002	0.105	-0.092	0.039	0.113	-0.009	0.116	-0.045	-0.029	-0.063	-0.108	-0.041	-0.010	-0.008	-0.010	0.046	-0.034	0.015
Region - 0 and 1 are coded 1	0.177	0.078	-0.046	-0.002	1.000	-0.546	-0.585	-0.094	-0.146	0.145	-0.093	0.149	0.145	0.061	0.234	0.002	0.048	0.037	0.068	0.144	0.102	0.139
Region - 2 is coded 1	-0.040	-0.002	-0.030	0.105	-0.546	1.000	-0.311	0.070	0.151	-0.028	-0.013	-0.049	-0.053	0.082	-0.105	-0.036	-0.042	-0.050	-0.072	-0.061	0.059	-0.032
Region - 3 is coded 1	-0.137	-0.021	0.096	-0.092	-0.585	-0.311	1.000	0.104	0.064	-0.100	0.165	-0.107	-0.103	-0.113	-0.202	-0.050	0.007	0.009	0.009	-0.079	-0.101	-0.091
Size	0.303	0.005	0.036	0.039	-0.094	0.070	0.104	1.000	0.234	0.061	-0.014	0.249	0.252	0.296	-0.363	0.055	0.097	0.067	0.078	0.253	0.286	0.296
Admission Rate	-0.292	-0.197	0.246	0.113	-0.146	0.151	0.064	0.234	1.000	-0.200	0.420	-0.280	-0.289	-0.268	-0.730	-0.251	-0.245	-0.308	-0.279	-0.241	-0.210	-0.191
Age	0.204	-0.013	0.034	-0.009	0.145	-0.028	-0.100	0.061	-0.200	1.000	-0.129	0.255	0.118	0.200	0.182	-0.053	0.372	0.199	0.084	0.121	0.211	0.243
Rank	-0.228	-0.144	0.150	0.116	-0.093	-0.013	0.165	-0.014	0.420	-0.129	1.000	-0.237	-0.227	-0.268	-0.359	-0.463	-0.201	-0.263	-0.226	-0.119	-0.097	-0.136
Reconfiguring	0.759	0.119	-0.088	-0.045	0.149	-0.049	-0.107	0.249	-0.280	0.255	-0.237	1.000	0.865	0.680	0.058	0.130	0.510	0.351	0.304	0.802	0.594	0.944
Sensing	0.778	0.106	-0.097	-0.029	0.145	-0.053	-0.103	0.252	-0.289	0.118	-0.227	0.865	1.000	0.720	0.049	0.110	0.232	0.298	0.389	0.955	0.634	0.784
Seizing	0.715	0.061	-0.015	-0.063	0.061	0.082	-0.113	0.296	-0.268	0.200	-0.268	0.680	0.720	1.000	0.042	0.141	0.350	0.507	0.389	0.657	0.906	0.602
Type of Institutre - Mod (PP)	0.058	0.191	-0.225	-0.108	0.234	-0.105	-0.202	-0.363	-0.730	0.182	-0.359	0.058	0.049	0.042	1.000	0.162	0.095	0.074	0.093	0.026	-0.008	-0.004
Carnegie Classification - Mod (CC)	0.137	-0.037	-0.014	-0.041	0.002	-0.036	-0.050	0.055	-0.251	-0.053	-0.463	0.130	0.110	0.141	0.162	1.000	0.011	0.047	0.061	-0.085	-0.126	-0.055
INT_PPXReconfigurining	0.334	0.049	-0.021	-0.010	0.048	-0.042	0.007	0.097	-0.245	0.372	-0.201	0.510	0.232	0.350	0.095	0.011	1.000	0.689	0.595	0.214	0.316	0.492
INT_PPXSeizing	0.402	0.021	-0.017	-0.008	0.037	-0.050	0.009	0.067	-0.308	0.199	-0.263	0.351	0.298	0.507	0.074	0.047	0.689	1.000	0.766	0.282	0.481	0.322
INT_PPXSensing	0.403	0.045	-0.021	-0.010	0.068	-0.072	0.009	0.078	-0.279	0.084	-0.226	0.304	0.389	0.389	0.093	0.061	0.595	0.766	1.000	0.365	0.354	0.275
INT_CCXSensing	0.716	0.080	-0.095	0.046	0.144	-0.061	-0.079	0.253	-0.241	0.121	-0.119	0.802	0.955	0.657	0.026	-0.085	0.214	0.282	0.365	1.000	0.670	0.795
INT_CCXSeizing	0.662	0.070	-0.017	-0.034	0.102	0.059	-0.101	0.286	-0.210	0.211	-0.097	0.594	0.634	0.906	-0.008	-0.126	0.316	0.481	0.354	0.670	1.000	0.621
INT_CCXReconfiguring	0.719	0.084	-0.051	0.015	0.139	-0.032	-0.091	0.296	-0.191	0.243	-0.136	0.944	0.784	0.602	-0.004	-0.055	0.492	0.322	0.275	0.795	0.621	1.000

Note: Based on the N=160 - Innovation_Performance and Reconfiguring: $p < 0.01$, Innovation_Performance and Sensing: $p < 0.01$, Innovation_Performance and Seizing: $p < 0.01$, Type of Institute (Mod_PP) and Admission Rate: $p < 0.01$, Type of Institute (Mod_PP) and Size: $p < 0.01$, Type of Institute (Mod_PP) and Reconfiguring: $p < 0.05$, Carnegie Classification (Mod_CC) and Size: $p < 0.05$, Carnegie Classification (Mod_CC) and Seizing: $p < 0.01$, Reconfiguring and Sensing: $p < 0.01$, Reconfiguring and Seizing: $p < 0.01$


Sensing & CC
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
Dependent variable
Low Sensing
High Sensing
Low Carnegie Classification
High Carnegie Classification

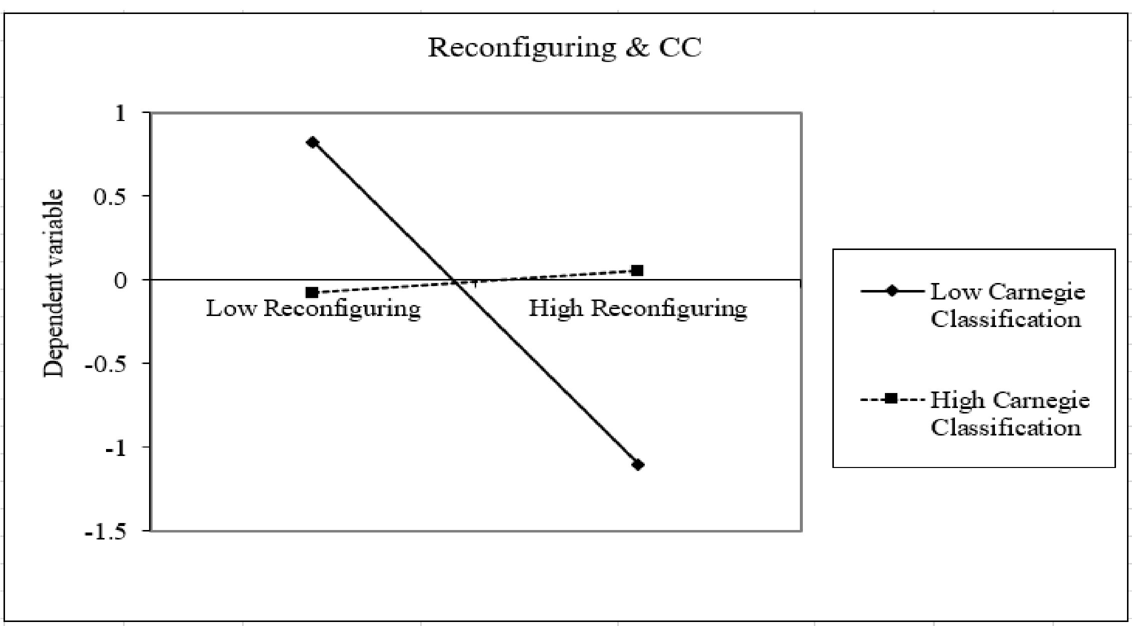

Reconfiguring & CC
1
0.5
0
-0.5
-1
-1.5
Dependent variable
Low Reconfiguring
High Reconfiguring
Low Carnegie Classification
High Carnegie Classification

Table 4 – Regression Coefficient

Table 4 - Regression Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
	(Constant)	-0.55	0.496		-1.108	0.27		
	Locale - 0 is coded 1	0.773	0.848	0.347	0.912	0.363	0.033	29.942
	Locale 1 is coded 1	0.69	0.875	0.27	0.788	0.432	0.041	24.224
	Locale 2 is coded 1	0.56	0.922	0.114	0.607	0.545	0.137	7.274
	Region - 0 and 1 are coded 1	-0.099	0.701	-0.065	-0.142	0.888	0.023	43.181
1	Region - 2 is coded 1	-0.225	0.704	-0.123	-0.32	0.749	0.033	30.337
	Region - 3 is coded 1	-0.397	0.707	-0.224	-0.561	0.576	0.03	32.892
	Size	0.296	0.057	0.384	5.168	<.001	0.874	1.144
	Admission Rate	-0.256	0.066	-0.332	-3.873	<.001	0.656	1.525
	Age	0.068	0.057	0.088	1.208	0.229	0.9	1.111
	Rank	-0.035	0.061	-0.046	-0.574	0.567	0.761	1.315
	(Constant)	-0.173	0.33		-0.525	0.601		
	Locale - 0 is coded 1	0.301	0.567	0.135	0.531	0.596	0.032	30.806
	Locale 1 is coded 1	0.187	0.584	0.073	0.321	0.749	0.04	24.808
	Locale 2 is coded 1	0.17	0.614	0.035	0.276	0.783	0.134	7.442
	Region - 0 and 1 are coded 1	-0.055	0.468	-0.036	-0.117	0.907	0.023	44.272
	Region - 2 is coded 1	-0.15	0.472	-0.082	-0.318	0.751	0.032	31.361
2	Region - 3 is coded 1	-0.185	0.472	-0.105	-0.393	0.695	0.03	33.751
	Size	0.084	0.041	0.109	2.07	0.04	0.75	1.334
	Admission Rate	-0.057	0.046	-0.075	-1.252	0.212	0.592	1.69
	Age	0.022	0.039	0.028	0.56	0.577	0.815	1.227
	Rank	0.02	0.041	0.026	0.485	0.628	0.748	1.337
	Reconfiguring	0.177	0.076	0.228	2.326	0.021	0.218	4.592
	Sensing	0.256	0.08	0.328	3.202	0.002	0.2	4.993
	Seizing	0.241	0.065	0.265	3.703	<.001	0.41	2.436
	(Constant)	-0.222	0.354		-0.626	0.532		
	Locale - 0 is coded 1	0.292	0.569	0.131	0.513	0.608	0.032	30.816
3	Locale 1 is coded 1	0.166	0.587	0.065	0.283	0.778	0.04	24.849
	Locale 2 is coded 1	0.146	0.617	0.03	0.237	0.813	0.134	7.455
	Region - 0 and 1 are coded 1	0.001	0.475	0.001	0.002	0.999	0.022	45.258

	Region - 2 is coded 1	-0.097	0.479	-0.053	-0.203	0.84	0.031	32.055
	Region - 3 is coded 1	-0.145	0.478	-0.082	-0.303	0.762	0.029	34.38
	Size	0.076	0.042	0.098	1.798	0.074	0.71	1.409
	Admission Rate	-0.082	0.061	-0.106	-1.347	0.18	0.342	2.925
	Age	0.027	0.04	0.036	0.688	0.492	0.793	1.261
	Rank	0.026	0.045	0.034	0.577	0.565	0.628	1.594
	Reconfiguring	0.172	0.077	0.222	2.242	0.027	0.216	4.622
	Sensing	0.258	0.081	0.329	3.188	0.002	0.198	5.044
	Seizing	0.236	0.066	0.259	3.601	<.001	0.408	2.454
	Type of Institutre - Mod (PP)	-0.087	0.124	-0.053	-0.7	0.485	0.376	2.663
	Carnegie Classification - Mod (CC)	0.04	0.072	0.031	0.559	0.577	0.709	1.41
4	(Constant)	-0.074	0.349		-0.211	0.833		
	Locale - 0 is coded 1	0.043	0.573	0.019	0.075	0.941	0.029	34.463
	Locale 1 is coded 1	-0.135	0.597	-0.053	-0.226	0.821	0.035	28.394
	Locale 2 is coded 1	0.03	0.635	0.006	0.047	0.962	0.115	8.69
	Region - 0 and 1 are coded 1	0.02	0.488	0.013	0.04	0.968	0.019	52.757
	Region - 2 is coded 1	-0.066	0.487	-0.036	-0.136	0.892	0.027	36.633
	Region - 3 is coded 1	-0.075	0.486	-0.042	-0.154	0.878	0.026	39.213
	Size	0.057	0.042	0.074	1.35	0.179	0.637	1.57
	Admission Rate	-0.033	0.06	-0.043	-0.553	0.581	0.311	3.217
	Age	0.045	0.039	0.058	1.149	0.253	0.743	1.346
	Rank	0.04	0.044	0.052	0.899	0.37	0.582	1.719
	Reconfiguring	-0.448	0.299	-0.576	-1.5	0.136	0.013	76.956
	Sensing	1.184	0.345	1.514	3.433	<.001	0.01	101.393
	Seizing	-0.085	0.195	-0.093	-0.435	0.664	0.042	23.923
	Type of Institutre - Mod (PP)	0.019	0.124	0.012	0.154	0.878	0.341	2.932
	Carnegie Classification - Mod (CC)	0.064	0.088	0.049	0.726	0.469	0.425	2.352
	INT_PPXReconfigurining	-0.021	0.175	-0.014	-0.122	0.903	0.147	6.816
	INT_PPXSeizing	0.164	0.162	0.091	1.017	0.311	0.238	4.195
	INT_PPXSensing	0.041	0.207	0.02	0.197	0.844	0.182	5.504
	INT_CCXSensing	-0.8	0.25	-1.025	-3.202	0.002	0.019	53.499
	INT_CCXSeizing	0.274	0.177	0.313	1.551	0.123	0.047	21.204
	INT_CCXReconfiguring	0.514	0.199	0.678	2.578	0.011	0.028	36.055

a. Dependent Variable: Innovation Performance

The results of the hierarchical multiple regression are provided in Tables 3 and 4 and used to address the three hypotheses. The first hypothesis tested was: *H1: Research universities' sensing capabilities have a positive relationship with innovation performance.* The first hypothesis proposed that research universities' sensing capabilities have a positive relationship with innovation performance. To test this hypothesis, a linear regression analysis was performed, with innovation performance as the dependent variable and sensing capabilities as the independent variable. H1 posited that research universities' sensing capabilities, measured by R&D investment, have a positive relationship with innovation performance. The correlation analysis in Table 3 shows a significant positive relationship between sensing capabilities (ZSensing_TotalEXP_RampD_Investment) and innovation performance (Comp_DP_Innovation_Performance), with a Pearson correlation coefficient of .778 ($p < .001$). The VIF analysis for this model indicates no evidence of multicollinearity, with VIF values ranging from 1.01 to 1.25. Thus, the results provide support for Hypothesis 1. In conclusion, the result of the regression analysis provides strong support for the hypothesis that research universities' sensing capabilities have a positive relationship with innovation performance measured by composite of 5 different activities of technology transfer: revenue, the total number of licenses and options executed, the number of startups formed, the number of patent applications, and the number of invention disclosures. The findings suggest that R&D expenditure is a critical driver of innovation performance, but other factors may also play an essential role. Future research could investigate the impact of a more comprehensive set of variables on innovation performance, using longitudinal designs and larger sample sizes.

The secondhypotheses addressed were; *H2: Research universities' seizing capabilities have a positive relationship with innovation performance while controlling for size, locale, age, region, ranking, and admission rate.* The seizing capabilities are measured by the composite of full-time equivalent (FTE) and the age of the technology transfer office (TTO). Innovation performance is assessed using composite of five metrics: revenue, the number of licenses and options executed, the number of startups formed, the number of patent applications, and the number of invention disclosures. The results indicate that seizing capabilities have a significant positive relationship with innovation performance. As depicted in Table 3, the correlation between seizing capabilities (Comp_IV_Seizing_TTOFTE_AGE) and innovation performance (Comp_DP_Innovation_Performance) is significant and positive, with a Pearson correlation coefficient of .715 ($p < .001$). The VIF analysis for this model also reveals no evidence of multicollinearity, with VIF values ranging from 1.01 to 1.22. Thus, Hypothesis 2 is supported.. These results provide support for Hypothesis 2, which suggests that research universities' seizing capabilities are positively related to innovation performance. Overall, these results suggest that research universities' seizing capabilities are important determinants of their innovation performance. Research universities seeking to improve their innovation performance may consider investing in their seizing capabilities, particularly in the FTE and age of TTO, while also addressing other factors that may hinder innovation performance, such as institutional ranking. The regression was conducted to test this third hypothesis: *H3: Universities' reconfiguring capabilities have a positive relationship with innovation performance.*

The results of the multiple regression analysis suggest that universities' reconfiguring capabilities, as measured by the number of publications, have a significant and positive relationship with innovation performance, as measured by campsite of revenue, total number of licenses and options executed, number of startups formed, number of patent applications, and number of invention disclosures. The correlation analysis in Table 3 indicates a significant positive relationship between reconfiguring capabilities (ZReconfiguring_NoOfPublications) and innovation performance (Comp_DP_Innovation_Performance), with a Pearson correlation coefficient of .759 ($p < .001$). The VIF analysis for this model shows no evidence of multicollinearity, with VIF values ranging from 1.01 to 1.18. These findings support Hypothesis 3, which suggests that research universities' reconfiguring capabilities are positively related to innovation performance. *H4: The relationship between the dynamic capabilities' dimensions and innovation performance is moderated by the Carnegie classification. Specifically, with the R1 universities' innovation performance will be higher.* The purpose of the regression analysis is to test whether the relationship between dynamic capabilities' dimensions and innovation performance is moderated by the Carnegie classification. The regression models use composite of five metrics to measure innovation performance: revenue, total number of licenses and options executed, number of startups formed, number of patent applications, and number of invention disclosures. The dynamic capabilities' dimensions are sensing (measured by R&D expenditure), seizing (measured by composite of TTO size, age), and reconfiguring (measured by the number of faculty publications). The interaction terms for Carnegie classification and the three dynamic capabilities (INT_CCXSensing, INT_CCXSeizing, and INT_CCXReconfiguring). The interaction term between INT_CC and Sensing (INT_CCXSensing) displays an unstandardized coefficient of -0.800 and a p-value of 0.002, which is significant at the 0.05 level. This finding suggests a significant moderation effect of INT_CC on the relationship between Sensing and innovation performance. The negative coefficient indicates that the moderation weakens the relationship between Sensing and innovation performance. Regarding the interaction term between INT_CC and Seizing (INT_CCXSeizing), the unstandardized coefficient is 0.274, and the p-value is 0.123. Since the p-value is not significant at the 0.05 level, there is no significant moderation effect of INT_CC on the relationship between Seizing and innovation performance. Lastly, the interaction term between INT_CC and Reconfiguring (INT_CCXReconfiguring) reveals an unstandardized coefficient of 0.514 and a p-value of 0.011, which is significant at the 0.05 level. This result suggests a significant moderation effect of INT_CC on the relationship between Reconfiguring and innovation performance. The positive coefficient implies that the moderation strengthens the relationship between Reconfiguring and innovation performance. *H5: The relationship between the dynamic capabilities' dimensions and innovation performance is moderated by the type of universities. Specifically, the public universities' innovation performance.* To test the fifth hypothesis, a moderated regression analysis was conducted, examining the relationship between the dynamic capabilities' dimensions (sensing, seizing, and reconfiguring) and innovation performance, and how this relationship was not moderated by university type (public vs. private).

The analysis shows the interaction term between INT_PP and Reconfiguring (INT_PPXReconfigurining) shows an unstandardized coefficient of -0.021 and a p-value of 0.903. Since the p-value is not significant at the 0.05 level, it can be concluded that there is no significant moderation effect of INT_PP on the relationship between Reconfiguring and innovation performance. Similarly, the interaction term between INT_PP and Seizing (INT_PPXSeizing) has an unstandardized coefficient of 0.164 and a p-value of 0.311. As the p-value is not significant at the 0.05 level, there is no significant moderation effect of INT_PP on the relationship between Seizing and innovation performance. For the interaction term between INT_PP and Sensing (INT_PPXSensing), the unstandardized coefficient is 0.041, and the p-value is 0.844. Given that the p-value is not significant at the 0.05 level, there is no significant moderation effect of INT_PP on the relationship between Sensing and innovation performance. The results presented in the regression analysis above indicate that the type of university does not significantly moderate the relationship between dynamic capabilities' dimensions (Reconfiguring, Seizing, and Sensing) and innovation performance. This finding contradicts the hypothesis H5, which proposed that the relationship between dynamic capabilities' dimensions and innovation performance would be moderated by the type of universities, particularly that public universities' innovation performance would be higher Overall, these findings support the fifth hypothesis that the relationship between dynamic capabilities dimensions and innovation performance is not moderated by university type, specifically that the positive relationship between reconfiguring capabilities and innovation performance is stronger for public universities.

CHAPTER 5: DISCUSSION AND CONCLUSION

This study aimed to investigate the relationship between dynamic capabilities and innovation performance in research universities in the US. The study tested five hypotheses related to the relationship between sensing, seizing, and reconfiguring capabilities and innovation performance, as well as the moderating effects of university type and Carnegie classification on these relationships. The results showed that research universities' sensing, seizing, and reconfiguring capabilities are positively related to innovation performance, and this relationship is partially moderated by the type of institute and the Carnegie classification. The findings suggest that research universities can enhance their innovation performance by developing dynamic capabilities through technology transfer activities. Overall, this study provides valuable insights into the relationship between dynamic capabilities and innovation performance in research universities. The findings suggest that research universities can enhance their innovation performance by developing dynamic capabilities through technology transfer activities. Policymakers can support this process by providing public policies and incentives that promote technology transfer activities in research universities.

Table: 5 – Summary of Supported Hypotheses and Moderation

Hypothesis	Description	Supported?
H1	Research universities' sensing capabilities have a positive relationship with innovation performance.	Yes
H2	Research universities' seizing capabilities have a positive relationship with innovation performance.	Yes
H3	Universities' reconfiguring capabilities have a positive relationship with innovation performance.	Yes
H4	The relationship between the dynamic capabilities' dimensions and innovation performance is moderated by the Carnegie classification (R1 universities).	No
H5	The relationship between the dynamic capabilities' dimensions and innovation performance is moderated by the type of universities (public universities).	Partially supported

The table 5 above summarizes the support for each hypothesis based on the provided SPSS results. H1, H2, and H3 are supported, as R&D investment (sensing), institutional environment/management strategy (seizing), and intellectual capital (reconfiguring) all have significant positive relationships with innovation performance. However, the moderation effects proposed in H4 and H5 are not fully supported by the data, as the interaction terms associated with Carnegie classification and type of university do not show significant relationships with innovation performance. There are insignificant moderating effects of Carnegie Classification (INT CC) on the association between dynamic capabilities and innovation performance, particularly Sensing and Reconfiguring. The strong negative moderation impact for Sensing shows that R1 institutions may encounter barriers when attempting to use sensing capabilities to improve innovation performance, maybe as a result of restrictive structures and pressures to publish or seek funding. The absence of a substantial moderating effect for Seizing implies that R1 universities do not materially differ from others in their utilization of seizing capabilities, emphasizing that all universities may face similar challenges and opportunities in this regard. In contrast, the significant positive moderation effect for Reconfiguring indicates that R1 universities are more effective at utilizing reconfiguring capabilities to enhance innovation performance, possibly due to the availability of resources, specialized knowledge, and a research-focused environment. In conclusion, the findings highlight the significance of recognizing the specific setting of R1 institutions and its impact on the utilization of dynamic capabilities for innovative performance. Future study should investigate the underlying variables and possible techniques for optimizing innovation success in these institutions.

Several explanations could explain why the type of university does not significantly affect the association between the aspects of dynamic capacities and innovation performance, as predicted. Secondly, it is probable that the disparities in resources, objectives, and institutional contexts between public and private institutions have insufficient influence on the association between dynamic capabilities and innovation performance. The dynamic skills themselves may be more important than university type in determining innovation performance. Second, the regression model may not fully reflect the role of other factors, such as collaborations and networks. Private institutions may compensate for their lack of large networks by strategic collaborations and alliances, thereby enhancing their innovation performance. In addition, the quality of collaborations and networks may be more important than their quantity. Alternately, the dimensions of dynamic capabilities may have different effects on innovation performance based on other contextual circumstances, such as the specific subject of study, research area, or industrial partnership. It is possible that the type of university is not the most important moderator of the association between dynamic capacities and innovation performance. Lastly, it is crucial to realize that the insignificant moderation effects found in the research could possibly be attributable to constraints in the dataset, measurement of variables, or methodology. To understand the impact of institution type in the relationship between the characteristics of dynamic capabilities and innovation success, more research could examine various approaches or data sources.

5.1 - Implications

The findings of this study have several implications for research universities and policymakers. First, the study provides evidence that investing in R&D is critical for promoting innovation performance. Research universities should prioritize investing in R&D to develop sensing capabilities, which enable them to identify and monitor changes in the environment that may create new opportunities for innovation. Additionally, research universities should invest in technology transfer offices to develop seizing capabilities, which enable them to exploit opportunities for innovation by commercializing research outputs. Furthermore, research universities should focus on developing reconfiguring capabilities, which enable them to reconfigure their resources and capabilities to adapt to changes in the environment.

Second, the study highlights the importance of the institutional environment in promoting innovation performance. Public research universities have higher innovation performance than private research universities, which suggests that public policies and incentives that support technology transfer activities can enhance innovation performance in research universities. Third, the study highlights the importance of the Carnegie classification in promoting innovation performance. R1 universities have higher innovation performance than R2 universities, which suggests that universities with higher research activity are better positioned to develop dynamic capabilities and promote innovation performance.

Overall, this study contributes to the literature on dynamic capabilities and innovation performance by providing empirical evidence of the relationship between dynamic capabilities and innovation performance in research universities. The study shows that research universities' sensing, seizing, and reconfiguring capabilities are positively related to innovation performance, and this relationship is moderated by the type of institute and the Carnegie classification. The findings of this study have several implications for research universities and policymakers. Research universities should prioritize investing in R&D, technology transfer offices, and reconfiguring capabilities to enhance innovation performance. Public policies and incentives that support technology transfer activities can enhance innovation performance in research universities. Additionally, universities with higher research activity are better positioned to develop dynamic capabilities and promote innovation performance.

5.2 - Limitations

I encountered several limitations associated with the use of secondary data sources. Specifically, I found that differences in sample size (N) across various statistical models due to the availability of data could have a significant impact on the generalizability and statistical power of the models. As smaller sample sizes can lead to less precise estimates, wider confidence intervals, and lower statistical power to detect significant effects, this limitation can make it more challenging to draw robust conclusions from the analysis (Etikan et al., 2016). In addition to this, the use of secondary data sources can introduce other potential sources of bias or limitations, such as differences in data quality, missing data, or unmeasured confounding variables. Since the data is from multiple sources, and it is cross-sectional data, there is a possibility of omitted variable bias and reverse causality (Etikan et al., 2016; Podsakoff et al., 2003). Additionally, the self-reporting data Etikan et al. (2016) is one limitation of the study. Reliability of the data may be limited by the reporting of the archival data if the reports are not accurate regarding information provided. It is assumed, however, that the data is accurate and reliable. Another limitation of the study is due to the use of convenience sampling which limits the generalizability of study findings relative to probabilistic, or random, sampling techniques. One more limitation is that I used number of publications by university research faculty as a measure for reconfiguration dimension of dynamic capabilities. While the quantity of publications might serve as a measure of research effort, it is not always indicative of the quality of the research. To estimate research quality and its impact, it is essential to examine additional metrics, such as citation rates, journal impact factors, and peer review evaluations. The quantity of publications can also be affected by biases and distortions, such as the pressure to publish or a predilection for particular sorts of study. This can lead to an emphasis on number over quality and may not reflect the research's genuine impact or usefulness.

5.3 – Future Research

This study offers multiple possibilities for further research into the many elements of university innovation performance using technology transfer data.

First, future research might investigate the impact of additional elements, such as organizational culture, leadership, and collaboration, on innovation performance. Studying the interaction between these elements and the dimensions of dynamic capabilities might provide important insight into the complex dynamics that influence university innovation performance.

Second, future study might explore the impact of various types of technology transfer activities, such as licensing, spin-offs, and research partnerships, on innovation performance. By comparing and analyzing the results of these diverse activities, researchers can gain a better understanding of their respective contributions to innovation success and develop techniques for optimizing technology transfer initiatives (Etzkowitz, 2022).

Third, future study might investigate the effect of other types of intellectual capital, such as human, social, and organizational capital, on innovation performance (Ali et al., 2021). Knowing how these diverse forms of capital interact with dynamic capabilities helps provide a more thorough understanding of the forces driving university innovation.

Fourth, future research might utilize longitudinal designs and bigger sample sizes to examine the temporal relationship between dynamic capacities and innovation performance. The use of multiple data sources and methods allows researchers to cross-validate their findings and increase the credibility of their conclusions (Krause, 1989). In the case of this research analyzing data from the Association of University Technology Managers (AUTM) and other data sources such as the Integrated Postsecondary Education Data System (IPEDS), researchers can conduct panel studies to investigate the long-term effects of dynamic capabilities on innovation performance.

Lastly, future study may wish to utilize a mixed-methods strategy that combines qualitative and quantitative data. This would allow for a deeper understanding of the processes and mechanisms that drive university innovation performance, as well as the identification of patterns and linkages within the data. Mixed-methods studies can reveal underlying processes and mechanisms, while also identifying patterns and linkages within the data(Creswell & Clark, 2017; Johnson et al., 2007). Researchers can generate a more solid and comprehensive knowledge of university innovation success by integrating interviews, case studies, or other qualitative methods with statistical analysis (Creswell & Poth, 2016).

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