DISSERTATION

STRATEGIC FACTORS FOR IMPLEMENTING A MULTIPLE CAREER PATH CONSTRUCTION DOCTORAL PROGRAM: A MIXED METHODS STUDY

Submitted by

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ABSTRACT

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According to the recent literature, a notable percentage of STEM doctoral graduates prefer employment in non-academic career paths such as industry due to diminishing opportunities in academia. However, the doctoral education in the U.S. is designed to prepare graduates to become researchers and teachers for careers in academia. There is limited training available to Ph.D. students related to their training for non-academic career paths. Construction Ph.D. programs are designated as STEM programs and are no exception to this changing career preferences of Ph.D. graduates. Given the changing career landscape of doctoral graduates, it is important for construction Ph.D. programs to prepare doctoral students for success in diverse career paths (academia and industry). A large share of the current research in doctoral education primarily focusses on engineering disciplines, and very limited knowledge is available related to preparation of construction focused Ph.D. graduates effectively for multiple career paths.

The broad research objective of this study is to develop strategic factors for construction Ph.D. programs to prepare students for diverse career paths. To achieve the research objective, the study explored the factors that influence construction Ph.D. students career choices through social cognitive career theory theoretical lens, competencies required by construction Ph.D. students for careers in academia and industry, various ways construction Ph.D. programs can prepare students for diverse career paths, and benefits of preparing construction Ph.D. students for various career paths. The study adopted a mixed methods approach, where 38 qualitative interviews were conducted and a quantitative survey was developed and administered (329 responses) with construction Ph.D. students, construction Ph.D. graduates working in the industry, construction faculty, and construction industry professionals.

Results indicate that construction-focused Ph.D. students are equally interested in industry-related career choices alongside academia. Factors such as interest in teaching and research, passion for student mentoring and engagement, flexibility in working hours, support from an advisor, unawareness about non-academic opportunities, and satisfaction obtained from teaching influence construction Ph.D. students towards academic careers. Factors such as better salaries, ability to make a difference and advance construction industry, disinterest in academic culture, lack of enough academic jobs, no support from an advisor, and competitive academic funding climate influence construction Ph.D. students towards non-academic (industry) careers. Written and oral communication, problem solving skills, and critical independent thinking competencies are critical to employability success of construction Ph.D. students in both academic and industry career paths. Opportunities to complete industry internships, performing research relevant to construction industry's challenges by balancing both theory and practice, support from advisor related to either of the career choices, networking with both academic and industry professionals are important strategies to prepare construction Ph.D. student for diverse career paths. Preparing construction Ph.D. students for diverse career paths not only improves employability of Ph.D. students but also enhances university-industry research collaborations and improves the ability of construction industry to constantly innovate, adopt technology, and gain access to university research relevant to their needs.

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DEDICATION

To *Mom and Dad,* for unwavering love and sacrifices for my education

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CHAPTER 1: INTRODUCTION

In the United States, the construction industry contributes 6.2% to the national gross domestic product (Markstein, 2017). Construction, being one of the major contributors to the economy employs more than eight million individuals with over 680,000 employers while creating nearly $1.2 trillion worth of structures (Simonson, 2019). The construction industry is expected to continue the growth as the industry has registering more than 7% year-on-year growth in the last five years and is projected to grow by 11% through the year 2026 (Bureau of Labor Statistics [BLS], 2018). Although construction is one of the largest economic contributors, higher education graduate programs offered in construction are limited and are not designed to prepare students for pursuits beyond academia. To meet future professional demands, academia should consider offering more advanced and comprehensive graduate programs related to construction that prepare students for multiple career pathways (Lee et al., 2012). There have been some studies on the expansion of construction management master's level education, but studies on construction management (CM) doctoral level education are limited. The dearth of research focused on construction doctoral education (Lee et al., 2012) highlights the gap in understanding on how programs can prepare students for multiple career pathways. This study is focused on the ways in which construction focused doctoral education can better prepare students for multiple career pathways in construction management.

In this chapter, I explain the background and context of this study, which is grounded in the needs of construction academia and industry to develop guidance for construction focused doctoral program in preparing students for multiple career paths. This is followed by problem statement followed by the purpose of the study and research questions. The research objectives are presented, followed by the delimitations of this study. The final section of the chapter will include potential limitations, assumptions, significance, and the researcher's perspective.

1.1 Background

1.1.1 New Evolutions in Construction Industry

Traditionally, construction professionals were either craft persons without a college degree or undergraduates in construction and trained on the job (Arditi & Polat, 2010). However, the growing complexity of construction projects in the recent years, requires construction personnel to enhance their skills, evolve and adapt to changes in the industry. The level of education for construction personnel has become much higher due to changing workforce conditions as the demand for specialized expertise has grown (Yepes et al., 2012). In addition to this, the construction industry is changing rapidly as it undergoes digital transformation and integrates with a wide variety of new technologies such as building information modelling (BIM), unmanned aircraft vehicles (UAVs), robotics, internet of things (IoT), laser scanning, virtual and augmented reality, data analytics and many others. To take advantage of the new technologies that improve construction efficiency, it is important to have a highly skilled workforce who can understand and effectively operate the latest technologies to optimize construction efficiency (Arditi & Polat, 2010; Atalah & Muchemedzi, 2006; McIntyre, 2018).

Construction firms are currently faced with numerous issues related to BIM, marketing, finance, accounting, human resources, contract law, economics, feasibility analysis, and effectively adopting technological innovation. The performance of construction firms depends on the skill levels and expertise of their workforce in their ability to seamlessly use the new technologies that are becoming more commonplace in the industry.

A study by World Economic Forum (2018) titled "Shaping the Future of Construction: Future Scenarios and Implications for the Industry" reported that tech-based construction is the future and construction companies should find ways to draw talent that possess these skills to stay competitive. Another study suggested that the construction industry should hire workforce with technology and innovation skills to take construction to the next level (Boston Consulting Group, 2018). There is a shortage of construction professionals who can meet these desired skills and it is vital for construction businesses to plan ahead, as technology continues to rapidly advance, and without workers who have the proper skills, companies can easily fall behind or even fail (Predicting the Future: Construction Industry Job Skills to recruit, 2019). Construction firms, to stay competitive, have to prioritize upskilling their current workforce though education by engaging in long-term thinking and investing to recruit highly skilled workforce that can adapt to the technological evolution in construction (Shultz, 2020). The doctoral graduates in construction management have the required intelligence and abilities, and are needed to be prepared for multiple career opportunities including these types of positions.

1.1.2 STEM Related Doctoral Education

To address the emerging and ever-changing needs of industry, this study will examine the preparation of doctoral students in construction management which is considered a STEM (Science, Technology, Engineering and Math) related program. The number of doctoral degrees awarded in STEM disciplines by the U.S. institutions have been increasing in the last several years (National Academies of Science, 2018). Doctoral education is often considered the quintessential preparation for a STEM faculty career. However, a greater number of STEM doctoral graduates are seeking careers in industry making their career paths less straight forward. As such, the intended outcomes of doctoral education are no longer to solely train future academic faculty because non-academic career paths in STEM fields have become more than an alternative (Nerad, 2010; Wendler et al., 2012). This indicates it is important for academic institutions to provide training and support system tailored for doctoral students as they show interest in multiple career path options. Notably, STEM Ph.D. students believe they are rarely provided with adequate career preparation and training for multiple career paths (Marbouti & Lynch, 2014).

1.1.3 Doctoral Graduates for Construction Industry

The primary emphasis of construction education at the university level has been on undergraduate and master's program with little attention given to doctoral education. According to Rudd and Nerad (2015), doctoral education is a critical setting where novice Ph.D. students learn to become proficient in producing, transforming, and disseminating disciplinary knowledge for real world and industry related applications. Unfortunately, in construction doctoral education, there has been a lack of collaboration between academia and industry in producing industry specific research (Bigelow et al., 2016) and preparing future doctoral students for multiple career pathways.

Doctoral graduates are well positioned to meet the needs of the industry due to their ability to apply scientific knowledge to make sound decisions and improve outcomes (Gittings et al., 2018). In fact, several advancements and emerging technologies in construction (e.g., BIM, UAVs), construction economics and analytics, and advanced project delivery systems that are used in the construction industry today have been developed by doctoral graduates (Cunningham, 2016; Houdayfa, 2017). Ph.D. graduates have potential to take on leadership, management, and technological roles in construction companies. However, despite being highly skilled human resources that can work for the betterment of construction industry, doctoral graduates have not traditionally been provided with opportunities for construction industry employment (McCuen et al., 2019). Most Ph.D. graduates are self-directed and quick learners (Green & Macauley, 2007), which are important skills that every construction firm needs in this new digital transformation era (Designing Digitally, 2021). Today's construction industry heavily relies on technological innovations and advanced skills to improve productivity (Hardie et al., 2005). As doctoral students typically learn advanced skills, it is understandable that doctoral students in construction discipline are suitable for industry employment if they are provided with essential educational experiences (e.g., industry experience and relevant coursework) during doctoral education. The construction academic settings must consider making appropriate changes in Ph.D. programs and curriculum to train doctoral students for employment in the industry and other possible career avenues.

1.1.4 Construction Academia

Associated Schools of Construction (ASC) has approximately 160 construction academic institutions that offer undergraduate and graduate programs with a construction emphasis. Almost all these construction programs experience high demand for their graduates, which indicates high demand for faculty to teach at these programs (McCuen et al., 2019). The accreditation agencies such as Accreditation Board for Engineering and Technology (ABET) and American Council for Construction Education (ACCE) place high emphasis on hiring faculty with construction industry experience as construction is an applied discipline like medicine or law, where actual experiences can be utilized to reinforce the concepts being taught in the classroom. In addition to this, construction related academic departments also require faculty to have a doctoral degree to be able to do research in the discipline. However, it is becoming increasingly difficult to find tenure-track faculty applicants with both a Ph.D. and relevant industry experience in construction (Holliday et al., 2014).

1.2 Problem Statement

Traditionally, many individuals inside and outside academia assume that most Ph.D. graduates seek academic careers. However, an increasing number of Ph.D. graduates have pursued multiple career paths (e.g., industry, government) in the last several years (National Science Foundation [NSF], 2017).

The National Science Foundation (NSF) indicate that more than 50% of STEM Ph.D. graduates have opted for industry careers post completion of their Ph.D. and indicate the trend could continue to be the same for future (NSF, 2017). Further, National Academies of Science (NSF, 2018) advises universities to adapt Ph.D. education to train Ph.D. students as per their changing career aspirations. This indicates that it is important for STEM Ph.D. students to have opportunities, tools, and an educational environment available to them to prepare for multiple career paths. Currently, the STEM Ph.D. education in the U.S. primarily focuses on training students for academic careers but does not focus on training students for multiple career paths. Despite the changing scenario, academic educational institutions are not adapting to the needs of industry or the expectations of potential Ph.D. students (Akay, 2008).

The case for construction Ph.D. programs is no different. Although data specific to construction Ph.D. education is unavailable, it is assumed that the National Science Foundation data is applicable as construction programs are classified as STEM degree by (Department of Homeland Security, 2020) and offered through STEM departments at universities (Colorado State University, 2020; Washington State University, 2020).

Construction Ph.D. programs in the U.S. are inconsistent in terms of curricula, structure, degree title and other program characteristics. In addition to that, these programs do not commonly train or provide educational opportunities to Ph.D. students for multiple career paths (personal communication, Kristen Parrish, NSF Future Faculty Training workshop, 2020). Many construction focused Ph.D. graduates are competing for a few academic positions annually, leaving other construction focused Ph.D. graduates to turn towards supplementary career paths in industry, government, and non-profit organizations. But it is not easy for these Ph.D. graduates to get hired by the construction industry as they are not trained to meet the needs of industry during their doctoral education. Therefore, expanding educational opportunities to construction focused doctoral students will help them secure employment in multiple career avenues including working in the construction industry. Further, this also helps construction industry tap potential talent for the new digital construction era as well as the increase in complexity to construction projects.

In addition to this, the construction academia is currently facing a unique problem. Construction departments at U.S. colleges and universities typically require faculty to have construction industry experience and a Ph.D. degree to be hired. Construction industry experience is a great asset to teach the students while a Ph.D. degree will be additionally useful to obtain grants and further research in construction discipline. Construction management departments currently find it extremely difficult to hire faculty candidates with industry experience (Holliday et al., 2014; McCuen et al., 2019). This is because, once someone leaves education and enters industry, it is difficult to return to full-time doctoral education (McCuen et al., 2019). Whereas a masters student opting for a doctoral degree in construction often does not have construction industry work experience due to the education path offered by universities (McCuen, 2007). Hence, it is difficult to find faculty with both a Ph.D. degree and industry experience. This indicates that expanding educational opportunities to prepare doctoral students for multiple career avenues will not only prepare them for industry and academic employments but also improve the quality of construction related academic programs.

If construction focused Ph.D. students are prepared for multiple career pathways by providing relevant educational opportunities (through industry experience, coursework and, research) it would be beneficial to construction industry, students, and the construction management academic departments as well. This would benefit the construction industry as it would supply advanced workforce required by the industry for the emerging digitized construction era. This would benefit construction focused Ph.D. students because students will be provided multiple employment opportunities. This would benefit construction management academic departments because this would create future potential faculty with both industry and research experience. Hence, this research will explore how construction focused Ph.D. education can address the changing career needs of construction related Ph.D. students, suitability of Ph.D. graduate's employment in emerging digitized construction era, and challenges acknowledged by construction academia to hire faculty with industry experience through the following research questions.

1.3 Research Questions

To investigate these issues, this study will be guided by the following questions:

1. What factors are influencing current construction focused Ph.D. students to pursue multiple career paths (academia and industry)?
2. What are the core competencies required by construction focused Ph.D. graduates to be employable in multiple career pathways (academia and industry)?
3. What are the different ways construction focused Ph.D. programs can prepare students for a variety of career options?
4. How would a construction focused Ph.D. program that prepares students for multiple career paths benefit the construction industry, students, and academia?

1.4 Purpose

The purpose of the study is twofold. First, this study seeks to understand perspectives of construction focused doctoral students regarding their career decision making. This is important to understand to provide student centric doctoral education. Understanding doctoral students' career experiences and diverse career needs is critical to understand what they need in order to prepare them for a variety of career paths both inside and outside academia. Second, this study aims to provide recommendations to construction academia to develop doctoral programs that prepare doctoral graduates for multiple career paths including industry and academic employment. This is accomplished through the inclusion of multiple stakeholder perspectives (students, faculty, and industry) and examination of desired skills to prepare students for various career paths.

1.5 Objectives

The following are the objectives of this research study, which are to address the research questions.

- Demonstrate the need for multiple career path-oriented training in construction focused doctoral education.
- Determine the core competencies required by construction focused Ph.D. graduates to be employable in multiple career pathways.
- Provide recommendations and develop features of a construction focused Ph.D. program that provides experiences to prepare students for a variety of career options in construction academia and industry.
- Develop different ways to create construction focused Ph.D. graduates with industry knowledge and experience.
- Understand the perceived benefits of a multiple career focused Ph.D. program from industry, academia, and student's perspective.

- Identify the actions and the type of support necessary from academia and industry for enhancing emphasis on multiple career pathway training in construction focused doctoral education.

This dissertation recommends factors for change that must be considered to train construction focused Ph.D. graduates for multiple career avenues and attempts to address the challenges of construction academia in hiring industry experienced faculty.

1.6 Delimitations

One of the delimitations of this study was including students, faculty, and Ph.D. graduates from only STEM classified construction management and construction engineering programs. There are additional construction Ph.D. programs that are offered through other departments (such as Architecture, School of Education), and the students/faculty graduated from these programs are not considered mainly because these programs have shared emphasis (e.g., construction management and education). Another delimitation is allied members of the construction industry that have hired in the past and that may hire construction Ph.D.s in the future such as construction equipment manufacturers are not included in the study. These groups of individuals may be stakeholders in the results of this study, but they are not included in this study. These delimitations were found to be appropriate because the findings of this study demonstrate the importance of preparing construction Ph.D. students for multiple career paths. The perspectives of construction Ph.D. students, faculty, and Ph.D. graduates from other construction Ph.D. programs (such as Architecture, School of Education) and allied employers in the construction industry that hire Ph.D.'s is important, and it is recommended that this be included in a future study.

1.7 Limitations

One possible limitation of this study was a smaller number of qualitative participants from construction industry professional's category. Although, the study had 37 qualitative participants across construction Ph.D. students, construction Ph.D. graduates, construction faculty, and construction industry professionals, the number of participants from construction industry professional's category is just five. This causes a concern regarding capturing construction industry professionals' perceptions sufficiently. However, the quantitative phase gathered good number of responses from construction industry professionals.

1.8 Assumptions

The assumption that historical data and literature related to changing career preferences of STEM Ph.D. students apply to construction Ph.D. student also as most construction programs are STEM designated in the United States. Another assumption was that there is a need to prepare construction Ph.D. students for diverse career paths. Therefore, with an assumption it is important to train construction Ph.D. students for diverse career paths, this study identified competencies required and resources to be provided to train construction Ph.D. students for diverse career paths.

1.9 Significance

The significance of this study is that it identifies competencies required by construction Ph.D. graduates relevant to academic and non-academic professional settings. The universities interested in preparing their construction Ph.D. graduates for diverse career paths will be able to use this information to train students effectively for diverse career paths. This study also develops strategic factors of recommendations for universities and construction Ph.D. students to implement to be prepared for diverse career paths. Identifying the benefits of construction Ph.D. students for diverse career paths helps construction industry and universities realize the importance of preparing Ph.D. students for multiple career paths and creates the awareness needed. Additionally, understanding and changing how construction Ph.D. programs can support current generation Ph.D. students career aspirations must start somewhere, and the researcher believes this study will be a starting point to that change.

1.10 Researcher's Perspective

The researcher is a construction Ph.D. student and experienced himself the intense competition of obtaining an employment in academia and the difficulties to obtain an employment in the non-academic careers being a construction Ph.D. student (due to lack of sufficient training provided). The researcher is interested in an academic position, however, acknowledges several individuals in his circle that are interested in construction industry employment post completion of their Ph.D.'s. However, anecdotally it is evident that there is limited training provided to construction Ph.D. students to obtain employment opportunities in non-academic career paths. The researcher believes the same can be captured empirically through this study and opines it is very important to train construction Ph.D. students for diverse career paths. Additionally, the researcher observed different individuals that finished construction Ph.D. and transitioned into academic and non-academic roles respectively. Through this study, the researcher attempts to know various factors that determine construction Ph.D. students career choices through theoretical lens (SCCT). The researcher believes a combination of personal (e.g., interest in teaching/industry), and external factors (e.g., salary, working conditions) determine construction Ph.D. students career paths. The researcher also has observed some individuals transitioning into construction industry roles after Ph.D., and there is limited understanding regarding competencies that helped them obtain an employment in the industry even though there is no training available from the universities. The researcher is interested in understanding the competencies that are important to be employable in both academia and construction industry, ways to prepare construction Ph.D. students for diverse careers, and benefits of doing so. The researcher believes that commonality exists in competencies required for both academic and industry paths and hopes to find that through the study. The researcher further believes that preparing construction Ph.D. students for diverse career paths is beneficial to students, universities, and industry.

CHAPTER 2: LITERATURE REVIEW

The primary focus of this research is preparation of construction doctoral students (STEM degree) for multitude of careers. The first aspect of the literature review focuses on traditional doctoral education in general and specific to construction management in the U.S. This provides common ground on which further information relevant to this research can be built. The subsequent section of this literature investigates doctoral students' perception on career preparation, skills required by doctoral graduates for multitude of careers, and current status of construction Ph.D. programs in the U.S. The last section will explore industry-university collaboration in doctoral education and its associated benefits in building the knowledge economy.

2.1 Literature Review Focus

The following review of literature is intended to be exploratory in nature, investigating literature relevant to training doctoral students for multiple career paths and developing a relevant curriculum model. The emphasis of my doctoral dissertation will potentially focus on identifying factors that influence changing career decisions of construction management doctoral students, core competencies required by construction management doctoral graduates for multiple career paths and providing appropriate recommendations for current construction management doctoral curriculum models.

2.2 Literature Review

Research plays an important role in advancement of any industry. Research is widely recognized as a critical component of the advancement of technology and knowledge in any field of study. Although construction is one of the largest industries in the U.S., it is one that performs very limited research according to needs of the industry (Abudayyeh et al., 2002). The construction industry and universities are generally disunited in terms of research and education. Due to this, the construction industry and construction academic research have grown apart. This is one of the reasons the advances in construction industry are not rapid as other industries (Bigelow et al., 2016). Although the construction industry has been recognized as a leading driver of the national economy, research education efforts are lacking that are common in other industries (Tucker, 2007). It is important for construction academic researchers to understand the research needs of industry in order to develop research that supports the growth of the construction industry. A CM doctoral program that prepares students for multiple career avenues in construction by providing relevant educational opportunities (e.g., industry experience, relevant coursework and research), can create future potential researchers that can understand the needs of the construction industry and develop appropriate research that supports the growth of construction industry.

2.3 History of Construction Management Education in the U.S.

The history of construction management dates to early 1900s (Heery, 2011). Engineers and architects are the people who designed projects and then supervised the actual construction by employing a contractor to provide and manage the labor force (Chinowsky & Diekmann, 2004). Design was considered as a distinct discipline. The education for design has carried a substantial role and the advances in design started to appear soon in books and other publications suitable for teaching students at the college level. Eventually, there was more focus on design as a profession, while at the same time paying no attention to managerial and leadership aspects of construction (Oglesby, 1990). Gradually, the actual construction work and its supervision was left to contractors. Technical know-how and management practices was passed on to the next generation mainly through trade practices as there were relatively very few books that taught construction management practices and procedures (Oglesby, 1990). The contractors were entrepreneurs, with a primary motive of “making profit”. For various reasons, the majority of design experts and engineering educators viewed construction as a profession that is conducted ruthlessly and dishonestly and therefore, construction was not seen by engineers and architects as a profession nor a proper subject for university education (Oglesby, 1990).

This perspective about construction remained until World War II. During World War II, there was almost no construction taking place in the US except work pertaining to the war effort. After the end of World War II, into the late 1940s, most of the construction was planned for “cope up” projects and expansion of existing important facilities, commercial, industrial and governmental projects. Little by little, many new projects were planned to include large hospitals, school building programs, massive public projects such as bridges, highways and expressways, tunnels, industrial, commercial, military facilities, and other important projects of all kinds.

Realizing the need for skilled construction managers, a group of construction industry professionals approached universities to establish higher education programs that can prepare students to meet the to meet the federal government’s projected demand for construction managers (Knievel, 1965). Upon their request, a construction management program was introduced at the Colorado Agricultural and Mechanical College (now Colorado State University) in 1946, and was run by the Industrial Arts Department (Gunderson et al., 2002; Hauck, 1998). This program was similar to programs initiated at 20 other universities as a result of combined efforts of F. H. Kellogg from the University of Mississippi, Eugene Grant at Stanford, and Walter Voss at MIT, which established a new construction engineering community (Ledbetter, 1985). But, through the next few years, a struggle established itself between the American Society of Civil Engineers (ASCE) and the universities, the Associated General

Contractors (AGC) and the universities, and within the professional and academic communities (Oglesby, 1990) regarding whether or not construction engineering and management was a true academic pursuit and whether or not the field could develop research activities worthy of an academic degree (Chinowsky & Diekmann, 2004) This internal struggle did not end until numerous far-sighted construction educators such as Clarkson Oglesby at Stanford, Glen Alt at the University of Michigan, and E.I. Brown at North Carolina State University convinced academic and professional societies that construction not only deserved to be a specialty within civil engineering, but the body of knowledge was advanced enough to warrant the establishment of degrees in the construction management discipline (Ledbetter, 1985).

In due time, the initiation of construction engineering and management programs at various universities occurred, including the University of Michigan, Iowa State University, and North Carolina State University (Chinowsky & Diekmann, 2004). After these construction education programs were established, accreditation was the ensuing step in gaining academic and industry recognition. The first construction education program to earn accreditation was the University of Florida in 1975 by the American Council of Construction Education (ACCE). Today, this landscape has grown multi fold with close to 75 baccalaureate and five master's construction management programs accredited by ACCE across the US. However, currently there are no doctoral construction management programs accredited by ACCE in the US. Currently, neither ACCE nor ABET has developed accreditation standards for doctoral programs in CM. An email inquiry with ACCE informed the researcher that ACCE is exploring opportunities to develop accreditation standards for CM Ph.D. programs and aiming to finish the first accreditation by 2022.

2.4 Ph.D. Education in the U.S.

A Ph.D. degree is defined as the "highest qualification awarded by a university that requires a research thesis above the master's degree level" (Noble, 1994, page 1). A Ph.D. qualified person, often referred to as doctor, is defined as "a person competent by reason of skill and knowledge to teach or expound authoritatively on a subject or field of knowledge" (Gunderson & Gloeckner, 2006). Ph.D. programs are designed to prepare students to become scholars, capable of discovering, integrating, and applying knowledge, as well as communicating and disseminating it (Gunderson & Gloeckner, 2006). The Ph.D. degree had its origins first in the European nations and then spread to the United States in late 1800's. In 1861, Yale University awarded the first doctoral degree in the U.S.

The growth of Ph.D. programs and degrees started from the year 1900 as several other research universities including Harvard, University of Illinois, and others started awarding doctoral degrees. In the United States, the growth of the Ph.D. is well documented in terms of the annual number of Ph.D. degrees conferred. The number of Ph.D. awardees grew from a total of 562 in 1918 (Geiger, 1997) to 54,664 in 2017 (NSF, 2018).

The requirements to confer a Ph.D. degree in the earlier years included two years of study in two distinct departments, pass a final exam and present a thesis proving high attainment in a subject. The requirements evolved over a period and today doctoral students spend several years in advanced study of a specialized field, by writing a high-quality dissertation, completing advanced coursework, and passing numerous rigorous examinations.

The primary reason for creating doctoral programs in the U.S was to create university teachers and promote research. Ph.D. programs in the U.S. traditionally prepares students for teaching and research careers. But the recent social, economic, and cultural changes in the last few decades resulted in doctoral graduates to aspire not just towards academic careers but also careers in industry (NSF, 2018). Additionally, it was identified that some Ph.D. graduates are not interested in academic careers leading to emergence of industry related Ph.D. programs that leverage the knowledge of industry and provide employment opportunities to doctoral graduates in both industry and academia (Ori, 2013).

The traditional Ph.D. programs offered at U.S. universities prepare candidates for academic careers but not necessarily for the professional industry (Santos et al., 2018). These traditional doctorate programs are narrow in focus and Ph.D. graduates from these programs are less likely to secure industry employment (Usher, 2002). Sometimes it is also observed that the graduates of traditional Ph.D. programs lack skills such as science, communication, and leadership, which are favorable for successful employment, implying that these programs are not training enough for an academic employment (Noble, 1994). Leake (2013) argued that doctoral education should be designed to prepare students for a variety of responsibilities and professional careers in both academia and industry. Currently, in the United States, there is shortage of Ph.D. programs which train students for a successful career in both academia and professional industries (Wood, 2019). Construction management is no exception to this, as CM education has a shortage of traditional Ph.D. programs as well.

2.5 Current Scenario of Construction Ph.D. Programs in U.S.

Construction Management is unique and interdisciplinary in nature as it draws contents from engineering, architecture, technology, business, and law. Across the US, schools offer doctoral degrees individually in Civil Engineering, Education and Business with emphasis in construction management. However, not many universities offer a doctoral degree itself in construction management. These programs are indeed not accredited by any accreditation institutions. This is because accrediting bodies currently do not have an accreditation structure in place to look at doctoral education, providing more evidence that CM academia has not been seriously considered in how to best prepare students for multiple career pathways.

2.6 Needs Assessment of Construction Focused Ph.D. Programs in U.S.

The need to establish graduate doctoral programs focused on construction management was first reported in the late 1980s (Moss, 1989), but this need was never addressed, and no one has provided leadership and guidance in establishing the same (Williamson & Bilbo, 1999). The Associated Schools of Construction mid-year board meeting in 1998 identified the need for more Ph.D. programs in construction management to produce quality construction educators and to produce productive research in the area of construction management (Associated Schools of Construction, 1998). Williamson and Bilbo (1999) further argued that the universities should take responsibility in developing terminal doctoral programs in construction management that will produce the professional construction educators who are highly trained in research.

The demand for construction management Ph.D. graduates in academia has been extremely high for several years (Gunderson & Gloeckner, 2006; McCuen et al., 2019). A survey conducted by Gunderson & Gloeckner (2006) with construction management department heads and faculty indicated a need to establish construction management focused doctoral degrees. The creation of doctoral programs focused solely on construction management would also increase the amount of research being done in this field (Gunderson & Gloeckner, 2006). Currently the faculty hired by construction schools are mostly from civil engineering or architecture due to the availability of doctoral degrees in these fields. However, it is important to realize that construction management is different than civil engineering and needs an exclusive doctoral degree. Badger (2002) identified that there is a need for universities to produce more Ph.D. programs in construction management with improved recognition in industry and academia.

Additionally, the Associated Schools of Construction posts several construction management faculty job opportunities across schools every year with doctoral degree “preferred”, whereas faculty positions in other disciplines “require” doctoral degree. This indicates that the supply of doctoral graduates in construction management is scarce and demand for doctoral education in construction management is high (Gunderson & Gloeckner, 2006).

Historically, faculty teaching at construction programs with doctoral degrees have been those with engineering, education, or industrial technology degrees (Gravitt & Haddad, 2004). Badger (2002) mentioned that there is a critical need to establish new construction focused Ph.D. programs that actively engage research in the discipline.

2.7 Industry – University Collaborative Ph.D.

Ph.D. programs generally focus on providing academic career related preparation. The traditional role of doctoral programs primarily engaging in teaching and research has now extended to collaboration with industry (Assbring & Nuur, 2017) in many countries such as the United Kingdom, Sweden, Denmark and others in various fields such as manufacturing, construction, and automotive as these countries realized the economic contributions and importance of providing multiple career path training to doctoral- level students. A collaborative Ph.D. program can be defined as an arrangement in which the cost, supervision and research outcomes for the Ph.D. program are shared by industry, funding bodies and universities (Assbring & Nuur, 2017). An Industry-University doctoral program involves close interaction between a company, doctoral student and a university (Borrell-Damian, 2009). Another important characteristic of Industry-University collaborative doctoral program is the selection of a research topic that meets the needs of the university, the industry and the doctoral candidate (Assbring & Nuur, 2017).

Industry-University collaboration in doctoral training benefits the industry in several ways including new product development, identifying new user case scenarios, increase in competence, increased capability for research and development (R & D) and innovation (Thune & Boring, 2015). The companies participating in the collaborative industry-university doctoral programs have noticed an increase in the number of patents, gross profits, employment growth and total factor productivity as per a report published by The Danish Agency for Science, Technology and Innovation (2013). The Industry-University collaboration in doctoral education also benefits universities as students and faculty access additional funding, diversify research areas and have more resources to undertake research, and provides for industry feedback and guidance for research projects (Rybnicek & Königsgruber, 2019). These collaborations are also advantageous to students as it improves chances of hiring in industries, increased access to industry resources and network, and more nuanced understanding of the different skills required (Germain-Alamartine & Moghadam-Saman, 2019). The doctoral students participating in Industry-University collaborative doctoral programs were more satisfied and performed much better academically and professionally when compared to traditional doctoral program students (Harman, 2002). Additionally, it is also evident that prior engagement with universities encourages industry firms to recruit Ph.D. graduates (Garcia-Quevedo et al., 2012).

2.8 Industry – University Collaborations in Construction Ph.D. Program

The literature review informs that the construction industry interacts with universities for mere business services although construction is very research dependent (Bröchner & Sezer, 2020). To develop research that support the growth of industry, a collaborative Ph.D. program in CM was established in Sweden that has been functioning successfully since its inception in early 1990s. Bröchner & Sezer (2020) reported that many of the Ph.D. graduates from this program are in several managerial positions and technical specialist positions today across the world in construction firms. The dissertation topics from this program vary from management and business relations to new product innovations for construction industry. Furthermore, industry-university collaborative Ph.D. graduates are twice as likely as those traditional Ph.D. graduates to be employed in multiple career avenues (Bröchner & Sezer, 2020).

Additionally, Industry-University collaborative Ph.D. programs are advantageous to students wanting to pursue academic careers as well. Similar to medical and law education, where the majority of faculty members have worked as a medical doctor or an attorney, it is critical for faculty teaching at construction education programs to have construction industry experience (McCuen, 2007). Several of the faculty job postings on ASC website reveal that universities prefer candidates with at least five years of experience in the construction industry. However, it is observed that most of the young doctoral students do not have the required work experience to teach at universities (McCuen et al., 2019). Considering this, it is understandable that an Industry-University collaborative doctoral program providing both industrial and academic experience to students during their doctoral course of study will help them achieve required industry knowledge and experience to teach in construction programs. The university-industry collaborative Ph.D. in CM in Sweden was advantageous to employers as this program increased the efficiency of construction firms and was advantageous to students as it provided them opportunity to get employment in both academia and industry (Brochner & Sezer, 2020).

As it is evident that the Swedish construction industry is seeing the fruits of a university-industry collaborative Ph.D. in CM, it would be wise to explore if implementation of a similar program in the U.S. context would be advantageous to U.S. construction industry.

2.9 Need for Industry-University Collaborative Construction Ph.D. in the U.S

2.9.1 Construction Industry – Academia disconnect

There exists a strong disconnect between academic research and construction industry, resulting in academic research that lacks value for the industry (Bigelow et al., 2016). Current academic research in construction is not harmonious with technological advancements or with current needs of the construction industry (Doree & Miller, 2008). Industry will not value academia's research innovations if academia cannot help industry with the problems they face. Today's academic researchers in construction are struggling to develop research that meets the expectations of industry as they do not have a sound understanding on the pressing needs of the industry (Rigby, McCoy & Garvin, 2012).

If construction management research fails to connect with industry, academic researchers will further struggle to make meaningful contributions (Gastelum, 2017). It is important to note that other industries such as technology, manufacturing, and automotive advanced rapidly due to academic research that worked in cognizance with industry needs. This indicates the importance of academic research to align with construction industry (Gambatese & Hollowell, 2011). Rigby et al (2012) identified that one reason for "disconnect" between construction industry and academic research is that the information sharing between industry and academia does not happen as a proper communication/interaction exist between construction industry and academia. Earlier studies (Heldal et al., 2014; Khilander et al., 2011) reported that collaborative university-industry doctoral programs are potentially effective means to enhance transfer of knowledge between academia and industry. This indicates that implementing this Ph.D. program in CM could act as a communication vehicle between industry and academia as the collaborative Ph.D. students understand needs of construction industry while developing their research at the university.

Egan (1998) identified that a lack of leadership in the integration of academic research and industry needs as a major cause for low performance of the construction industry. Universities, as they act as a hub of academic research, have the responsibility to establish higher education research programs that work in tandem with the needs of industry to promote innovative research in construction. The proposed collaborative Ph.D. could address the problem of construction industry-academia disconnect by integrating more academic research with construction industry needs.

2.10 Construction Ph.D. Graduate's Employability Challenges

Traditionally, Ph.D. programs prepare graduates for academic jobs. In 2014, a study by Larson et al. (2014) estimated that in the coming years, only 12.8% of new Ph.D.s will be able to find tenure track faculty positions. This indicates that fewer than one in six has a chance to land in an academic job (Kolata, 2016). It was also reported that larger schools often receive hundreds of applicants for every open assistant professor job (Kolata, 2016), indicating the intense competition among academic faculty jobs. Due to the severe competition in academic employment, doctoral graduates also started showing strong interest in pursuing industry jobs. In recent decades, doctoral graduates in engineering have entered industry positions at rates higher than academia. In 2017, the doctoral graduates in engineering reported that 59% opted for employment in private for-profit industries (NSF, 2017). It is to be noted that most construction doctoral programs are offered through civil engineering departments and the above presented statistics include construction graduates as well. For the doctoral graduates that are interested in industry employment, there is a paucity of preparation for any position in industry, other than to be a researcher. This is one the most important missed opportunity in doctoral education (Akay, 2008).

Considering the changing times, it is important to understand that doctoral education should prepare students for a variety of responsibilities and professional careers in both academia and industry (Leake, 2013). Understanding the emerging trends in changing requirements of doctoral graduates, the recent NSF (2018) report on STEM graduate education calls for programs to more systematically provide advising and career preparation for academic and industry as well as government career paths.

Construction Management is no exception to this as the construction doctoral education face similar challenges. “Construction Ph.D. graduates aren’t only for the future of universities and research but are required by the industry as well. Today, every doctoral graduate does not have an opportunity to be employable in academia. We must be able to employ them in the industry too. It is important for the universities to train industry-oriented employability skills to doctoral students, but none of the universities are doing it” (Kristen Parrish, personal communication, NSF Workshop, March 8, 2020). It is important for universities in the U.S. to consider including industry-related skill training in their construction related doctoral curriculum. This indicates there is a need to study on ways to prepare CM doctoral students for multiple career avenues.

2.11 Ph.D. Students’ Multiple Career Pathways Preparation

Workforce across the globe is undergoing transformational changes, whereas the model of doctoral education yet remains traditional and unchanged (Thiry et al., 2015). Several educators have voiced concerns about lack of doctoral students’ professional preparation for careers other than academia (Wendler et al., 2012). The long-standing doctoral education model emphasizes preparation for the professoriate, while in fact, more doctorates in the 21st century are employed by industry/businesses than by universities (Subra, 2011). Recent studies identified that STEM doctoral students are showing more interest in non-academic jobs, but they are criticized for their lack of preparation for multiple career paths (Marbouti & Lynch, 2014). Further, Marbouti & Lynch (2014) reported that doctoral students self-reported low competency in majority of the skills required for employment in non-academic employment pathways.

But the reason for changing career preferences, strategies and resources needed to prepare for new career choices are not understood properly (St. Clair et al., 2017). A gap exists in our understanding of how and why doctoral students are interested in non-academic careers pathways, and the role of universities in preparing doctoral students for the changing career choices. The proposed dissertation seeks to address this gap through the inclusion of doctoral student voice and experience.

Doctoral students have expressed concerns about being trained only for academic careers and a lack of preparation for careers outside of academia (Golde & Dore, 2001). This is supported by the fact that universities devote the majority of their career development resources to preparing doctoral students for academic careers. This leaves doctoral students with no or less resources to succeed in the non-traditional career pathways.

Despite the fast-changing Ph.D. career landscape, doctoral students still perceive a lack of support and resources to address their diverse career development needs during their Ph.D. education and training (Gibbs & Griffin, 2013). This hinders the growth of doctoral students in terms of developing competencies for multiple career pathways and lose opportunities for diverse career options (Fuhrmann, 2016).

Considering the changing career needs of students, and the transformational workforce requirements, the educators and universities must provide doctoral students with the tools needed to contribute to innovation in academic and non-academic careers. Several researchers, educators, and industry professionals opined that offering systematic training through doctoral program and curriculum to prepare them for multiple career paths is an extremely important need of the 21^{st} century (Marbouti & Lynch, 2014).

2.12 Ph.D. Students' Knowledge, Skills and Attributes (KSAs) for Multiple Careers Success

The skills required by undergraduate students for success in industry career has been extensively studied by researchers, but studies are limited on knowledge, skills and abilities (KSAs) required by doctoral students for success in academic and industry career avenues. Several researchers (Lang et al., 1999; Martin et al., 2007; Nguyen, 2018) studied perceptions and expectations of baccalaureate level students by industry, but none of them addressed the specific perceptions and expectations from graduate students (masters and doctoral) by industry and academia.

The few studies that focused on doctoral students KSAs indicated that there exists a misalignment between desired competencies and skills possessed by doctoral students seeking careers in academia and industry (Berdanier et al., 2014). This misalignment can be avoided if universities identify the core competencies required by doctoral graduates and include relevant training in the doctoral program.

A study by Nair et al. (2009) noted that doctoral students in engineering disciplines should be good communicators, globally aware, technically competent, and understand business and management practices to be successful in industry employment. A study by Berdanier et al. (2014) reported that doctoral students need effective communication, self-learning capabilities, technical and academic writing, self-motivation, analytical thinking ability, and grant writing skills to be successful in academia. The same study reported the top five skills doctoral graduates should possess to be successful in industry employment includes problem solving, time management, learn and adapt new technologies, networking, and communication as essential skills. A study by Marbouti & Lynch (2014) indicated that intellectual abilities, risk assessment, time management, critical thinking and problem-solving ability are important skills required by engineering doctoral graduates to be successful in academia and industry employment settings. A study by Cui & Harshman (2020) on skills required by chemical doctoral students identified technical skills, communication skills, management skills, planning & organization skills, teaching skills, networking, and collaboration as critically essential skills for success in academic and industrial employment. Other studies also reported that self-promotion, managing people, and budgeting finances are critical skills that should be taught to doctoral graduates (Nerad, 2010; Rudd et al., 2008).

In the construction discipline, few researchers have studied key abilities and skills required by undergraduate students for success in industry employment. A study by Ahmed et al. (2014) identified knowledge of health and safety regulations, interpreting contract documents, listening ability, attention to details, knowledge of building codes and regulations, and time management as the most important skills required by undergraduate construction management students. Another study by Farooqui and Ahmed (2009) indicated that interpreting contract documents, listening ability, attention to details, time management, construction accounting, value engineering/ constructability analysis/ design review, and contract negotiations/ conflict resolution as essential skills required by graduate students to be successful in industry employment. There are no specific studies found that focused on knowledge, skills and abilities required by construction management doctoral graduates.

It is important to understand industry, faculty and doctoral students' perspectives on skills construction management doctoral graduates require for professional success in academia as well as industry. If doctoral students' views do not align with faculty and industry, it will be difficult for students to engage in training opportunities. It is important for faculty to understand views of doctoral students and industry to develop relevant curriculum and training material that prepares doctoral students for various career opportunities (Berdanier et al., 2014). It is critical for higher education construction departments to identify the career needs of doctoral students during their doctoral programs based on a thorough understanding of how career choices are made. Such research enables construction doctoral graduates to maximize their potential as advanced knowledge workers both within and outside of academia.

2.13 Current Status of Construction Focused Ph.D. Programs in the U.S.

Before making recommendations to the construction doctoral programs, it is important to know the current status of doctoral programs that offer emphasis in construction. A list of all the current programs that offer doctoral degree in construction emphasis gathered from construction program websites of all schools across the U.S. is provided in Appendix A.

The Ph.D. degree titles for these programs include Construction Management, Civil Engineering, Sustainable Construction Management, Planning, Design & the Built Environment, Building Construction, Technology Management, Environmental Design & Planning, Construction Engineering and Management, Engineering Science, Civil & Environmental Engineering, Education, Equity, and Transformation, Sustainable Design & Construction, Built Environment, and Interdisciplinary Sciences. With varying degree titles, these programs may focus in construction management, or construction engineering. Some programs have the word "construction management" in the title while others do not. One construction focused doctoral program that stands out with a unique degree title is "Education, Equity, and Transformation", offered as an interdisciplinary Ph.D. program from School of Education and Department of Construction Management at Colorado State University.

A quick look at the degree titles and departments through which the degrees are offered indicates construction management doctoral programs are treated as academic stepchildren of other programs, and that the jumble of degree titles can leave students and employers uninterested or confused. It was also observed that the curricula in these programs vary widely and several of these programs do not offer a variety of core construction management coursework.

2.14 Challenges of Construction Academic Departments

Construction is an applied discipline similar to medicine or law, and unlike architecture or other design disciplines which are more theory based (Gunderson & Gloeckner, 2006). As construction is an applied profession, it is important for the faculty teaching in these programs to possess relevant industry experience (McCuen et al., 2019). It is essential for faculty teaching applied disciplines to have real-world industry experience (Burgett et al., 2017). Further, construction education accreditation bodies require faculty to go beyond classic teaching methods and move emphasis to connecting students with industry by using applied projects and assignments (American Council for Construction Education Document 103, 2018). This is possible only when faculty has knowledge, skills, and experience directly from working in the construction industry. In addition, many universities currently also require construction management faculty to produce published research, and preferably funded research (McCuen et al., 2019). This is possible only if a faculty has earned a Ph.D. degree. Construction programs are being pressured to require both advanced education and construction experience in faculty. But it is becoming increasingly difficult to find construction faculty applicants with both a Ph.D. and industry experience (Holliday et al., 2014). The path to a Ph.D. does not leave room for gaining worthwhile construction industry experience (McCuen et al., 2019). Once a person leaves the education path and enters industry it is often hard to leave industry for full-time studies, which leads to a gap in prospective construction educators.

Providing an opportunity to gain industry experience during doctoral education in applied sciences programs can be beneficial to academic departments, prospective faculty, and doctoral students (Gasper & Lipinski, 2016). This study aims to explore ways to incorporate industry experience in construction management doctoral education to address the hiring challenges of construction departments.

2.15 Construction Ph.D. Curriculum Model Development

Curriculum model development is a deliberate process of establishing and prioritizing educational goals, designing the content, methods, and materials necessary to address the goals, purpose, and objectives of a program (Shafriz et al., 1989). Curriculum model development and innovation is critical to create successful education programs (Meixell et al., 2015). The process of curriculum model development should consider the curriculum elements, learners, purposes, content sequence, instructional resources, processes, assessment, and evaluation (Lattuca & Stark, 2009). In establishing the content of a curriculum, it is very important to ensure that the content is relevant, and reflects the needs of institutions, students, and the world of work (Zargari et al., 1995).

Currently there are many universities offering undergraduate degrees in construction throughout the U.S. These institutions vary from public to private, small to large, and research to teaching schools. There are, however, a few universities that offer Ph.D. degrees in construction in different variations, and the curricula among these different variations is not consistent. It is important to note that maintaining consistency of curricula among doctoral programs will be a benefit for the development of the program (McEwen & Bechtel, 2000), and to industry as well as students to gain similar education regardless of where they attend. The inconsistency among the curricula in construction doctoral programs could be one reason that these programs did not progress as much as other programs and warrants a need to review the current curricula to analyze similarities and dissimilarities.

In studies that employ curriculum review, it is important to acknowledge that student voices are extremely important to identify concerns and improvements of the curriculum (Chadha et al., 2019). Students are one of the most important users of curriculum and their voice is extremely powerful (Cuthbert, 2010). Graduate students from STEM disciplines in the last few years have reported that they are actively considering multiple career options, often reporting a simultaneous interest in the faculty track and several other career tracks including industry employment (Roach & Sauermann, 2017).

Curricula review and gathering student's opinions can provide for a good understanding about construction doctoral curricula changes. In curriculum development practices, universities generally refer to the accreditation bodies for guidance on curriculum development and revisions (Meixell et al., 2015). If accreditation standards are not available, it is important to consider the role of internal and external influences in developing the curriculum model (Lattuca & Stark, 2009). The internal influences include the university and its affiliated resources, whereas the external influences include market forces such as industry practitioners and economic conditions. The internal and external influences inform that research focusing on development of construction doctoral curriculum model should consider perspectives of academia, industry, and students when accreditation standards are not available.

2.16 Theoretical Perspective

2.16.1 Social Cognitive Career Theory

This study is grounded in social learning theory based on the assumptions that the interaction between various learning experiences and the environment leads to an individual's career choice decision making (Brown & Lent, 1992). Specifically, the study is guided by social cognitive career theory (SCCT) (Lent & Brown, 1996). Deriving on the work of Bandura (1986), social cognitive career theory examines the cognitive aspects and environmental factors that influence the career decision making process.

One of the objectives of this study is to understand various factors that influence the career preference of construction Ph.D. students. SCCT is considered an effective framework to examine the process by which individuals make and pursue career choices (Bullock-Yowell et al., 2012). Adopting the lens of SCCT helps to understand the role of various cognitive learning variables and perceived educational environment influences on the career decision-making processes of construction Ph.D. students. Understanding these factors will further help this study in developing strategic guidance that considers the needs and expectation of students according to their career choices.

Three groups of theoretical approaches are evidently common in research related to career choice: developmental theoretical approach, trait and factor theoretical approach, and social learning theory. Career choice, according to developmental theory, is a process that unfolds over time and consists of defined stages during which an individual gains proficiency in skills and advance to subsequent stages (Super, 1991). According to the trait and factor theory, positive career outcomes occur only when an individual’s characteristics and occupational environment are compatible. It implies that it is important for an individual to realize occupational preferences to have a positive outcome in career (Holland, 1985). According to social learning theory, the interaction of various learning experiences and the environment influences an individual’s career choice decision-making (Brown & Lent, 1992). In the last two decades, researchers proposed several theoretical models in career choice based on convergence of these three theoretical approaches. One such convergence theorical model that is widely approved by researchers in career development is SCCT developed by Lent et al. (1994). The studies on career interests of higher education students often draw upon Social Cognitive Career Theory.

Social cognitive career theory (SCCT) is a comprehensive theoretical framework derived from social cognitive theory (Bandura, 1986), that can be used to understand elements fostering career development based on interactions between person, environment, and behavior that shape career related interests and choices. Social cognitive career theory is a well-established, comprehensive theoretical framework for comprehending the dynamic mechanisms by which individuals interact with cognitive and contextual factors that influence, shape, and implement career choices (Raque et al., 2013; Swanson et al., 1996). According to Social cognitive career theory, an individual’s career development stems from their background (such as demographics, family education, etc.) and learning experiences (Lent & Brown, 2013). Career development evolves over time and has several components such as a) career interest b) academic development and c) performance outcomes. These components interact with individual’s behavior and environment such as self-efficacy, outcome expectations and goals to influence career choice and development (Lent et al., 2000).

SCCT is based on a two-tiered theoretical analysis (Lent et al., 2000). The first level denotes socio cognitive-person variables such as self-efficacy, outcome expectations, and goals. The second level comprises of contextual influences (career barriers, available support) that influence career related choices and interests (Lent et al., 2000). Social cognitive career theory cognitive-person variables emphasize socio-cognitive mechanisms that influence an individual’s career development. Figure 1 represents cognitive-person process from SCCT framework along with the paths that exist between the variables.

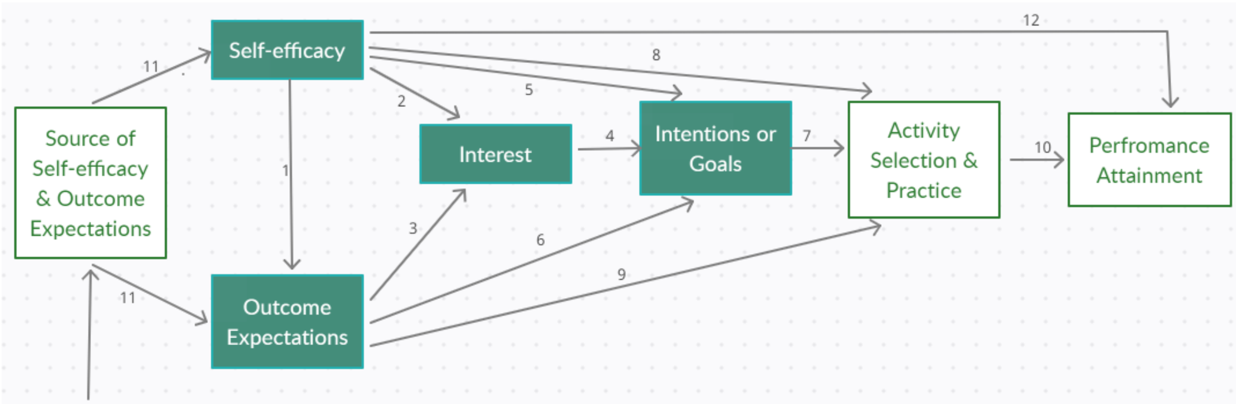

Figure 1. *SCCT framework showing cognitive-person process (modified from Lent et al., 1994)*

According to the SCCT framework, individuals develop a sense of self-efficacy beliefs and certain expectations regarding the likely outcomes of their behaviors as a result of repeated performance accomplishments (paths 1 and 11). Then, career interest formation is influenced by these perceptions of outcome expectations and self-efficacy (paths 2 and 3). In other words, if an individual believes that they have ability to perform certain tasks in their pursuit of a career, and at the same time if they determine these careers result in desired outcomes, they are likely to express interest in academic or industry career pursuit. As a result of the interests they develop, they develop goals. They develop goals because they feel capable (and skilled) and can anticipate positive outcomes (path 4, 5, and 6). The willpower to achieve goals will increase their involvement with those specific activities (paths 7, 8 and 9). Involvement in the selected activities result in achieving performance attainments (paths 10 and 12). The accomplishments associated with activity participation then generate a socio-cognitive feedback loop that modifies self-efficacy and outcome expectations (path 11).

The SCCT framework (Lent et al., 2002) highlights four critical cognitive variables a) self-efficacy b) outcome expectations c) interest, and d) goals. These variables interact with each other and influence the process of interest formation and career decision making (Lent et al., 2002). The four variables are explained further in detail.

2.16.1.1 Self-Efficacy Beliefs. Self-efficacy beliefs are considered to play a significant role in an individual's choice of activities and opportunities (Bandura, 1986). Self-efficacy refers to one's belief about their own capabilities to successfully perform an activity. Self-efficacy beliefs also have an effect on the amount of effort expended toward achieving a goal, the persistence demonstrated, and the thought patterns and emotional responses experienced when confronted with obstacles. Self-efficacy beliefs take shape through performance accomplishments (previous success based on one's talents and abilities), vicarious learning (beliefs formed by observing accomplishments of others), social persuasion (influence of others such as others assurance on his/her abilities), and physiological (and emotional) states. Self-efficacy has been found to predict academic and career choices, specific performance attainments, job satisfaction and retention (Sadri & Robertson, 1993).

To develop a construction doctoral program that prepares students for multiple career paths, it is important to understand self-efficacy beliefs of students because, if an individual believes they will do well in industry career but not in academic career, they will be more inclined towards a career in industry and vice versa. It is important to understand what influences the students to develop those beliefs. For example, why did an individual believe they will not be able to do well in academia? The "self-efficacy" aspect of SCCT will be used in this study to understand construction doctoral student's self-efficacy beliefs related to various educational/learning activities related to career and how they influence their career choices. Thus, examining self-efficacy in construction doctoral students for various activities in multiple career path preparation may be important as it relates to the development of an individual's career interests.

2.16.1.2 Outcome Expectations. Outcome expectations refer to one's perceived probable rewards (or outcomes) from performing certain actions. According to Lent et al. (1994) there are three types of outcome expectations, physical (e.g., monetary), social (e.g., pride) and self-evaluating (e.g., self-satisfaction), which influence career related decision making. According to SCCT, an individual's interest in a particular career choice is partially determined by the outcomes of career choice. Thus, according to SCCT, outcome expectations have a significant impact on the development of career interests. The "outcome expectations" aspect of SCCT will help this study understand the role of monetary benefits, societal status, time availability, work satisfaction and other rewards for career choices of construction doctoral students.

2.16.1.3 Interests. Interests refer to "individual's pattern of likes, dislikes, and indifferences related to various occupations and career-relevant activities" (Lent et al., 2002, page #?). According to the SCCT framework, career interest formation is a collective function of self-efficacy and outcome expectations. Social Cognitive Career Theory specifically posits that individuals develop enduring interests in certain actions if they have confidence in performing it competently and expect it to yield positive desired outcomes (Lent et al., 2002; Bandura, 1986). On the contrary, if an individual predicts negative outcomes and opine that they are not competent enough to perform, it results in low career interest.

2.16.1.4 Goals. Goals refer to an individual's willingness to perform a specific activity or to accomplish a specific outcome as per SCCT framework (Lent et al., 2002). In SCCT, the goals are generally career aspirations, career plans, expressed career choice, or career decisions. In the SCCT framework, the process of goal setting in which personal interests determine decisions concerning desired outcomes is central (Lent et al., 2002). An individuals' goals are established through their self-efficacy beliefs, outcome expectations and interests (Lent et al., 1994). According to SCCT, there are two types of goals: choice content goals and performance goals. Choice content goals refer to type of activity an individual chooses to participate, such as their choice for doctoral research. Performance goals refer to level of a skill a person is determined to demonstrate, such as a doctoral student's intention to achieve high GPA in the program or attain a preferred job.

According to SCCT framework, while forming an individual's career choice, socio cognitive variables alone do not operate, but a set of other important environmental or contextual variables (e.g., social, cultural) also play an important role (Lent et al., 2002). These are the second level of variables that are mentioned earlier to comprehend how environmental factors interact with a person's cognitive variables during their career development.

2.16.1.5 Contextual Influences. Contextual influences are those that have a direct impact on an individual's career goals and actions. These supports or barriers are a significant area of research in SCCT because they are predictive of goal attainment and play a significant role in the career decision-making process (Lent et al., 2006). Career barriers are defined as "conditions, either internal to the individual or external to the individual, that make career advancement difficult" (Swanson & Woitke, 1997). Despite having high self-efficacy, high expectations for positive outcomes and a solid interest in a specific career, people avoid a career choice if they perceive difficulties to enter a career path (Lent & Brown, 1996). Career supports are defined as "activities, conditions, or resources that facilitate career progress" (Lent et al., 2000). Career supports are an important contextual influence in career decision making process. In other words, an individual is more likely to translate their career interest into career goals, and goals into career related actions, when favorable contextual influences (e.g., few barriers and more supports) are present (Lent et al., 2006). The "contextual influences" aspect of SCCT helps this study in understanding influence of contextual learning resources provided to construction doctoral students in their career decision making process. For example, studying at a doctoral program that emphasizes preparation for multiple career options would be different from studying at a doctoral program that emphasizes preparation only for one career option. This aspect of SCCT helps this study in identifying the contextual learning resources that impact the career decision making of construction doctoral students.

Overall, the SCCT framework will help answering Research Question #1 (What factors are influencing current and potential construction Ph.D. students to pursue multiple career paths alongside academia?) of this study in identifying various cognitive and environmental factors that influence the career choices of construction doctoral students. Incorporating SCCT into this study helps to understand construction doctoral students' level and nature of confidence in their own ability to perform well in a position, their interest in various career choices, and the context in which their career decision making occurs. This will further help to develop an understanding regarding what experiences and activities are to be provided to construction doctoral students to effectively train them for multiple career paths. The researcher collected data related to self-efficacy beliefs, outcome expectations and contextual influences of learning environment related to construction Ph.D. education. Understanding these factors further helped this study in developing strategic guidance that considers these needs and expectation of students.

2.16.2 Experiential Learning

Another theory that will be vital to understanding construction doctoral education is Experiential Learning. Experiential learning is a hands-on educational process that combines experience, reflection, conceptualization of the experience, and application of learned ideas to make decisions to develop knowledge and skills (Kolb, 1984). This kind of learning is valuable for doctoral students' education and career exploration, because it provides an opportunity for doctoral students to gain understanding of various professions and job cultures, reflect and assess if their skill sets are good fit, and further develop valuable skills in order to make informed career decisions (Schnoes et al., 2018). Hands on learning through experiences can be very beneficial for multiple career path exploration and career development (Van Wart et al., 2020).

Experiential Learning Theory is based on the premise that the best way to learn is through actual experiences. The pioneer of experiential learning is John Dewey, who emphasized the existence of "organic connection between education and personal experience" for effective learning to happen (Dewey, 1986). John Dewey's theory of experiences tied to scientific inquiry was catalyst in developing the groundwork for experiential learning movement. Building on Dewey's work, Kolb (1984) developed Experiential Learning Theory (ELT), that consists of four stages – concrete experience (do), reflective observation (observe), abstract conceptualization (think), and active experimentation (plan) (Kolb et al., 1999). "Experiential learning theory defines learning as the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping, reflecting, and transforming experiences" (Kolb & Kolb, 2009, page 42). In curriculum development, the experiential learning theory is beneficial because it emphasizes the breadth of interactions between participants and the social environments that may influence their career choice, as well as the process over the outcome.

Construction is an applied discipline similar to medicine and law (Gunderson & Gloeckner, 2006). This indicates that construction education should also be similar to medical or law education in terms of curricular design and providing learning opportunities to students. Typically, in graduate level medical education, students are provided with an opportunity to practice with real humans and gain experience (through residency) by assisting professional medical practitioners that supports experiential education (McLachlan et al., 2004). Experiential learning has been given high priority at the doctoral level in several other applied disciplines such as counselling therapy, psychiatric studies, and chemistry (Miller et al., 2010). Despite being an applied discipline and having resemblance with medical education, construction graduate education is currently lecturer centered (Park et al., 2016). Further, Park et al. (2016) stated that medical education has advanced to greater heights by providing concrete experience to students and implementing a similar strategy that provides experiences in undergraduate and graduate construction programs could benefit construction education to a great extent. Incorporating experiential learning opportunities related to various career paths in construction doctoral education will allow for doctoral students learn from those experiences, be trained and prepared for various career paths, and reflect on those experiences to evaluate their skills to opt for an apt career choice. Therefore, this study utilized Experiential Learning Theory to provide recommendations for construction doctoral programs to offer experiences for doctoral students to prepare themselves for multiple career paths in construction management.

This study examined how the variables of self-efficacy, outcome expectations, goal attainments and contextual influences impact the career choices of construction management doctoral students and how an understanding of these factors may inform universities to develop relevant doctoral programs in construction to train doctoral students for multiple career paths. Further, to provide recommendations to the current construction doctoral programs, experiential learning theoretical framework will be used to offer the experiences of multiple career paths for effective student career preparation. Overall, while SCCT helps to understand what experiences and activities to be provided for construction doctoral students to prepare them for multiple career paths, Experiential Learning helps this study to understand how to provide those experiences and activities in the doctoral curriculum.

Incorporating experiential learning into career exploration and development opportunities integrates well with Social Cognitive Career Theory's concept of self-efficacy. According to Bandura (1986), practicing and experiencing a specific task result in increasing an individual's confidence and their self-efficacy beliefs. Self-efficacy beliefs developed on experience basis serve as a foundation for successful performance (Lent & Brown, 1996). By providing educational opportunities to experience careers which were previously unfamiliar, even on a small scale, doctoral students can develop increased understanding of what suits them and what does not. This develops increased self-efficacy and enhanced confidence in career decision making. After the small-scale experience, even rejection of a career path, is a valuable outcome, as the doctoral student can now avoid unaware career decisions that could lead to failure.

This study aims to develop different ways to incorporate experiential learning into construction doctoral education setting, so that it provides educational opportunities for construction doctoral students to opt for multiple career paths and ascertain an apt career path for themselves.

The experiential learning theory helps to identify various learning approaches that recognizes transferability of construction doctoral students existing skill sets and develop new skills that can prepare them for success across a wide range of careers in academia and beyond.

2.17 Chapter Concluding Remarks

This literature review informed that STEM doctoral graduates are preferring industry employment as a career choice as much as they consider academic employment and there is a great need to train these doctoral students for multiple career paths during their doctoral education considering their changing career choices. This research particularly attempts to study the case of construction management doctoral education. Additionally, it also informs that it is important to identify various factors that influence changing career choices of construction management doctoral graduates. The literature also informs that training doctoral students for multiple career paths could be beneficial to the U.S construction industry, academia, and students. Hence, the proposed research will identify various factors (according to the SCCT framework) contributing to changing career choices of doctoral construction management students and the core competencies required by construction management doctoral students for multiple career opportunities.

This study also aims to review current CM Ph.D. programs and provide recommendations to make necessary changes in the program characteristics to prepare doctoral students for multiple career paths.

The current literature available regarding CM doctoral education is very limited and it identifies a lack of direction and leadership concerning the development and expansion of doctoral programs focused in construction management. The proposed study aims to contribute to the current literature and provide the required research support to develop and expand new generation CM doctoral education.

CHAPTER 3: METHODOLOGY

This chapter begins with a brief overview of the research methodology adopted in this study. Following the brief overview is a discussion of the research design, rationale for choosing a mixed methods approach, the research setting, sampling, and instruments used in this study.

3.1 Mixed Methods Research Design

The objective of this research is to develop strategic factors for preparing construction Ph.D. students for diverse career opportunities within academia or industry, where it is important to qualitatively understand the needs of research participants and quantitatively generalize them. To achieve the stated research objectives (refer to Chapter 1), the selected research design for this study is mixed methods. Mixed Methods research, grounded in pragmatic worldviews, integrates qualitative as well as quantitative research approaches within the scope of a single study (Cresswell, 2014). Qualitative studies often collect undetermined open-ended information in order to capture multiple truths, whereas quantitative studies typically collect closed-ended survey responses aimed at obtaining a more generalizable truth. Within a research paradigm, qualitative and quantitative research methods are located at opposite ends of a continuum. Mixed methods research is placed in the middle of this continuum because it incorporates both qualitative and quantitative perspectives (Johnson et al., 2007). Mixed methods research is expected to collect data on the phenomenon under investigation in a more comprehensive manner than a single research method (Greene et al., 2001).

There are variations in mixed methods research: convergent mixed methods design, explanatory sequential design and exploratory sequential design (Tashakkori & Teddlie, 2010). This study will use exploratory sequential mixed methods design to perform needs assessment for construction management doctoral education that prepares students for multiple career paths.

3.1.1 Rationale for Choosing Mixed Methods Design

The rationale behind the researcher's decision to use this approach was as follows. First, qualitative data collection will support understanding the needs of the research participants while the subsequent quantitative data was used for confirming and generalizing of the findings. Second, by including various types of participants (students, Ph.D. graduates, faculty and industry professionals) and speaking with them, the researcher was able to acquire knowledge as well as perceptions from multiple perspectives related to not just the needs but also different approaches that can be adopted to train construction focused Ph.D. students for multiple career paths. Finally, by combining data from various methods (qualitative and quantitative), this study was able to identify overlapping and distinct aspects of career decision-making processes of construction focused doctoral students', as well as ways to prepare them for these various career choices, which will aid the development of strategic factors of recommendations for current construction Ph.D. programs.

3.1.2 Exploratory Sequential Mixed Methods Design

The exploratory sequential mixed methods design begins with and typically prioritizes the qualitative data collection and analysis. The qualitative results are then used to develop a quantitative instrument to collect and analyze quantitative data. This research method is generally used when a topic needs to be explored qualitatively before it can be measured or tested quantitatively (Clark & Creswell, 2008). This means that the approach will typically be grounded in the views of participants (Cresswell, 2014). Figure 2 shows a graphic representation of the research process of exploratory sequential mixed methods design.

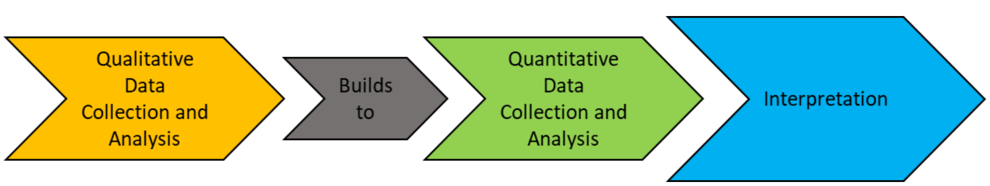

Figure 2. *Exploratory Sequential Mixed Methods Design*

3.1.3 Research Design

This study adopted a sequential exploratory mixed methods design that consisted of two phases. Phase 1 was the initial exploratory stage to collect perceptions from participants about the research topic followed by in-depth qualitative interviews with students to identify factors that influenced their career choices in construction as well as interviews with faculty and industry to identify needs and ways for establishing multiple career path preparatory doctoral education in construction. Phase II incorporated the quantitative data collection phase that administered a questionnaire survey that generalized the findings and examined how a larger sample of students, faculty and industry perceived the needs of establishing multiple career path preparatory doctoral education in construction. An outline of the sequential exploratory mixed methods design that was used in this study is shown in Figure 3 and further details of the phases are discussed in detail in the following sections.

This sequential exploratory research phase was initiated with conducting a comprehensive literature review, related to preparing Ph.D. students for diverse career paths. The researcher used keywords such as "Ph.D. students career choice", "Ph.D. students career preparation", "multiple career path doctoral preparation", "industry-university collaborative Ph.D.", etc. in data base such as Google Scholar, and Web of Science including journals such as *International Journal of Construction Education and Research*, *Journal of Civil Engineering Education*, *International Journal of Doctoral Studies*, *Studies in Graduate and Postdoctoral Education*, *Journal of Planning Education and Research*, *Journal of Industry - University Collaboration*, *Journal of Career Development*, and *Industry and Higher Education*. In finding literature relevant to doctoral student career choice and preparation, International Journal of Doctoral Studies and Industry and Higher Education journals had several useful literature, while other journals were helpful but not to a great extent. This was then followed by conducting initial exploratory interviews with industry and academic experts to gather preliminary perspectives, interest, and perceptions regarding this study. This resulted in assessing the interest of faculty and construction industry leaders in preparing construction focused Ph.D. students for careers in construction industry in addition to academia. This was followed by conducting detailed qualitative interviews and distributing quantitative questionnaire surveys.

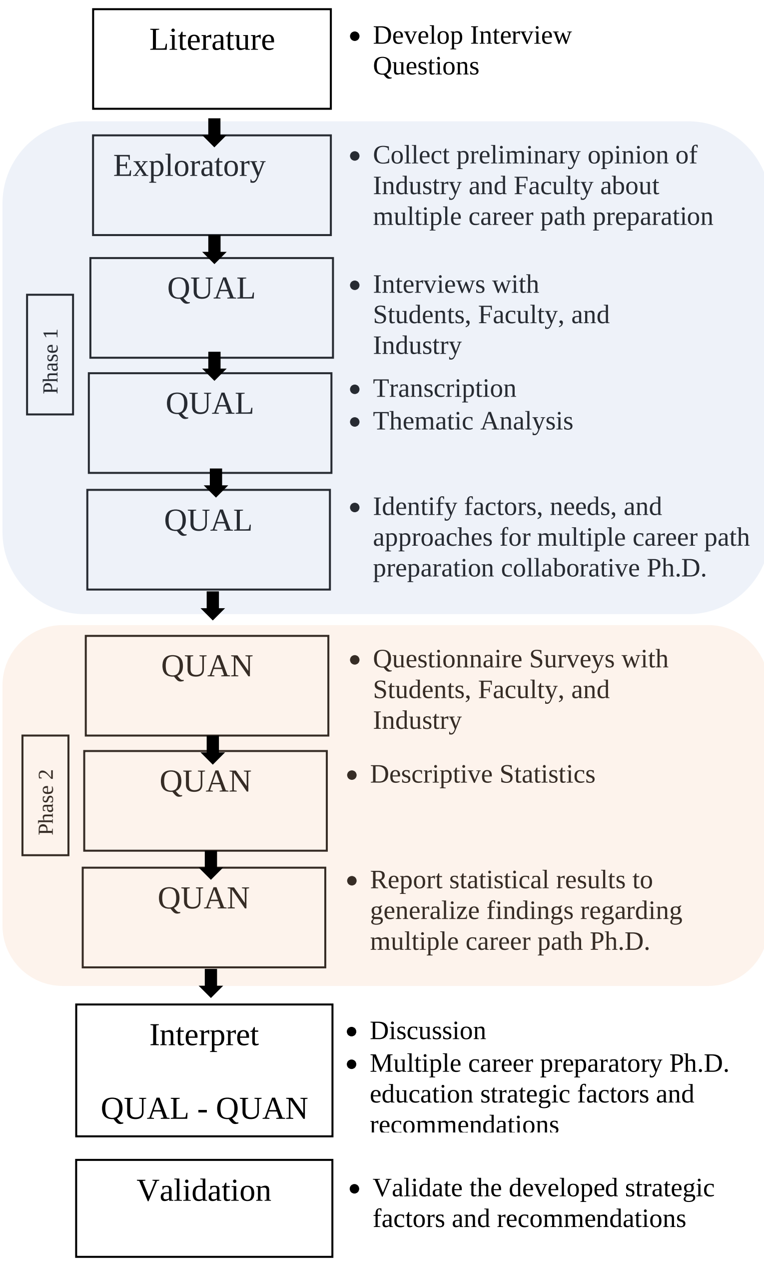

Figure 3. *Sequential exploratory mixed-methods research design for this study*

According to Creswell (2014), sequential exploratory research designs qualitatively explore a phenomenon and expand on the qualitative findings. Therefore, the next step of Phase I of this study after conducting the literature review and initial interviews included conducting in-depth qualitative interviews with students, recent construction Ph.D. graduates working in the construction industry, faculty, and construction industry professionals to assess the needs of a multiple career path preparatory doctoral education program that prepares construction Ph.D. students for multiple career paths within the construction industry and academia. After completing the interviews in Phase I, a subsequent Phase II focusing on quantitative data was conducted by developing a survey questionnaire based on the preliminary data analysis from the qualitative phase. The survey questionnaire was distributed to current construction focused Ph.D. students, recent construction Ph.D. graduates working in the construction industry, construction faculty, and construction industry professionals to generalize the needs of a multiple career path Ph.D. program in construction management.

In order to investigate the needs of a multiple career preparatory construction focused Ph.D. program and to understand stakeholder perceptions regarding the same, the researcher adopted an inductive approach. An inductive approach is appropriate to explore a new phenomenon, identify the patterns, and contribute to new generalizations (Bell et al., 2018; Saunders et al., 2019; Thomas, 2003).

The qualitative data was analyzed using thematic analysis whereas the quantitative data collected was analyzed with descriptive statistics. Integrating both qualitative and quantitative data collection and analysis methods enhanced and brought synergistic effects for answering the research questions and developing strategic factors for a multiple career path construction-related Ph.D. program. Further, this research design also provided triangulation of data from multiple sources (qualitative and quantitative data collection). Triangulation is a way of combining multiple methods to study the same phenomenon to ensure validity and reliability (Denzin, 2012; Merriam & Grenier, 2019; Tashakkori & Teddlie, 2010) Shown in Figure 4.

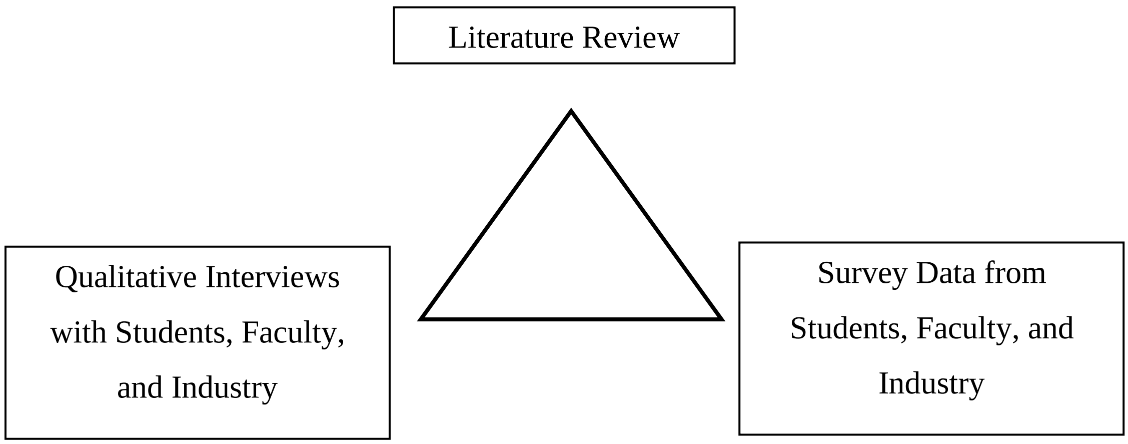

Figure 4. *Triangulation using multiple investigators and multiple sources of data to confirm emerging findings (adapted from Merriam and Grenier, 2019)*

3.1.4 Human Subjects/Institutional Review Board (IRB) Approval

This study received human subject research approval from Colorado State University's institutional review board (IRB, see Appendix B). To ensure protection of participants' privacy, a voluntary consent form was provided to potential participants that included information about the research study's purpose, data collection procedures, and strategies for maintaining participants' anonymity during analysis and reporting findings. The confidentiality and anonymity of individuals who agreed to participate in this research were maintained throughout. To disguise participant information, unique identifiers were created which were only used to identify associations between interviews and survey data if necessary. For qualitative data collection and analysis, names of the participants were not identified, instead, codes (e.g., SP01, FP 01, CIP01) were used. Particularly for the qualitative data, the researcher initially reviewed all interview transcripts to recognize and remove any data that divulges participants' information. For quantitative data collection and analysis, participant identifying information was not collected, and if any identifying information was provided by the participant, they were removed during the data analysis stage.

3.2 Phase I Qualitative

3.2.1 Phase I(a) Initial Exploratory Interviews

The aim of the initial exploratory interviews was to understand whether the researcher's topic is of interest to sample participants from academia and the construction industry (Glesne, 2011). The researcher conducted the interviews with two faculty members and four industry professionals. The interviews lasted less than ten minutes as the aim of this task in Phase I is to understand if there is interest from academia and industry in the proposed research study. The researcher asked the following three questions in each interview:

1. What is your opinion regarding training construction-related doctoral students for careers in both academia and construction industry?
2. Do you think there is a need to have doctoral students employed in the construction industry?
3. Would you be willing to participate if this research is further expanded to develop ways industry and academia can collaborate for construction -related doctoral education?

The details of the participants are provided in Table 1.

__Table 1__. Exploratory Interviews Participant Information

Participant	Designation	Affiliation
Participant 1	Associate Professor	Arizona State University
Participant 2	Associate Professor	Washington State University
Participant 3	CEO	Commercial Construction Company in the Western US
Participant 4	Innovation director	Commercial Construction Company in the Western US
Participant 5	Director of Virtual Construction	Heavy Civil Construction Company in the Midwestern US
Participant 6	Director of Scheduling	Residential Construction Company in the eastern US

The initial exploratory interviews informed the research that there is a need and interest from both academia and the construction industry regarding preparing doctoral students for multiple career paths. Therefore, exploring a multiple career path construction-related Ph.D. program is warranted at this time. This instilled confidence in the researcher to go ahead and perform further research in this area. The following section discusses the in-depth qualitative interviews conducted with current construction Ph.D. students, construction Ph.D. graduates, faculty, and industry professionals to assess their perceptions regarding preparing construction focused Ph.D. students for both academic and industry careers.

3.2.2 Phase I(b) In-depth Interviews

3.2.2.1 Participants and Procedure. Qualitative data was collected from in-depth interviews using semi-structured and open-ended questions. Collecting qualitative data through interviews allowed for a thorough exploration of the topic (Charmaz & Belgrave, 2012) and the semi-structured format offered participants enough time and scope to provide their perceptions while also allowing the researcher to follow up on emerging ideas (Nohl, 2009). A purposive maximal variation sampling (Creswell & Clark, 2018) combined with snowball sampling (Johnson, 2014; Goodman, 1961) was adopted to include a diverse pool of individuals who hold different perspectives that suit the purpose of this study and that were available and willing to participate in the study. Purposive maximal variation sampling is a sampling approach where diverse individuals who are expected to hold different perspectives on the central phenomenon are chosen as participants (Creswell & Clark, 2018). Snowball sampling approach is a recruitment technique in which research participants are asked to assist researchers in identifying other potential subjects that are believed to have interest in the study (Johnson, 2014). The researcher used a combination of purposive maximal variation and snowball sampling to:

- Understand diverse perspectives regarding needs and ways to train construction Ph.D. students for multiple career pathways from multiple stakeholders such as students, faculty, and industry as these groups tend to have differing perspectives; and
- Identify additional participants by asking the already recruited research participants to assist.

To understand multiple perspectives and develop strategic factors for a multiple career pathway Ph.D. program, it is important to include a wide variety of stakeholders involved in a construction-related doctoral education. Therefore, this study included participants from different categories: (a) students (b) faculty (c) construction Ph.D. graduates working in the industry and (d) industry professionals. It is important to consider perceptions of these different categories of participants because each category of participants have distinct and unique perspectives regarding needs, expectation, and skills required by doctoral students to be employable and successful in multiple careers within the construction industry or academia.

3.2.2.2 Data Collection. The data for the qualitative phase of this study came primarily from interviews with students, faculty, construction Ph.D. graduates working in the industry and construction industry professionals. After receiving IRB approval, participants were recruited based on their interest and availability. The student participants were identified and recruited based on following criteria:

- currently pursuing Ph.D. degree in construction emphasis and close to graduation;

The faculty participants were identified and recruited based on the following criteria:

- Faculty (assistant, associate, or full professor level) at a construction-related discipline and that have advised or currently advising students pursuing Ph.D. degree in a construction-related discipline;
- current or past construction management graduate program faculty coordinator; or
- current or past program director/chair/head at a department that offers either a doctoral or master's degree in a construction-related field

The industry participants were identified and recruited based on the following criteria:

- currently working in construction industry after completing a Ph.D. degree in construction field emphasis; or
- works for a construction company at a managerial/leadership/executive role that currently employs Ph.D. graduates; or
- works at a managerial/leadership role in Innovation Development or Research & Development teams at construction companies; or
- show interest in collaborative doctoral education in a construction-related field.

Building from the literature review, open-ended, semi-structured interview questions were developed. Appendices D, E, and F provide the qualitative interview questions for students and Ph.D. graduates, faculty, and industry professionals respectively. The development of interview questions followed DiCicco-Bloom and Crabtree's (2006) recommendations that included experience/behavior questions, opinion/values questions, and knowledge questions. In addition to the open-ended questions, the researcher also asked follow-up probing questions (e.g., "could you provide an example") to provide an opportunity for the participants to elaborate on their responses, which helped to gain informative data and a deeper understandings of participants perceptions (Alam, 2005; Bogdan & Biklen, 2016; Rubin & Rubin, 2012). Furthermore, an interview protocol to guide the interview sessions was developed (See Appendix G).

Pilot interviews conducted in Phase I(a) assisted the researcher in examining the interview structure and provided an opportunity to make revisions on the interview questions prior to conducting the full study. The pilot interviews were conducted in August 2021, and the participants for pilot study were from the target population of this study. The pilot interview participants were told to point out unclear questions and ask questions, if they do not understand something. After completion of the pilot interviews, the researcher invited one of the pilot participants for review of interview questions. The researcher gathered feedback in the following ways: 1) during the interview, when participants asked for additional clarifications regarding any questions, 2) after the interview, when participants inquired as to why they were asked a particular question; and 3) after the interview, the researcher reached out to one previous pilot interview participant and requested an in-depth review. This resulted in reviewing and revising the interview questions to make them more clear and easily understandable to the full study participants. Appendix C (Table 84) provides a sample of the changes made to the interview questions from the pilot interviews feedback.

After understandability and quality of interview questions were improved through pilot interviews, the researcher contacted the potential participants via email and provided preliminary research information to seek their willingness to participate. The interested participants were provided with further details such as the purpose of the study, research goals, consent information, time commitment, interview dates and time availability, and meeting modality (e.g., in person, phone or Zoom). The participants that agreed to participate received the interview questions in advance of the scheduled interview, so that they were prepared and this helped them provide thoughtful answers. The researcher conducted a total of thirty-eight interviews that includes nine current construction focused Ph.D. students, eight faculty members working in construction related academic departments that offer Ph.D. degrees, and 18 construction Ph.D. graduates and industry professionals. Table 2, 3, 4 and 5 provide the participant information. The interviews were conducted in September and October of 2021. The interviews lasted between 45 and 90 mins. The interviews were recorded (with permission from the participants) and transcribed for analysis purposes. The transcripts and audio recordings are kept confidential and only accessible by the researcher.

Table 2. *Distribution of Interview participants (Students)*

Participant Identifier	Student Status	Regional Location*	Degree Title
SP01	Domestic	East South	PhD in Building Construction
SP02	International	Pacific	Ph.D. in Civil Engineering with a focus in Construction Engineering Management
SP03	International	South Atlantic	Ph.D. in Design, Construction and Planning with a concentration in Construction Management
SP04	International	Mountain	Ph.D. in Civil & Environmental Engineering with a focus in Construction Engineering Management
SP05	International	South Atlantic	Ph.D. in Civil Engineering with a focus in Construction Engineering
SP06	International	East South	Ph.D. in Engineering with a focus in Construction Engineering and Management
SP07	International	West South	Ph.D. in Engineering Sciences with a focus in Construction Management
SP08	International	Mountain	Ph.D. in Civil Engineering with a focus in Construction Engineering Management
SP09	International	South Atlantic	Ph.D. in Design, Construction and Planning with a concentration in Construction Management

**Regions as categorized by the U.S. Bureau of Census in 2007*

__Table 3.__ Distribution of Interview participants (Industry)

Participant Identifier	Designation	Company Type and Experience	Education	Construction Experience
CIP01	President	Construction Consultant firm	Masters	30 years’
CIP02	Chief Operations Officer	International Construction firm	Bachelors	35 years’
CIP03	Vice President - Training	International Construction firm	Ph.D.	25 years’
CIP04	Chairman	Regional Construction firm	Masters	40 years’
CIP05	Lead – University relations	Construction Technology firm	Ph.D.	25 years’

__Table 4.__ Distribution of Interview participants (Faculty)

Participant Identifier	Region Location	Department
FP01	Pacific	College of Built Environment
FP02	South Atlantic	Department of Building Construction
FP03	South Atlantic	Design, Construction, and Planning Department
FP04	Pacific	School of Civil and Construction Engineering
FP05	South Atlantic	Civil, Construction, and Environmental Engineering
FP06	West North	Civil, Construction, and Environmental Engineering
FP07	West North	Civil, Construction, and Environmental Engineering
FP08	West South	Civil Architectural and Environmental Engineering

**Regions as categorized by the U.S. Bureau of Census in 2007*

Table 5 shows information for the construction-focused Ph.D. graduate participants that work in the construction industry. This list of participants is very crucial in this study as they have perspectives both from the Ph.D. student side and the industry side. Saturation, or the point at which data is no longer providing new information, dictates sample sizes in qualitative research (Strauss & Corbin, 1998). This study took a different approach as true saturation was not achieved. Saturation was observed for some interview questions, and new information was coming for a few questions. For example, a question related to the benefits of multiple career path preparation achieved saturation within the groups of participants. However, a question related to different knowledge areas/courses that must be taught to construction-focused Ph.D.

students gave new information every time, as students and recent Ph.D. graduates answered it based on their experience and expertise related to their unique dissertation topic.

The varied backgrounds of participants ranging from students to construction industry leaders are also one of the reasons for not achieving saturation. One of the primary reasons for recruiting these participants was their experience, expertise, and willingness to participate in the study. Implementing such a strategy, according to Simms and Rogers (2006), increases the richness of data due to the commitment of the interviewees.

3.2.2.3 Data Analysis. In Phase I, data analysis entailed transcribing the data, organizing it, breaking it down into manageable units, coding it, synthesizing it, and searching for patterns (Bogdan & Biklen, 2016). To analyze these data, the researcher transcribed the interview recordings. The researcher then thoroughly reviewed all the transcripts to gain an overall understanding of the data.

For Research Question 1, to understand various factors that influence construction-focused doctoral students' career choices, the analysis was guided by Social Cognitive Career Theory (SCCT) and Experiential Learning Theory (ELT). SCCT provided a lens for understanding student perceptions related to self-efficacy, future outcomes, and situational contexts related to their career choices. Additionally, ELT helped understand how educational experiences influence learning processes, needs, and resources, and provides the basis for future career-related decision making.

The researcher analyzed the data using thematic analysis (Nowell et al., 2017) open axial coding to identify, analyze, and report patterns to allow themes to emerge from the data. Braun & Clarke (2006) and King (2004) noted that thematic analysis is a useful method for examining the perspectives of different research participants, highlighting similarities and differences, and

Table 5. *Distribution of Interview participants (Ph.D. graduates working in industry)*

Participant Identifier	Graduation year Ph.D.	Designation after Ph.D. completion	Current Designation	Current Company size	Construction Experience prior/during Ph.D.
CIP06	2018	VP of Construction	VP of Construction & Strategic Innovation	Small	Internships
CIP07	2021	VDC Specialist	VDC Specialist	Large	Internships
CIP08	2017	Project Controls Specialist	Construction Program Manager and Global Research Lead	Small to Medium	Internships
CIP09	2021	Co-founder	Co-founder	Small	5 years
CIP010	2021	Sr. Preconstruction Engineer	Sr. Preconstruction Engineer	Large	Internships
CIP11	2018	Project Engineer	Sr. Project Engineer	Medium to Large	Internships
CIP12	2020	Project Manager	Project Manager	Small to Medium	Internships
CIP13	2020	Construction Project Manager	Director of Project Services	Small to Medium	20 years
CIP14	2015	Knowledge Management Consultant	Knowledge Strategy Manager	Large	Internships
CIP15	2019	Assistant Project Manager	Director, Strategy, and Innovation	Medium	Internships
CIP16	2019	Construction Technology Lead, Center of Innovation	Construction Technology Lead, Center of Innovation	International Technology firm	Internships
CIP17	2012	Senior Principal	Senior Principal	Medium consultant firm	25 years
CIP18	2015	Manager, Planning and Scheduling	Director, Planning and Scheduling	Large Construction firm	8 years
CIP19	1998	Project Manager	Managing Director	Medium Research firm	4 years
CIP20	2009	Project Controls Specialist	Director of Schedule and Risk Management	State Government	Internships
CIP21	2015	Project Manager	Construction Program Manager	Large Utility firm	Internships

generating unanticipated insights. Considering the exploratory nature of the Phase I research, thematic analysis was selected to capture important themes of information that could be relevant to this study.

In addition, a constant comparative method Glaser and Strauss (1967) was used to analyze the data. The constant comparative method was advocated by Glaser and Strauss (1967) as part of their grounded theory approach, and it can be used in all kinds of qualitative data analyses as it relies on constantly comparing and contrasting the collected data (Sage Research Methods, 2015). The data from multiple sources was analyzed and themes among and between students, faculty, and industry professionals were identified by constantly comparing and contrasting. All coding in this study is considered "in vivo" because the codes came from the exact words of the participant (Creswell & Clark, 2018). The researcher used the latest version of the NVivo software platform to perform the content analysis, which helped to facilitate the better organization of the themes identified. In addition to Nvivo, the researcher also performed coding manually as the researcher found greater comfort and confidence by doing so. The opinions and perceptions of the participants collected in Phase I of the study that resulted in emergent themes helped the creation and modification of the questionnaire survey for Phase II of this study.

3.2.2.4 Trustworthiness. Trustworthiness and authenticity have been used as alternative terms for qualitative validity (Golafshani, 2003). During Phase I of the study, there is more of a focus on validity than reliability since there can be no validity without reliability in qualitative research, and a demonstration of validity is sufficient to establish reliability (Creswell & Clark, 2018; Golafshani, 2003; Lincoln & Guba, 1985). To ensure validity, the researcher used member checking where the summaries of interviews and findings were taken back to the participants and asked whether it was an accurate representation of their perception.

Furthermore, the researcher addressed validity concerns through triangulation (literature review, interviews, and survey) by collecting data from multiple sources and individuals involved in this study. The data was collected from students, faculty members, Ph.D. graduates working in the construction industry, and industry professionals, which was then corroborated.

The researcher addressed credibility, transferability, dependability, and confirmability concerns. Credibility refers to the confidence that can be placed in the truth of the research findings and whether the research findings represent plausible information drawn from the participants' original data (Korstjens & Moser, 2018). Credibility in this study is addressed through member checking and data collection from multiple sources (Creswell & Clark, 2018). Representativeness also confirms the credibility of qualitative studies (Onwuebuzie & Leech, 2007), which was established in this study as participants with knowledge and experience related to construction-focused Ph.D. education only were selected.

Transferability refers to the degree to which the results of qualitative research can be transferred to other contexts and researchers address this through detailed and thorough description (Korstjens & Moser, 2018). This study addressed transferability by describing the participant behavior and experiences, and clearly explaining the context, and background of the research and the participants. This enables external researchers to assess whether this study's findings are transferable to other settings.

Dependability refers to the stability of the data and the evaluation that the findings are supported by the data (Nowell et al., 2017). Additionally, the perspective of the researcher for this study was also provided (refer Chapter 1.10), to inform readers about the researcher's bias. According to Lincoln and Guba (1985), dependability can be addressed when outside researchers can examine the research process.

Confirmability refers to establishing that the data and interpretations of the findings are not figments of the researcher's imagination, but clearly derived from the data (Korstjens & Moser, 2018). Dependability and confirmability are addressed in this study by clearly and transparently describing the research process which is logical and traceable from the start of a research project to the development and reporting of the findings. However, Lincoln and Guba (1985) stated that confirmability is automatically established when credibility, transferability, and dependability are all achieved. In this way, this researcher established internal validity (credibility), external validity (transferability), and reliability (dependability and confirmability) for the qualitative phase of this study.

3.2.2.5 Researchers Role. The researcher was the primary data collector during the qualitative phase. All thirty-seven interviews were coordinated and conducted by the researcher. The researcher developed a protocol for the interviews, which is included in Appendix G. The researcher's role was not limited to data collection; but also conducted the interview analysis and coding.

3.3 Phase II: Quantitative

The quantitative phase (Phase II) started after completion of data collection and preliminary analysis from Phase I. This study is descriptive in nature and the intent to include quantitative phase is to obtain quantitative data to generalize and support the findings from qualitative phase that further supports the development of strategic factors for a multiple career preparatory construction focused Ph.D. program. Therefore, a survey technique, to collect the data was determined to be appropriate (Borg & Gall, 1989). The aim of the quantitative phase was to generalize the qualitative findings from a larger sample as survey techniques provide numeric descriptions of trends, opinions, attitudes, or perceptions of a population by studying a sample of that population (Creswell, 2014).

3.3.1 Participants and Response Rate

The target audience for the quantitative phase of the research are construction faculty, construction focused Ph.D. students, construction Ph.D. graduates working in the industry, and construction industry professionals.

3.3.1.1 Faculty. Faculty members working in the construction management department that possess Ph.D. degrees, teach undergraduate courses, graduate courses, and holding leadership positions (e.g., graduate program coordinator, department chair) were included in this phase. The researcher identified email contacts from respective websites of construction academic departments and reached out to them with the link to questionnaire survey. A total of 750 construction faculty members were contacted to complete the survey, out of which 77 responses were recorded, only 71 responses (9.4% response rate) were valid and are used. The demographics of the faculty participants are provided in Table 6.

Table 6. *Demographics of faculty participants*

Demographics	N	Percentage
Total Participants (N)	71	
Current role		
Assistant Professor	37	51%
Associate Professor	9	13%
Professor	16	23%
Leadership positions	9	13%
Department offers Ph.D.		
Yes	36	51%
No	35	49%
Construction experience		
Yes	63	89%
No	5	7%
Intern Exp	3	4%

3.3.1.2 Construction Focused Current Ph.D. Students. The current construction focused Ph.D. students were included in this study. The researcher used snowball sampling approach to identify the student participants for this study. Initially, the researcher gathered a contact list of 100 current construction Ph.D. students from university websites and social media pages (LinkedIn). The researcher then sent the questionnaire survey to these gathered contacts and requested them to forward the invitation to other relevant contacts. The researcher additionally reached out to construction management department administrators, construction student clubs and faculty members research groups to recruit more student participants for the survey. A total of 100 current construction focused Ph.D. students were initially contacted to complete the survey, and the survey recorded 50 student responses (50% response rate). However, this cannot be considered as the true response rate as the researcher adopted snowball sampling and contacted administrative staff at various construction Ph.D. programs and requested them to share the survey link with their Ph.D. students. The demographics of the student participants are provided in Table 7.

Table 7. *Demographics of student participants*

Demographics	N	Percentage
Total Participants (N)	50	
Student Status		
Domestic	15	30%
International	35	70%
Construction Experience		
Yes	33	66%
No	17	34%
Current Year of Ph.D.		
Year 1	11	22%
Year 2	8	16%
Year 3	8	16%
Year 4	14	28%
Year 5 and beyond	9	18%

3.3.1.3 Construction Focused Ph.D. Graduates Working in the Construction Industry. The current construction focused Ph.D. graduates were included in this study as they would give perspectives of both academia and industry. The researcher identified a snowball sampling approach to recruit participants from this category. Initially, the researcher gathered a contact list of 70 construction focused Ph.D. graduates that are working in the construction industry from social media pages (LinkedIn). Contacts were emailed and requested to forward the questionnaire survey to others deemed fit for this study. A total of 25 responses were recorded indicating a response rate of 35.7%. However, this is not true response rate as the actual number of relevant participants that are reached out (snowball sampling) is unknown. The demographics of the Ph.D. graduates that participated in this study are provided in Table 8.

Table 8. *Demographics of Ph.D. graduate participants*

Demographics	N	Percentage
Total Participants (N)	25	
Status		
Domestic	8	32%
International	12	48%
Not prefer to answer	5	20%
Industry experience prior to Ph.D.		
Yes	20	80%
No	5	20%
Size of Construction firm		
Small (< 36.5 million USD annual revenue)	6	24%
Small to Medium (36.5 million USD to 200 million USD)	5	20%
Medium (200 million USD to 600 million USD)	2	8%
Medium to Large (600 million USD to 1 billion USD)	2	8%
Large (more than 1 billion USD)	9	36%
Not prefer to answer	1	4%
Current roles		
Innovation Teams	10	40%
Project Management	9	36%
Leadership	6	24%

3.3.1.4 Construction Industry. Industry professionals with at least 10 years' experience working in the construction industry including construction leaders (e.g., directors, CEOs, CFOs, Vice Presidents) were included in the study. A snowball sampling approach was used, where contacts were sent the survey questionnaire and requested to forward the invitation to their contacts. The researcher additionally reached out to Construction Management Association of America member list, thereby reaching out to about 7,500 construction industry professionals. A total of 197 responses were recorded, indicating a response rate of 2.62%. However, this is not true response rate as the actual number of relevant participants that are reached out (snowball sampling) is unknown. However, a total 18 responses were discarded as they do not fit the study's requirements. The demographics of the construction industry professional participants are provided in Table 9.

Table 8. *Demographics of industry participants*

Demographics	N	Percentage
Total Participants (N)	179	
Type of Construction firm		
General Contractor	88	49.16%
Sub-Contractor	1	0.56%
Construction Technology firm	2	1.12%
Construction Consultant	87	48.60%
Construction Allied firm	1	0.56%
Construction Sector		
Heavy Civil/Highway/Infrastructure	122	68.16%
Residential	21	11.73%
Industrial	55	30.73%
Commercial	78	43.58%
Electrical	34	18.99%
Mechanical	37	20.67%
Size of Construction firm		
Small (< 36.5 million USD annual revenue)	35	19.55%
Small to Medium (36.5 million USD to 200 million USD)	22	12.29%
Medium (200 million USD to 600 million USD)	19	10.61%
Medium to Large (600 million USD to 1 billion USD)	16	8.94%
Large (more than 1 billion USD)	87	48.60%
Experience		
10-15 years	35	19.55%
16-20 years	24	13.41%
more than 20 years	120	67.04%

Table 9 *(continued)*

Demographics	N	%
Highest level of Education		
High School	6	3.35%
Associates Degree	3	1.68%
Bachelor’s degree	84	46.93%
Master’s degree	81	45.25%
Doctorate degree	5	2.79%
Current Role		
Executive role (E.g., CEO)	13	7.26%
Leadership role (E.g., Vice President, Head)	65	36.31%
Managerial role (E.g., Program Manager)	67	37.43%
Consulting role	15	8.38%
Others (Directors, Engineers, Leads, Chiefs)	19	10.61%

3.3.2 Survey Instrument and Data Collection

Researchers use survey questionnaires to collect data that describes participants perspectives, opinions, beliefs, attitudes, and values (Creswell, 2014). The survey instrument used in the quantitative phase of this study was developed from the literature review and preliminary findings from the qualitative phase (interviews with Ph.D. students, Ph.D. graduates, faculty and construction industry professionals). The survey collected information related to participant demographics, participant perceptions related to competencies required by construction focused Ph.D. students for employment in academia and construction industry, and perceptions related to opportunities to be provided for preparing construction Ph.D. students for multiple career paths. The survey instrument is a five-point Likert questionnaire. The participants were asked to select from 1 to 5, where one is described as “not important” and five is described as “very important”. Appendix H provides the survey instrument used in this study.

The survey was hosted and distributed electronically via Qualtrics platform to collect the data from respondents. As the study sought IRB approval from CSU, those details are provided, and the participants were requested to provide consent before participating in the survey. The survey was kept open for 45 days, and three reminders were sent to all potential participants to improve the response rate. The survey was closed on December 20, 2021, in order to begin the analysis process.

3.3.3 Pilot Survey

A pilot survey was conducted to verify that the designed survey would work in practice and have an opportunity to gather feedback to make necessary revisions to improve the survey instrument prior to conducting the full study (Arain et al., 2010). The participants of the pilot survey were similar to target population and included five construction Ph.D. students, three construction Ph.D. graduates, three construction faculty, and two construction industry professionals. The pilot survey was conducted to assess reliability, clarity of the wordings of the survey questions, the flow and format of the survey, and to determine the time required to complete the survey. The pilot survey test informed that the survey questionnaire functioned well, and it took in between 15 and 25 mins for the respondents to complete the survey. The researcher collected written feedback from all pilot survey participants, and additionally met with three pilot participants to understand if any changes are required in the questionnaire wordings. The pilot participants provided suggestions for improving the questionnaire's format, language and grammar, and scale instructions. The pilot survey feedback and changes made to the actual survey are provided in Appendix C (Table 85).

3.3.4 Data Analysis

The data from survey was analyzed using descriptive statistics using the latest version (version 28) of SPSS. Descriptive statistics are useful in determining the perceived needs and understanding the opinions of a larger sample of participants. A reliability analysis was conducted to test internal consistency of measures using Cronbach’s alpha along with ensuring validity concerns.

3.3.5 Reliability Analysis

Reliability refers to consistency of a series of measurements (Cronbach, 1990). If the survey cannot collect and provide reliable data, then the results of the data cannot be measured accurately. This study ensured internal reliability for the survey instrument by calculating the Cronbach's alpha. For questions in the surveys that have multiple choices, such as a Likert scale, Cronbach's alpha is the most appropriate method of choice to determine reliability (Gliner et al., 2016). Internal consistency was determined using a minimum value of.70, as a Cronbach's alpha value of.70 or greater is considered to be sufficient reliability (Nunnally & Bernstein, 1994). The Cronbach's alpha for competencies for academia is 0.801. The Cronbach's alpha for competencies for construction industry is 0.764.

3.3.6 Validity Concerns

Due to the fact that this study did not measure any constructs, the measurement validity was determined by the evidence presented in five areas.by Gliner et al. (2016); content, response process, internal structure, relation to other variables, and consequences. Table 10 provides a summary of this study's response to the aforementioned measurements.

Measurement validity based on content is considered strong because the survey was piloted and reviewed multiple times by the researcher, faculty advisors, and it was agreed that the survey content could collect the data intended to be collected. Measurement validity based on response progress is considered strong because the survey was web based and anonymous meaning it mitigates socially desirables answers and improves the honesty of the responses.

Additionally, the influence of the external environment is also minimal because the survey is voluntary. Measurement validity based on internal structure and relation to other variables is weak because the survey did not measure any construct and therefore these aspects are not evaluated. Although, the relationship between the survey questionnaire, study design and study's goal to develop the strategic factors are explained, it is considered that the explanation is subjective and without objective numerical quantification, these are considered weak. Measurement validity based on consequences is strong because there weren't any negative consequences that were identified, and positive consequences could be creation of awareness regarding employing Ph.D. graduates in the construction industry.

Table 9. Measurement Validity

Validity aspects	Strength (Gliner et al., 2016)	Explanation
Content	Strong	Revised based on the pilot survey feedback. Review of survey by all participant categories.
Response Process	Strong	No social pressure/influence as survey was online and anonymous
Internal Structure	Weak	No factor analysis or differential item functioning because of the study goals
Relation to other variables	Weak	Not applicable as no construct is measured, and not any variables are interlinked with each other
Consequences	Strong	No negative consequences to participants were identified.
Overall	Medium	Three strong and two weak means, overall medium

3.3.7 External Validation

Furthermore, it is also important to ensure external validity. External validity refers to the extent to which samples, settings, treatment variables, and measurement variables can be generalized beyond this study (Creswell, 2014). The representative sample included construction focused Ph.D. students (international, domestic, students with industry experience, students without industry experience), construction faculty (assistant professors, associate professors, professors, department chairs, grad program coordinators), construction Ph.D. graduates working in the industry, construction industry professionals (small, medium, large general and sub-contractors, CEO's, VP's, and project managers across various domains such as commercial, heavy civil, etc.). This helps establish the external validity.

Additionally, based on the qualitative and quantitative findings from this study, strategic factors for recommendation for students, faculty and construction industry are developed to prepare construction focused Ph.D. students for multiple career paths. The developed strategic factors are further validated (externally) through a process referred to as “vetting”. Vetting is an external validation technique that refers to evaluating the quality of research product (Lucko & Rojas, 2010; Craigie et al., 2020). The vetting for this study included construction focused Ph.D. students (2), construction faculty (3), construction Ph.D. graduates working in the industry (1), and construction industry professionals (1) to understand practicality of implementation and aspects that work well or do not work well with respect to the strategic factors for recommendations. The developed recommendations were sent to vetting participants (combination of same participants from interviews and new participants that showed interest in this study) and they were asked to provide their feedback as well as opinion regarding the implementation and practicality of the recommendations as per the external validation guidelines provided by Creswell (2014). The vetting questions asked for overall effectiveness of the recommendations, feasibility/practicality of implementing the recommendations, and challenges and suggestions for improving the recommendations.

Overall, the feedback gained from the vetting participants provided general acceptance of the recommendations provided through this research. The general feedback regarding acceptance and effectiveness of the recommendations are provided in Table 11. The participants also mentioned about suggestions to improve the effectiveness of the strategic factors. The trend of responses (Table 12) highlights two particular factors, the skillsets required by advisors to advise Ph.D. students to perform research balancing theory and application, as well as communicating the research effectively to industry.

Table 10. *Feedback Comments from vetting participants*

Participant	Feedback Comments
Faculty A	This is a comprehensive list of things to support Ph.D. student careers. All of the recommendations seem effective
Faculty B	The strategic factors and recommendations are well structured and considers the needs of academia and industry from PhD programs and graduates
Student A	This is a great guidance for students. It provides guidance not only for industry jobs, but also for effective academic job preparation
Student B	I wish I had known this in my first year of Ph.D. This is an excellent set of strategic factors, and this kind of information is very much required for both students and faculty advisors
Ph.D. Graduate	Ph.D. programs can incorporate these recommendations in a variety of ways. I believe it is an excellent list that provides numerous avenues for success
Industry Professional	I agree with all points listed in the recommendations.

Another suggestion was to develop more understanding regarding the university-industry collaborative model. It is important to note that these topics of out of scope for this dissertation, and the research plans to expand on these topics for future studies.

Table 11. *Suggestions for Improvements Comments from vetting participants*

Participant	Challenges and Suggestions for Improvements Comments
Faculty A	A model for university-industry collaborations requires effort and commitment from both sides. Developing the framework for the university-industry model itself makes this more effective
Faculty B	If advisors are unsure about a good balance between theory and applied research, and effectively communicating research in a language relevant to industry it makes it difficult for the success of this model
Faculty C	Changing university incentives for faculty can take decades. Training programs for PhD students require instructors and administrators, which isn’t feasible for small programs.
Student A	The university and faculty need to have a good structure to include industry members and companies in the university-industry collaboration process
Industry Professional	Recognize the types of resources and investments that university programs and partner companies would need to make to create university-industry collaborative programs

3.4 Chapter Summary

This study is guided by exploratory sequential mixed methods design that consisted of qualitative interviews and quantitative questionnaire survey. The collection and analysis of qualitative data was followed by collection and analysis of quantitative questionnaire data. The qualitative findings were used to develop the questionnaire survey, while the data from both the phases helped understand the needs and expectations of students, faculty and construction industry professionals which aided the development of strategic factors that provides educational experiences to prepare construction Ph.D. students for multiple career paths. This study contributes to the body of knowledge by providing the understanding of various factors that determine construction Ph.D. students career choices, core competencies required by Ph.D. students to be successful in multiple careers, unique ways to prepare construction Ph.D. students for multiple careers, and benefits of preparing construction Ph.D. students for multiple careers as perceived by construction Ph.D. students, construction Ph.D. graduates, faculty, and industry professionals. Creation of strategic factors that provides educational experiences for construction Ph.D. students for multiple career paths not only provides them with wide variety of career opportunities but also provides them an opportunity to understand what a good fit for them is.

CHAPTER 4: RESULTS

The objective of this study is to demonstrate the need for multiple career path training in construction doctoral education, determine competencies required by construction Ph.D. students to be employable in diverse career paths, develop recommendations and strategic factors for construction Ph.D. programs to prepare students for multiple career paths, and understand the perceived benefits. As a reminder, the following are the research questions that guide this study:

RQ1. What factors are influencing current construction focused Ph.D. students to pursue multiple career paths (academia and industry)?

RQ2. What are the core competencies required by construction focused Ph.D. graduates to be employable in multiple career pathways (academia and industry)?

RQ3. What are the different ways construction focused Ph.D. programs can prepare students for a variety of career options?

RQ4. How would a construction focused Ph.D. program that prepares students for multiple career paths benefit the construction industry, students, and academia?

For each research question, the quantitative results are followed qualitative, as they are intended to complement each other. The results of this study indicate

- Construction-focused Ph.D. students are equally interested in industry-related career choices alongside academia similar to students in other STEM doctoral programs.
- Factors influencing construction Ph.D. students for academic careers: interest in teaching and research, passion for student mentoring and engagement, flexibility in working hours, support from an advisor, unawareness about non-academic opportunities, and satisfaction obtained from teaching
- Factors influencing construction Ph.D. students for non-academic careers: better salaries, ability to make a difference and advance construction industry, disinterest in

academic culture, lack of enough academic jobs, no support from an advisor, and competitive academic funding climate.

- Written and oral communication, problem solving skills, and critical independent thinking competencies are most important in employability success of construction Ph.D. students in both academic and industry career paths.
- Opportunities to complete industry internships, performing research relevant to construction industry's challenges by balancing both theory and practice, support from advisor related to either of the career choices, networking with both academic and industry professionals are important strategies to prepare construction Ph.D. student for diverse career paths.
- Preparing construction Ph.D. students for diverse career paths not only improves employability of Ph.D. students but also enhances university-industry research collaborations and improves the ability of construction industry to constantly innovate, adopt technology, and gain access to university research relevant to their needs.

4.1 Research Question 1 Qualitative Findings

To answer this research question, the participants included are nine current students pursuing Ph.D. in construction emphasis ranging from Year III to Year VI of doctoral degree. In terms of experience working in the U.S. construction industry, the participants (n=4) have internship experience (SP01, SP02, SP03, SP04), while one student (n=1) has 3.5 years of construction industry experience (SP09), and four students (n=4) do not have any industry or internship experience (SP05, SP06, SP07, SP08). A majority of the participants (n=8) were international students (SP02 to SP09); one participant (n=1) is a domestic student (SP01).

4.1.1 Career Choice

This study originated based on an assumption from literature review that an increasing number of STEM doctoral graduates and students prefer careers beyond academia (NSF, 2017). As construction focused degrees are offered through STEM designated departments, it was assumed significant number of construction-focused doctoral students prefer employment beyond academia. The first step in the study was to identify if the assumption was correct. In addition to validation of the study's assumption, it is also important to answer questions such as "What do construction focused Ph.D. students want?", "What type of careers do construction-focused Ph.D. students wish to obtain after they finish the Ph.D. degree?" to recommend changes and improve the current construction-related Ph.D. programs based on the students' needs. This information will also help develop a set of strategic factors for multiple career path preparation.

Out of the nine construction focused Ph.D. students that participated in the qualitative phase, four students (45%) preferred immediate employment in academia (SP01, SP04, SP05, SP08) after completion of Ph.D., four students (45%) preferred immediate employment in the construction industry (SP03, SP06, SP07, SP09) after completion of Ph.D., while one student (SP02) (10%) is unsure about their career choice. All four students that primarily preferred employment in academia post completion of Ph.D. informed that their second choice of employment is the construction industry. Two students that prefer immediate employment in the construction industry further informed that they would like to take up some kind of academic position in the future after getting hands-on construction experience in the industry. The other two students that preferred employment in the construction industry informed that they want to find a career in the industry and contribute to the advancement of the construction industry. They mentioned that they would most likely not pursue an academic career. One student who is unsure of their career choice informed that they are confused between the academia and industry career choice as they find positives and negatives in both career choices, and further said they would prefer a career choice that comes their way first. This indicates that construction-focused Ph.D. students do not just consider industry employment as an alternative career choice but consider it as a primary career choice. Table 11 provides demographic details and career preferences of all qualitative participants.

Table 12. *Career preference of student participants*

Participant Identifier	Year in Ph.D.	Student Status	US Industry / Internship Exp	Preference
SP01	III	Domestic	1 Internship	Academia
SP02	IV (final)	International	1 Internship	Unsure
SP03	V	International	3 Internships	Industry*
SP04	IV	International	1 Internship	Academia
SP05	V (final)	International	None	Academia
SP06	IV	International	None	Industry*
SP07	V (final)	International	None	Industry
SP08	VI (final)	International	None	Academia
SP09	VI (final)	International	3.5 years Industry	Industry

*Indicates students that are interested in academic position at later point in their careers

Furthermore, all students that participated in this study opined that despite their interest in construction industry-related career choice, the support from their universities to kick start their careers in industry is very minimal. A student (SP06) interested in an industry career mentioned:

> I enrolled in the Ph.D. degree immediately after my Masters, because my advisor opined, I will do well, and he offered me a fully funded Ph.D. position. I want to work in the industry after completion of my Ph.D. degree, but there is no support either from my department or my advisor to pursue a career in the industry. I have been struggling to even find an internship.

This indicates the struggles and needs of construction-focused Ph.D. students interested in career beyond academia. Another student (SP09) that is interested in an industry career mentioned:

> I don't want to say that our university wouldn't provide training for industry and other careers, but it seems very much geared towards academic jobs.

This indicates that the academic departments focus mostly on preparing the construction-focused Ph.D. students for academic careers. An international student (SP07) interested in a construction industry career said:

> I am not at all interested in the academic career. I want to work in the construction industry. But our university system considers Ph.D.'s only for academia. I feel I'm not a good fit in academia, and I even thought of dropping out from Ph.D. because I cannot stay in academia and there's no support for industry career. But I will then lose my visa. What do I do now? I want the education system in construction management to realize that Ph.D. students in construction are interested in industry careers similar to Ph.D. students in biology or pharma or whatever.

This implies that construction focused Ph.D. students may prefer industry careers, and there is a need for academia to recognize this and provide resources to train Ph.D. students for multiple career paths in academia and construction industry.

4.1.1.2 Factors Influencing Construction Focused Ph.D. Students' Career Choice. To identify various factors that influence the career choice of current construction-focused Ph.D. students, the author performed a theory-driven thematic analysis (Boyatzis, 1998) using social cognitive career theory (SCCT). Each construction-focused Ph.D. student that participated in this study noted multiple factors that influence their career choice. Below, I organize themes among participant responses based on the SCCT variables and presented below. Appendix I provides a sample comprehensive list of keywords and coding process used in the analysis for answering this research question.

4.1.1.3 Self-Efficacy Beliefs. Self-efficacy beliefs play a major role in the career choice determination of Ph.D. students (Choi et al., 2012). Three construction-focused Ph.D. students (33%) that participated in this study provided responses that can be classified as self-efficacy beliefs when asked about factors that impact their career choice. A student (SP05) that is interested in an academic career added that:

> All my background is in academia. I like teaching in the form of mentoring, interacting with students, and teaching specific classes. I always hear my students giving great feedback, appreciating my teaching abilities. This tells me that I’m a good teacher, and my career as a teacher will be successful.

Another student (SP09) that is interested in industry career, and not at all interested in an academic career mentioned:

> After finishing my Ph.D., I will only prefer [employment in the] construction industry. I do not want to teach classes and grade papers. I cannot do that, no offense to instructors, but that is not my calling. I am not confident enough to teach a class.

This student also mentioned that they did not get enough opportunity to teach classes in their Ph.D. education, which is one potential reason for low self-confidence about their teaching abilities. The same student (SP09) further added:

> I’ve always liked the research aspect of construction industry and enjoyed doing research for my state DOT as a part of my responsibilities as research assistant. Several times, I’ve been praised by my advisor, and research project owners for my research skills. This increased my confidence, my ability and future interest to perform research. This strongly motivates me to pursue a research career in the industry or a career in the [construction] industry that involves some research.

This indicates that self-efficacy beliefs about their abilities to teach, research or work in the industry impact their confidence be successful in those particular roles/responsibilities and influence the career choices of construction focused Ph.D. students. A student (SP02) who is unsure about their career choice mentioned:

> I don't want to be a researcher. I don't think I'm good at it. Now, I'm even thinking why I started a Ph.D. because of the research and writing component. I'm sick and bored of writing. I don't want to write. I do not feel satisfied with my writing. It's really hard and difficult.

This indicates that low self-efficacy beliefs regarding tasks associated with a particular career influences construction focused Ph.D. students against those career choices.

4.1.2 Outcome Expectations

Outcome expectations are one of the important factors that determine the career choice of students (Betz & Voyten, 1997). Four construction-focused Ph.D. students (45%) that participated in this study provided responses that can be classified as outcome expectations when asked about factors that impact their career choice. These factors include salaries, flexible work schedule, satisfaction obtained, and location of working. Talking about the influence of flexibility on the career choice, a student interested in an academic career (SP01) said:

> I want time and work flexibility. A career in academia would let me be on campus on the days I want, and then I do not have to be at work when I do not teach. I have kids, flexibility is very important to me.

Another student interested in an academic career (SP04) added:

> I will have the flexibility to teach classes of my choice, the freedom to conduct research in multiple areas, pursue my unique inter-disciplinary research goals in collaboration with researchers from other disciplines and departments [with a career in academia].

Another student interested in an academic career (SP08) added:

> My career choice? I think it is a lifestyle choice than a career choice. Because, if I were to go into construction industry, I will have a lot less time. I want to be family oriented. If I stay in academia, I will become my own start-up. I know I need to get grants, write papers, teach classes, graduate students, and more…but all of this can be done at flexible times. I can support my husband, help my kids while I still meet my professional needs because of the flexible working hours. Construction industry jobs will not give that flexibility.

Adding to this, a student interested in an industry career (SP06) said:

> You get to live in a city [when you work in industry] rather than living in a small student town [working in academia]. The living standards and comfort of life are important after completion of Ph.D. The work-life balance is also important. In the industry, with a Ph.D., you have an 8am to 5pm job, but in academia, you have to pretty much work 11-12 hours a day for 6 days a week in the initial 3-5 years [as you have] to do a bunch of specific things like the grants, the publishing, graduate students, and all of that before [getting] tenure.

This indicates that flexibility with respect to work hours, type of work, comfort, living standards, and lifestyle outcomes influence the career choice of construction Ph.D. students. It is also evident that construction-focused Ph.D. students that are concerned about flexibility regarding work timing and type of work are inclined towards academic careers while students that are concerned about comforts, living standards, and location of work, as well as living, are inclined towards industry careers. Talking about the satisfaction that comes from a career, a student interested in academia (SP05) said:

> [I am interested in academia because] teaching gives me a lot of satisfaction. [As I mentioned earlier], when I receive good feedback from my students and mentors about my teaching, that gives me immense happiness. I would want to be in academia, teach classes, and do research just because it gives me satisfaction incomparable to anything else in life.

Adding to this, a student interested in industry career (SP03) said:

> A construction jobsite poses new challenges every day. A construction project has several uncertainties that need to be resolved to make profits. As an intern, when I worked, I used to figure out those uncertainties using the skills I attained from my Ph.D. When I implemented UASs for a job, it gave me high, satisfaction that I contribute to the advancement of our industry. I want that all throughout my career, the satisfaction that I advance construction industry and make difference to capital projects using skills I gained through my Ph.D.

This indicates that outcome expectations regarding satisfaction from a career influences the career choices of construction-focused Ph.D. students. Looking at other aspects related to outcome expectations, a student interested in an industry career (SP06) mentioned:

> The salaries are high in the industry when compared to academia. Academia doesn't offer more than 70-75k per annum, while industry definitely offers more.

Another student (SP02), that is unsure about their career choice said:

> [After finishing my internship this summer] I was offered a full-time job. They offered me a very good package. When I informed my advisor about the pay, they mentioned that they make less than that [was offered to me] after 6 years of being in academia. I was surprised. I want money, good money after working so hard for four years for my Ph.D. I deserve good money.

This indicates that outcome expectations regarding salaries for academics and industry employment influences the career choices of construction-focused Ph.D. students.

A plethora of outcome expectations from a career such as flexibility with respect to work hours, type of work, comfort, living standards, lifestyle, personal and professional satisfaction, and salary influence the career choice of construction-focused Ph.D. students.

4.1.3 Career Interests and Goals

Two construction-focused Ph.D. students (22%) that participated in this study provided responses that can be classified under Career interests and goals when asked about factors that impact their career choice. The participants described how career interests and goals directly influenced their career choices and provided examples of their goals and interests. One student informed how their interests led to their career choice while another student described their career choice as something they always wanted. A student participant (SP01) interested in an academic career said:

> My career goal was very focused. I want to become an assistant professor, teach and do research. I have been teaching for four years and I love talking to the students. I have a great passion for research. So, my career choice is clear, I want to get into academia. My career goal is to teach, and my career preference is academia.

Another student participant (SP06) interested in industry career said:

> I always want to work in latest technologies for built environment innovation teams. I can find these roles only in the industry, and hence I prefer employment in the construction industry.

This indicates that clear career goals and career interests influence career choices of construction-focused Ph.D. students as this study identifies that student who complete their Ph.D. with a clear career goal in mind as well as interests are influenced towards a career choice that is in line with their goals and interests.

4.1.4 Contextual Influences

Contextual Influences determine the career choice of Ph.D. students (Huang & Hsieh, 2011). Three construction-focused Ph.D. students (33%) that participated in this study provided responses that can be classified under contextual influences when asked about factors that impact their career choice. Talking about the reasons for inclining towards a career in industry, a student (SP03) interested in a construction industry career while also considering an adjunct teaching position said:

> One reason [for immediate industry employment interest] is - if you see most of the professors who are highly successful, they have certain kind of industry experience. They know how industry works. They know the practical and applied side of construction. That way, my teaching will become effective.

Another student (SP06) interested in industry position as well as in some kind of adjunct teaching position said:

> I have seen Assistant professors that joined academia without any industry experience who are not at all effective in teaching. I have also seen Assistant professors that worked in industry for few years after completion of their Ph.D. and came back to academia. These [professors] have a lot of knowledge and share real project experiences in the class. If I can't imagine myself what's happening on a job site, how can I be a good teacher?

This indicates that construction experience and exposure, influence the career choice of construction Ph.D. students. In both the cases, the students want to teach at some point of time in their career. They realize through their experiences (contextual influence) with other professors that have industry experience that they cannot be successful in academia without industry knowledge, and this influences their career choice. Talking about other contextual influences, a student (SP02) said:

> I like teaching because I grew up in a family where more than 50% of my family members are teachers. This motivates me to pursue a career in academia.

This indicates that influences from family, friends and other people around determining the career choices of construction-focused Ph.D. students. Three students (SP07, SP09, SP03) that participated in this study raised concerns about the culture of academia that influences their career choice. One student (SP09) said:

> The culture in academia is not for me. I cannot play politics within the close-set of people that I work with, I cannot fight over who gets a new graduate student, I cannot fight for tenure with other colleagues.

Another student (SP07) added:

> You have to play too many games to be successful in academia. It is not just about your talents; it is how well you can play those games. I cannot play those games. Because of this, I want to work in industry.

This particular student participant did not have any experience in the industry, and yet they prefer a career in the industry because they do not like the academic culture. In this particular case, an opportunity for the students to experience the construction industry will give them the ability to make better decisions related to their career choice. This informs the impact of culture in academia on the career choice of construction-focused Ph.D. students.

4.1.4.1 Other Factors. This study discovered several other factors that influence the career choice of construction-focused Ph.D. students that cannot be classified under any of the SCCT-driven categories. Although some of these can be categorized using SCCT, the researcher opines these deserve special attention and are therefore called out specifically below.

4.1.4.1.1 Support From Advisor. A pattern that has been observed from several of the participants (n=4) is the support of advisors regarding a Ph.D. student's career choice. A student (SP07) who is interested in an industry career as an alternative said:

> My advisor always says, 'You should do an academic job.' When I expressed my alternative career choice in the industry, he said, 'No, I don't support you for an industry job.'

Another student (SP06) added:

> If I tell my advisor that I am interested in an industry career. I'm scared, he will abandon me. He [advisor] thinks I am going to pursue a career in academia. But I am not interested in an academic career. I am struggling to identify resources and opportunities to obtain an industry job without his support. I wish he[advisor] understands my career preferences.

This suggests that an advisor's support in favor of a career choice influences a student’s choice towards that career. Another student (SP03) interested in industry career choice said:

> My advisor asked me what my career interest is. I said I have no clue where I should go after finishing my Ph.D. He [advisor] suggested to me to do one or two internships. He suggested to me to teach a class or two. He encourages me in whatever I choose. This provided me with wide options.

This implies the crucial role advisors play in the career choices and needs of construction-focused Ph.D. students. This is a very concerning issue, and the advisers in academic construction departments need to understand the career choices of their construction-focused Ph.D. students.

4.1.4.1.2 Impact of Internship Experience. Four students (45%) that were interviewed as part of this study indicated that internships during their Ph.D. education had a meaningful impact on their career choices. A student (SP02) that does not have internship or work experience in the construction industry before enrolling in the Ph.D. program said:

> I worked with Great Constructions (pseudonym) as an intern last year. The internship experience changed my whole perspective around my career choice. I worked on a very unique project that involved retrofitting underground tubes between San Francisco and Oakland. The project was very challenging and exciting at the same time. After working on that project, now I want to work in the industry. I can get a chance to work on various unique projects. They also made a full-time job offer.

Further the student added:

> I can come back to academia at a later point in my career and tell my students all the interesting project stories.

This indicates that internships in the industry during Ph.D. not only impact the career choices of construction-focused Ph.D. students but also increase their chances of getting hired in the construction industry. Another student (SP04) that was previously interested in an industry-related career, but now inclined towards a career in academia said:

> After finishing an internship this summer, I realized I am not a good fit for the industry. That is something I do not want to do. I now go back to my original career choice.

This suggests that internships also help construction-focused Ph.D. students identify which career is a good fit for them. Another student (SP03) that is interested in academic career added:

> I was on the jobsite for an internship last summer, and that resulted in generating a research idea for my dissertation. I am now working on that applied research idea for my dissertation. I have a lot of traction from the industry now.

This suggests that internship with the construction industry during Ph.D. education fosters the relationship between academia and industry and aids in the development of research ideas that support the research needs of the construction industry. A student (SP01) extremely focused on an academic career choice and that has just finished their first construction internship of their career said:

> Internships should be made mandatory to all construction-focused Ph.D. students. The internship experience opened a new world for me. While I was doing the internship, I was thinking about "How am I going to explain and share this with my students". The internship experience increased my excitement to be a better teacher and also strengthened my desire to become an assistant professor and share these stories with my students.

This implies internship experiences strengthen career choices of construction-focused Ph.D. students and create better educators for construction academia.

4.1.4.1.3 Lack of Enough Academic Positions. All students (100%) that were interviewed expressed concerns regarding a lack of enough academic jobs, which may influence them towards other careers in industry rather than academia. A student (SP05) that is interested in an academic career mentioned:

> I finished all my work for the thesis last year. I have been trying to obtain an academic job. I applied, attended interviews but never got an academic job. There are very few academic jobs available. I want to be in academia, but now I might have to look for alternative choices.

This infers that the lack of academic opportunities influences construction-focused Ph.D. students' career choices towards other employment choices.

Overall, factors such as teaching abilities, research abilities, confidence to be successful in a career, salaries, lifestyle, comfort, the flexibility of working, location of working, career goals, interests, internships, advisor support, access to resources and opportunities in non-academic career paths, immigration challenges, and culture in academia influence the career choices of construction focused Ph.D. students towards academic or construction industry career paths.

4.2 Research Question 1 Quantitative Findings

To support and generalize the qualitative findings, a questionnaire survey was sent to current construction-focused Ph.D. students, faculty members at construction departments, Ph.D. graduates working in the construction industry, and other construction industry professionals.

4.2.1 Pursuit of Career Paths

From Figure 5, the current construction-focused Ph.D. students believe they are most likely to pursue a career in academia, with about three-fourths (74%) giving this as their most probable career preference. However, they also see industry (48%) as a likely career pathway. This indicates the importance of training construction-focused Ph.D. students for careers in the construction industry in addition to academia as approximately half of the student respondents consider the industry as a likely career path after completion of Ph.D. studies. It is also important to observe that some students are not interested in academia (16%) or industry (24%) career paths after completion of their Ph.D. programs.

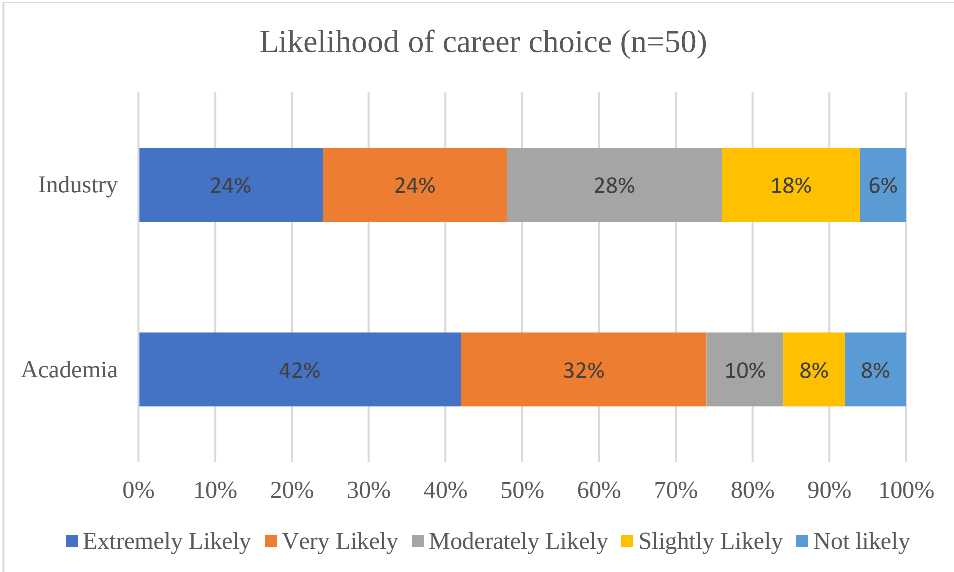

Figure 5. *Likelihood of career choice of construction focused Ph.D. students*

4.2.2 Employment Preference

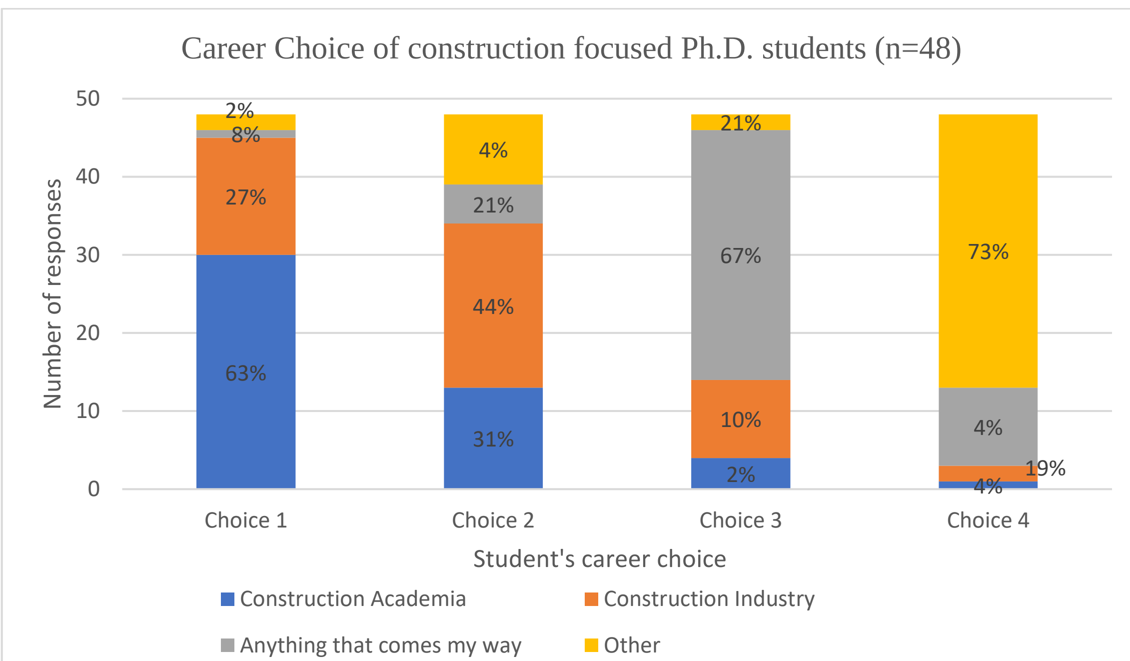

Figure 6. *Career Choice preference of current construction focused Ph.D. students*

As Figure 6 informs, about two-thirds (63%) of the current construction focused Ph.D. students prefer academia and a little over quarter of the respondents (27%) prefer industry as their primary career choice. For their secondary career preference, 31% preferred academia and

44% preferred industry employment. This indicates that a notable (71%) percentage of construction-focused Ph.D. students consider industry as one of their career preferences and it is important to train them in that area. A very little portion of students prefer anything that comes their way (8%) and other career choices (2%) that include careers with the government and non-profit organizations.

4.2.3 Preparation Provided by Ph.D. Programs

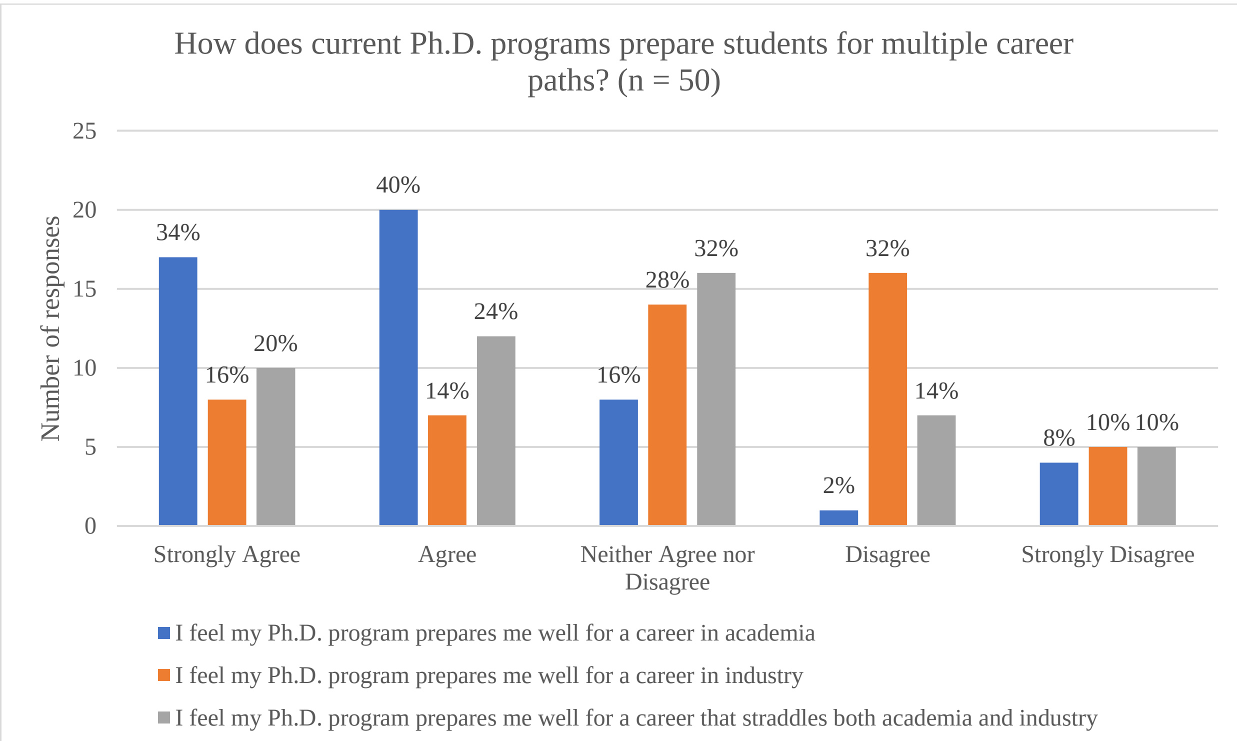

Figure 7. *Is your program preparing you well for industry employment in addition to academia?*

The construction-focused Ph.D. students are confident that their program is preparing them well for a career in academia with 74% agreeing or strongly agreeing (See Figure 7). Nearly half (44%) agree their program is preparing them well for a career straddling both academia and industry, while fewer (30%) feel that their program prepares them well for a career in the industry. While a significant number of students are interested in industry careers (48% in Figure 5), it is important to observe that only a minority of respondents agree that they are prepared well by their programs for industry careers.

4.2.4 Importance of Training Construction Ph.D. Students for Industry Careers

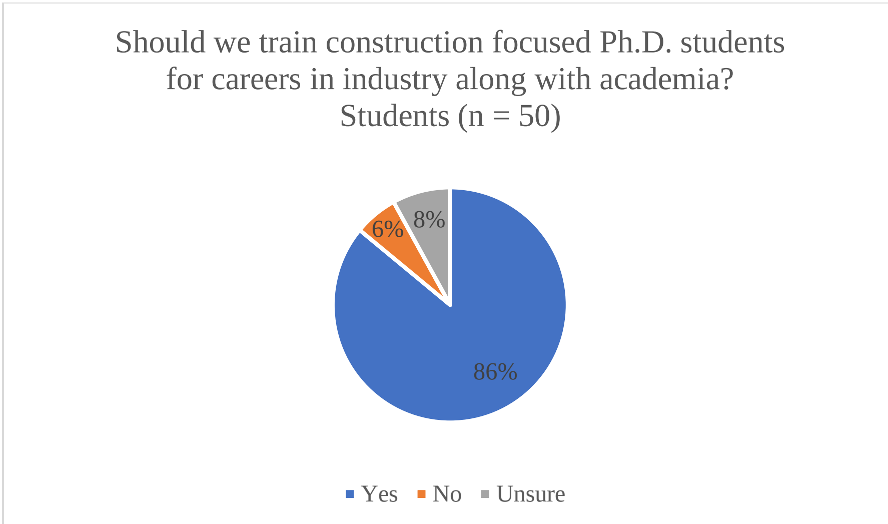

Figure 8. *Students: Should we train Ph.D. students for careers in industry along with academia?*

From Figure 8, 86% of student respondents said that it is important to train construction focused Ph.D. students for careers in industry along with academia, whereas 6% stated it is not required and 8% are unsure.

From Figure 9, 96% of PhD graduate respondents opined it is important to train construction-focused Ph.D. students for careers in the industry along with academia, whereas 4% said it is not required.

From Figure 10, 75% of faculty respondents perceived that it is important to train construction-focused Ph.D. students for careers in the industry along with academia, whereas 21% said it is not required and 4% are unsure. Faculty participants mentioned that critical steps in the process of training Ph.D. students for industry careers include training Ph.D. students to perform applied research relevant to the needs of the construction industry, providing Ph.D.

students the opportunity to experience industry, and creating awareness of the industry regarding the importance of employing Ph.D. graduates.

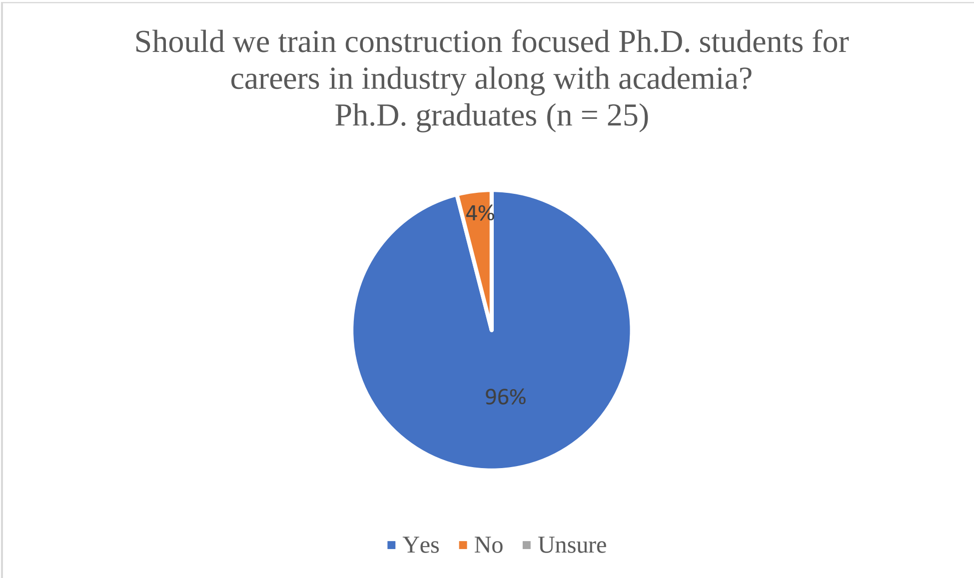

Figure 9. *Ph.D. graduates: Should we train Ph.D. students for careers in industry along with academia?*

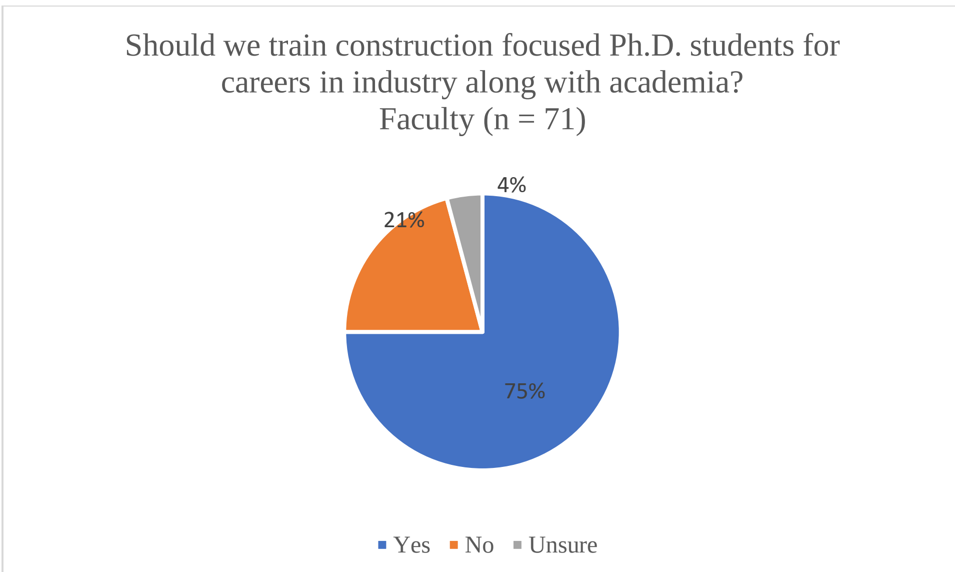

Figure 10. *Faculty: Should we train Ph.D. students for careers in industry along with academia?*

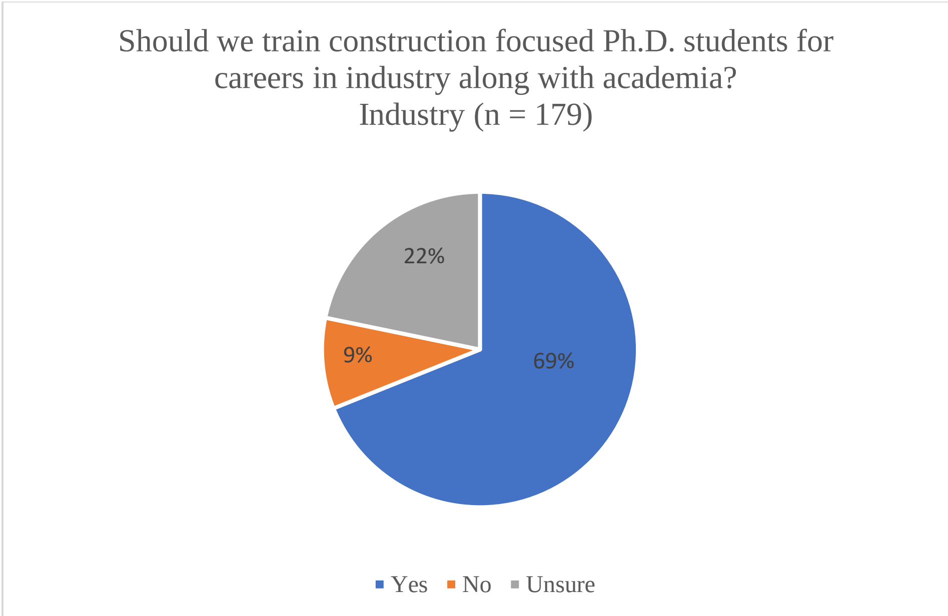

Figure 11. *Construction Industry professionals – Should we train Ph.D. students for careers in industry along with academia?*

From Figure 11, 69% of construction industry professional respondents opine it is important to train construction-focused Ph.D. students for careers in industry, whereas 9% mentioned that it is not required and 21% are unsure. When asked to provide comments, industry participants mentioned that providing practical experience in addition to theoretical preparation, having real-world field experience, and understanding of the latest technologies are important aspects to ensure industry positions for Ph.D. graduates.

4.2.5 Hiring Construction Ph.D. Graduates in the Construction Industry

From Figure 12, 12% of the construction industry professional respondents informed that they currently hire construction-focused Ph.D. graduates, 19% informed they do not hire Ph.D. graduates, and 59% indicated that they hire the best candidate that suits the position irrespective of having a Ph.D. However, 8% indicated they are unsure about their company's hiring.

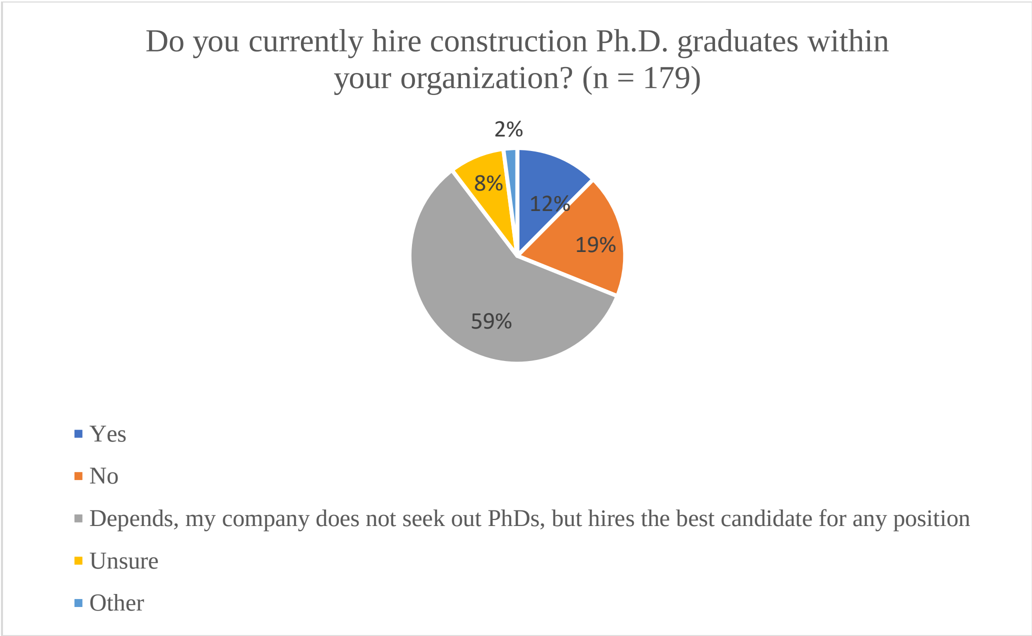

Figure 12. *Industry participants hiring Ph.D. graduates*

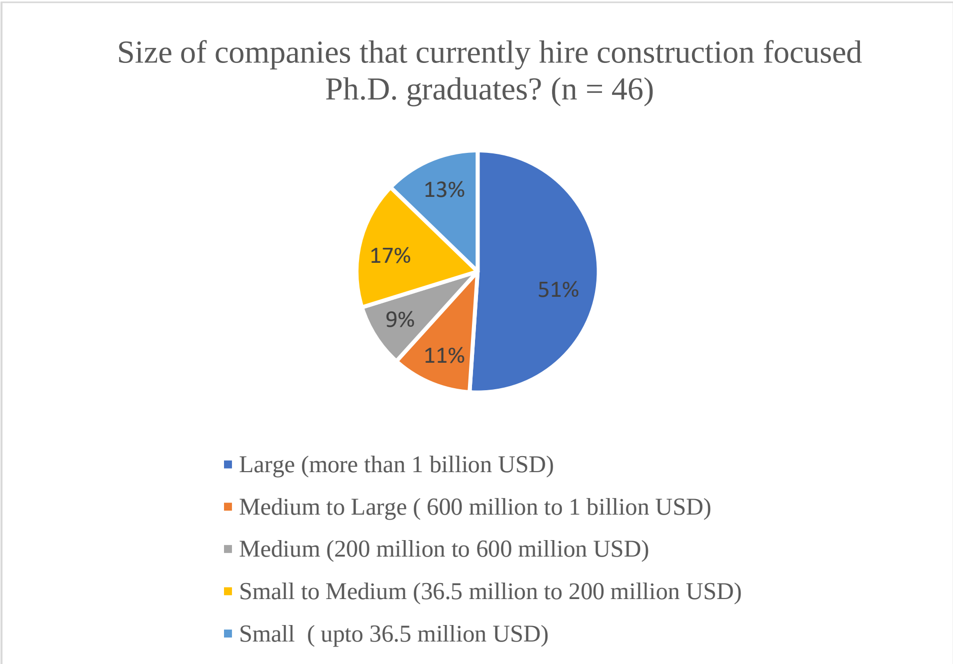

Figure 13. *Size of construction companies hiring Ph.D. graduates*

To further investigate the size of construction companies that hire Ph.D. graduates, the researcher collected company information as well. Figure 13 indicates that of the construction companies that hire construction-focused Ph.D. graduates, 51% are large, 11% are medium to large, 9% are medium, 17% are small to medium, and 13% are small sized companies. This indicates that all sizes of construction companies hire Ph.D. graduates. However, large construction companies (more than $1 billion in revenue) hire Ph.D. graduates more than others.

4.2.6 Factors Influencing Construction Focused Ph.D. Students' Career Choice

The questionnaire survey gathered information from the student participants regarding their factors for preferring a particular career choice.

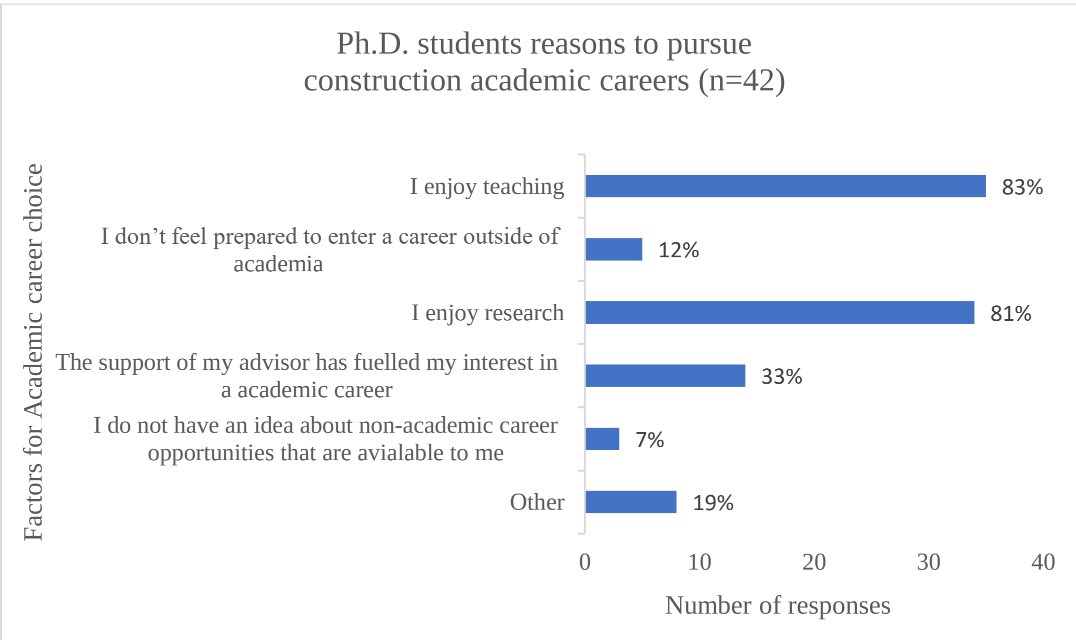

Figure 14. *Ph.D. Student Factors for Academic Career Choice*

From Figure 14, the most commonly cited (83%) reason for construction-focused Ph.D. students preferring academic careers is their love for teaching (83%), which is followed by their interest in research (81%). One-third (33%) said that the support from their advisor fuels their interest in an academic career, 12% opined that they do not feel prepared for a career outside academia, and 7% informed that they have no idea regarding non-academic career opportunities that are available to them as reasons for preferring academic employment. About 19% of the participants indicated other factors such as lack of support from an advisor for other career choices, no support for international students and minority students in the industry, flexible work schedule, ability to mentor and interact with students, satisfaction obtained from teaching, and flexibility for innovation and research without industry pressure as reasons for preferring employment in academia after completion of construction-focused Ph.D. education.

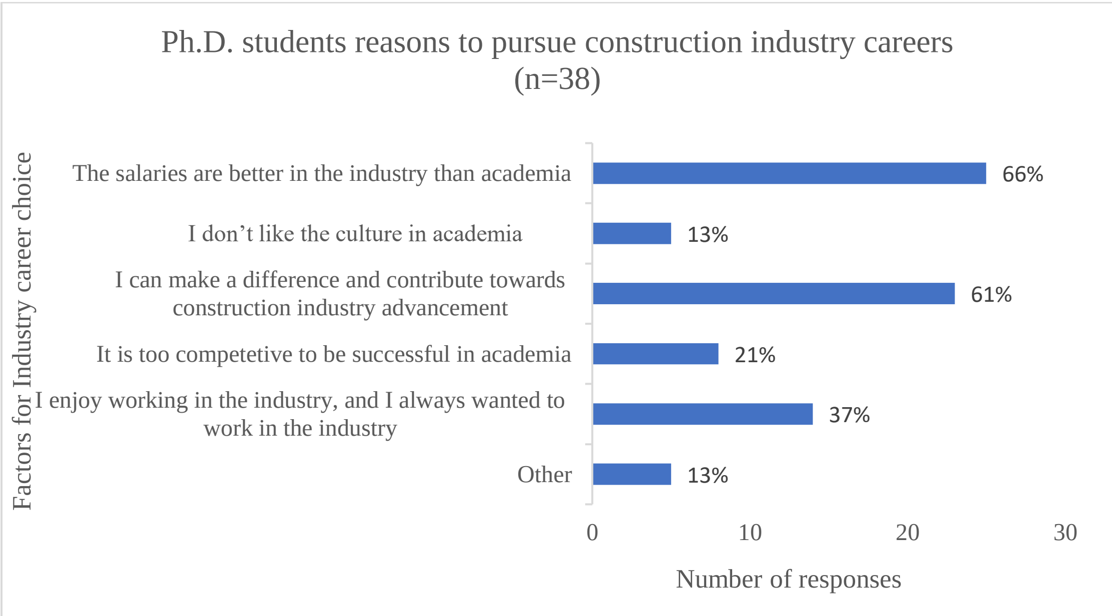

Figure 15. *Ph.D. student factors for industry career choice*

Then, Ph.D. students prefer employment in the industry for several reasons. As shown in Figure 15, most often cited is the better salary offered in the industry than academia (66%). The next most mentioned reason is their ability to make a difference and contribute towards the advancement of the construction industry (61%). Some Ph.D. students (37%) enjoy working in the industry and always wanted to work in the industry. Some Ph.D. students (21%) prefer to work in the industry because they believe it is very competitive to be successful in academia. A few (13%) Ph.D. students do not like the work culture in academia, while a similar proportion (13%) had other reasons for preferring industry careers such as lack of self-confidence to pursue academic research, ability to live in cities rather than a college town, limited working hours, lack of enough academic jobs, no support from an advisor, low salaries in academia, and competitive funding climate.

4.3 Research Question 1 Findings Summary

Overall, construction-focused Ph.D. students are equally interested in industry-related career choices alongside academia similar to students in other STEM doctoral programs. Many of the respondents from the construction-focused Ph.D. students, construction-focused Ph.D. graduates working in the industry, construction faculty, and construction industry professionals noted that it is important to train construction focused Ph.D. students for careers in industry in addition to academia. Construction companies of all sizes ranging from large to small are interested in hiring Ph.D. graduates. A small portion of (12%) of the construction companies that participated indicated that they currently hire construction-focused Ph.D. graduates, and it is expected that this number will rise in the future.

Regarding various factors that influence construction focused Ph.D. students' careers in academia and industry, this study identified that factors such as interest in teaching and research, passion for student mentoring and engagement, flexibility in working hours, support from an advisor, unawareness about non-academic opportunities, and satisfaction obtained from teaching influence construction focused Ph.D. students to choose careers in academia. Factors such as better salaries, ability to make a difference and advance construction industry, disinterest in academic culture, lack of enough academic jobs, no support from an advisor, and competitive academic funding climate influence construction-focused Ph.D. students to choose careers in the construction industry.

4.4 Research Question 2 Findings

To answer this research question, the researcher initially performed qualitative interviews to identify competencies required by construction-focused Ph.D. students for an academic career as well as for employment in the construction industry. To understand the competencies required for employment in construction academia, the researcher included construction faculty and students pursuing Ph.D. in construction-related disciplines in the qualitative interviews. The construction industry professional participants are omitted in identifying academic competencies because they have limited knowledge related to academic employment. To understand the competencies required for employment in the construction industry, the researcher included construction faculty, construction-focused Ph.D. students, construction-focused Ph.D. graduates working in the industry, and construction industry professionals in the qualitative interviews.

A total of 10 competencies: communication skills – oral and written, problem solving skills, technology adaptability, critical and independent thinking, networking, leadership, knowledge of project management, construction financial management, construction cost control, and construction risk management are identified by the participants as critical skills required by construction Ph.D. students to be employable in academia and industry.

4.4.1 Communication Skills – Written and Oral

The most mentioned competency that is required by construction Ph.D. students for both academic and industry careers by all categories of participants is communication skills including both written and oral. Communication skills have been rated as the most important skill for Ph.D. graduates interested in higher education careers (Gruber et al., 2010). The importance of communication skills for construction Ph.D. students' academic career is illustrated by following quotes (Table 14).

Table 13. *Quotes representing importance of Communication skills for academic careers*

Participant	Quote
FP08	Ph.D. students carry out and develop sort of methodologies for research. They analyze results, and they have to present those results back, and try to contextualize them within the broader literature and what's already been published in that field. So, they should have the writing skills to do that. Those are all skills that are highly valued in academia.
FP02	I think they need to understand some communication and how to do a technical paper as well as a presentation. I think they need to understand communication-related to teaching.
FP01	I think so much of it-- so much of an academic career is built off of writing, so you have to be a good communicator, both written and oral because you're going to have to do the teaching. You're going to have to present presentations, you're going to have to work with collaborators, and then your writing just has to be-- you have to be able to tell a story through writing. Even if it's something that's very research-oriented, you still have to be able to piece that into a story so that you can compel people, either through a proposal or through a journal article, that you have something worth saying. So, I think communication is huge.
SP01	We should have good proposal writing skills, presentation skills, and effective teaching skills.
SP05	It is important for Ph.D. students to clearly convey their points. And it could be either in the form of journals or conferences or even giving talks. I think those are important because if one is not able to communicate their research findings, it is as good as not doing the research at all.
SP02	Ph.D. students should be taught more about communicating their research outcomes in a manner that is readily understood and applied by stakeholders, researchers and general audience.

This indicates that ability to write (e.g., proposals, grants, publications) and speak (e.g., presenting, teaching) effectively to communicate research to varied audience (academic and general audience) is critical in academic careers. Construction Ph.D. programs must emphasize on training students to effectively communicate to all types of audience. Furthermore, the study also collected survey responses from participants performed descriptive analysis (Table 15)

The descriptive statistics indicate that all categories of participants emphasize the importance of written and oral communication skills for construction Ph.D. students interested in academic careers, however, written communication skills were emphasized slightly more than the oral communication skills. The faculty participants placed more importance on communication skills than other participants.

Table 14. *Descriptive Statistics for Communication Skills for Academic careers*

Competency	**Written Communication**			**Oral Communication**		
Sample Category	**Sample Size (N)**	**Mean**	**Standard Deviation**	**Sample Size (N)**	**Mean**	**Standard Deviation**
Faculty	67	4.87	0.385	67	4.75	0.560
Ph.D. Graduates	25	4.48	0.408	25	4.48	0.653
Ph.D. Students	49	4.65	0.277	49	4.65	0.751
Total	141	4.67	0.356	141	4.67	0.651

Furthermore, the participants identified oral communication skills as the most important competency required by construction Ph.D. students to be employable in construction industry. The participants noted that communication in academia is totally different from communication in the industry as the audiences are different and expectations are different. The participant quotes are provided in Table 16

Table 15. *Quotes representing importance of Communication skills for Industry careers*

Participant	**Quote**
FP03	Communication specific to industry is important. I think some of it is that communication in understanding the different perspectives and the different audiences and toning or talking about whatever you're talking about to those different audiences. I think a lot of our writing and a lot of our communication gets very academic. While maybe not at the theoretical level, it's seen as theoretical to industry.
CIP02	I think for someone with a Ph.D. to really succeed in the construction industry, they have to be very good at communication, they have to be able to take what are complex ideas and say them in the absolute simplest terms such that anyone can understand, because Ph.D.'s have this stigma of being, 'Oh, it's an intellectual type. He's going to be doing stuff-- none of us are going to understand what he's doing.' Communication ability and being able to explain things easily is a number one competency.
CIP07	No matter how perfect and strong technically your research or work is, if you cannot present it or communicate it to industry, nobody would understand the value of it. And that is a skill that is very apparent to be lacking in most Ph.D. students. But if you cannot communicate it, industry would not understand it and do not realize how valuable you could be for the company

Table 16 (continued)

Participant	Quote
CIP03	We want good communication skills. From my experience, a lot of construction Ph.D. students struggle to communicate what it is that they bring special. The bring unique skills definitely, but they do not know how to communicate in terms of industry needs and suitability.
SP03	Communication skills we are taught is academia to academia. But it is important to communicate academia to industry, and academia to the world. When a company asks me about my research, I struggle to explain that in an engaging way that they understand. Not just me, most of my peers also struggle to do that.
SP08	The Ph.D. students end up speaking super high level, and no one understands. The construction industry employers background is different, and you should speak to them in a way that they understand, but not in your dissertation academic style. That type of communication is missing from most of the Ph.D.'s. This is a challenge for most Ph.D. students I know

This indicates that construction-focused Ph.D. students should know how to effectively communicate their research to a construction industry audience. Industry professionals may not understand academic language, and it is important to communicate to them in an understandable way. Not being able to communicate research to the industry hinders an individual's chances of industry employment as industry may not understand the value Ph.D. students can bring. This implies that being able to effectively communicate complex research in a way that industry understands is important for construction-focused Ph.D. students to be employable in the non-academic career paths. And the student quotes indicate that one of the major struggles for construction Ph.D. students is to communicate their research in a language that can be understood by industry. However, it is important for Ph.D. students to ace this skill in order to be employable in the construction industry as it gives the ability for construction industry professionals to understand how Ph.D. students can make difference to their company. This further indicates that it is important for universities to train construction-focused Ph.D. students on transferable communication skills related to effectively communicating research and skills that are relevant to the construction industry. Furthermore, the study also collected survey responses from participants performed descriptive analysis (Table 17).

Table 16. *Descriptive Statistics for Communication Skills for Industry careers*

Competency	Written Communication			Oral Communication		
Sample Category	**Sample Size (N)**	**Mean**	**Standard Deviation**	**Sample Size (N)**	**Mean**	**Standard Deviation**
Faculty	66	4.53	0.706	66	4.80	0.503
Industry	179	4.54	0.638	178	4.63	0.579
Ph.D. Graduates	23	4.35	1.027	23	4.83	0.388
Ph.D. Students	48	3.90	0.881	48	4.69	0.552
Total	316	4.43	0.759	315	4.74	0.643

The descriptive results also indicate that all participants emphasize the importance of communication skills for employment in industry for construction Ph.D. students, however more emphasis is placed on oral communication than written communication in contrast to academic careers. Overall, this indicates that effective communication skills in diverse ways are essential for employability in both academic and non-academic careers of construction Ph.D. students.

4.4.2 Networking

Another important competency that has been emphasized as essential for both academic and non-academic employment of construction Ph.D. students is networking. The importance of networking for academic career is demonstrated by quotes presented in Table 18.

This indicates the need to possess networking skills to be employable and be successful in a construction academic career. Furthermore, the participants informed that the ability to network with professionals outside academia is an important competency required to be employable in the construction industry as illustrated by quotes shown in Table 19.

Table 17. Quotes representing importance of Networking skills for academic careers

Participant	Quote
FP05	Collaboration among disciplines is becoming standard practice in AEC (Architecture, Engineering, and Construction) research. An important skill that is a first step towards successful collaboration is networking.
FP01	In academia, it is important for students to know how to network, meet faculty and researchers at conferences.
SP03	I was offered a post doc position because of my networking ability. Networking opportunity at a conference helped me develop rapport with a faculty member that resulted in the post-doc position

Table 19. Quotes representing importance of Networking skills for Industry careers

Participant	Quote
FP07	My Ph.D. student who got an employment in industry actually worked with a bunch of construction professionals here locally as part of his research. He has that network that he has built through his Ph.D., and then that helped him get a job in the industry.
SP03	A lot of the Ph.D. students do not know how to network industry professionals. My advisor told me networking is crucial to obtain a job with the industry. He encouraged me to attend student club events, industry conferences, write for industry magazines and trade journals, interact with industry leaders, and take their opinion for my research
CIP08	One of the strong reasons that helped me get an internship and a job offer in the construction industry when I was a Ph.D. student was networking with the industry. Academia does not teach you that, but it is important to learn networking skills to be able to get an employment and sustain in the industry.

This indicates that networking with industry employers during the Ph.D. program and learning those networking skills will be helpful to obtain employment in the construction industry. Activities such as participating in industry conferences, writing for trade journals, and involving industry stakeholders in research help construction-focused Ph.D. students to improve their industry networking skills and are then more employable in the industry.

The descriptive analysis (Table 20) of participant perceptions regarding the importance of networking skills required for academic and industry employment of construction Ph.D. students indicates networking as a more important competency for industry careers (M= 4.04) than academic careers (M= 3.96) although it is required for both career paths. In both cases, construction Ph.D. students perceive networking skills more important than other categories of participants. This informs that construction Ph.D. students see a need to be provided with networking opportunities in Ph.D. program.

Table 20. *Descriptive Statistics for Networking Skills for Academic and Industry careers*

Competency	**Academic Careers**			**Industry Careers**		
Sample Category	**Sample Size (N)**	**Mean**	**Standard Deviation**	**Sample Size (N)**	**Mean**	**Standard Deviation**
Faculty	66	3.67	0.917	66	4.23	0.819
Industry	NA	NA	NA	178	3.77	0.869
Ph.D. Graduates	25	4.16	0.624	23	4.39	0.722
Ph.D. Students	48	4.25	0.786	48	4.60	0.676
Total	139	3.96	0.867	315	4.04	0.881

4.4.3 Problem Solving

Problem-solving skills refer to the ability to understand the problem, critically think about it, and proficiently perform procedures to develop a solution and take decisions to solve the problem (Van Merriënboer, 2013). The participants of this study informed that problem solving skills are important to obtain employment in both academia and industry (Table 21).

Table 21. *Quotes representing importance of Problem Solving for Academic and Industry careers*

Participant	**Quote**
FP04	A skill that you need for an academic career is research problem solving. As a Ph.D. student, you take a problem that no one saw before and solve it. You take a problem, develop some hypotheses, all the literature, collect data, do analysis. And you essentially come up with a solution or conclusion. You will be expected to do that throughout your academic career, its important skills
CIP12	I would say, from my experience so far in the industry, as a Ph.D., industry looks at you as a subject matter expert. They expect you to understand the root cause of the problem, identifying it early on, and providing your opinion in a presentable fashion. Expectation is high, especially related to problem-solving.
CIP02	If you want to work in industry after Ph.D., we [industry] expect you to take a firm related problem, look at what various work that's been done before, come up with some kind of objective and try to solve that with respect to the needs of the company.

This indicates that the construction industry expects construction-focused Ph.D. students interested in industry employment to possess problem-solving skills. The descriptive analysis (Table 22) reveals that participants emphasized problem solving as more important for industry careers (M=4.70) than academic careers (M=4.43). This indicates that problem solving skills relevant to construction industry context must be emphasized in Ph.D. programs.

Table 22. *Descriptive Statistics for Problem Solving for Academic and Industry careers*

Competency	**Academic Careers**			**Industry Careers**		
Sample Category	**Sample Size (N)**	**Mean**	**Standard Deviation**	**Sample Size (N)**	**Mean**	**Standard Deviation**
Faculty	67	4.53	0.804	66	4.65	0.712
Industry	NA	NA	NA	179	4.71	0.535
Ph.D. Graduates	25	4.35	0.802	23	4.83	0.388
Ph.D. Students	48	3.90	0.714	48	4.65	0.526
Total	140	4.43	0.772	316	4.70	0.566

4.4.4 Critical and Independent Thinking

Critical and independent thinking refers to a logical and reflective thought which focuses on a decision in what to believe and what to do (Ennis, 1985; Miri et al., 2007). Critical thinking involves a variety of skills such as the individual identifying the source of information, analyzing its credibility, reflecting on whether that information is consistent with their prior knowledge, and drawing conclusions based on their critical thinking (Linn, 2000). Prior research has indicated the need to train critical thinking skills in graduate students (Halpern, 1998). The participants mentioned critical independent thinking skills are important for both academic and industry careers according to quotes presented in Table 23. This indicates that critical and independent thinking specific to research and teaching are essential competencies for academic careers, however, being able to think critically to understand and solve industry challenges is important for industry careers.

Table 23. *Quotes representing importance of Critical Independent Thinking for Academic and Industry careers*

Participant	Quote
FP01	In academia, you should independently think critically to identify a research problem, and also develop a methodology to collect data and analyze data. It is a lot of thinking that is essential.
FP04	Figuring out what do you know, what you don't know, what data to gather, where are the gaps, and then setting research objectives. That critical thinking process is very critical in academia and research.
CIP14	Critical thinking is probably the most important thing. I would say critical thinking, regardless of what the trends are, is the biggest one for Ph.D.'s in construction industry.
CIP06	Industry has challenges all over. When they hire you, they want you to solve their problems. For which, you should be able to independently think critically

The descriptive analysis (Table 24) indicates that critical independent thinking skills are more important for employment in academia (M=4.67) than industry (M=4.46).

Table 24. *Descriptive Statistics for Critical Thinking for Academic and Industry careers*

Competency	Academic Careers			Industry Careers		
Sample Category	Sample Size (N)	Mean	Standard Deviation	Sample Size (N)	Mean	Standard Deviation
Faculty	67	4.66	0.617	66	4.33	0.883
Industry	NA	NA	NA	179	4.63	0.589
Ph.D. Graduates	25	4.52	0.653	23	4.57	0.590
Ph.D. Students	48	4.77	0.515	48	3.96	1.091
Total	140	4.67	0.593	316	4.46	0.786

4.4.5 Leadership

Leadership refers to a process whereby an individual influences a group of individuals to achieve a common goal, and successfully drive positive change (Summerfield, 2014). The participants noted that construction Ph.D. graduates will be expected to have leadership skills for both academia and industry careers in diverse ways. Table 25 presents quotes that demonstrate the importance of leadership skills for construction Ph.D. students.

__Table 25.__ Quotes representing importance of Leadership for Academic and Industry careers

Participant	Quote
CIP03	The Ph.D. student should have good leadership skills. In construction industry, we have innovation departments that sort of lead initiatives. Sometimes it's robotics, maybe it's IPD, maybe it's lean. If you're pushing some of these initiatives, you have to be a leader in order to do that. You need to lead people and say, "This is what's really important." You need to be a champion for something and get people behind that initiative, otherwise, everything you want to do is going to fail. It's going to be poorly received. Everyone's going to look at it and say, "Forget that." So, being a leader is very important.
CIP15	You will not be hired by any company with a Ph.D. expecting to just kind of being told what to do. You'll necessarily have to lead, have to create a vision for an organization, get people on board with that vision.
FP06	For academic careers, they [Ph.D. students] should possess leadership skills in a way that is transferable to successfully lead research collaborations and teams, and set examples for students to be successful

This indicates that leading research projects and setting examples of students are expected in academia. In the construction industry, Ph.D.s are expected to implement new technologies or methods and lead the change. The descriptive analysis (Table 26) indicates that critical independent thinking skills are more important for employment in industry (M=4.29) than academia (M=3.81)

__Table 26.__ Descriptive Statistics for Leadership for Academic and Industry careers

Competency	Academic Careers			Industry Careers		
Sample Category	**Sample Size (N)**	**Mean**	**Standard Deviation**	**Sample Size (N)**	**Mean**	**Standard Deviation**
Faculty	67	3.58	0.706	65	4.48	0.812
Industry	NA	NA	NA	178	4.13	0.833
Ph.D. Graduates	25	3.64	1.027	23	4.48	0.665
Ph.D. Students	48	4.21	0.881	48	4.52	0.799
Total	140	3.81	0.759	314	4.29	0.828

4.4.6 Technology Adaptability

Another important competency that was mentioned important for employability in academic and industry careers by participants was the ability to adapt to latest and evolving construction technology. The participant quotes presented in Table 27 demonstrates the importance of technology proficiency and adaptability for construction Ph.D. careers.

Table 27. *Quotes representing importance of Technology Adaptability for Academic and Industry careers*

Participant	Quote
FP04	Ph.D. students in construction should have touch with latest technologies and tools. Technology innovation is starting to heat up, which means teaching those technologies and tools inside classrooms starts increasing. Construction Ph.D.'s interested in academia will be expected to teach those technologies.
FP07	I see some significant changes in construction in the near future. Technologies that are just an "attraction" currently will become commonplace and a part of the contract in the near future. This increases demand for construction Ph.D.'s with technology knowledge and understanding in the industry and also in academia, because the Ph.D.'s will be the one who would have to teach those in the classrooms to next generation construction workforce.
CIP02	We look for individuals who very well understand technology and innovation. A lot of data moves in a construction firm. We look for Ph.D. graduates that understand data flow and integration within construction and apply new technologies and innovations for introducing new ways to do things for us. Understanding and adapting to new technologies is important.
CIP03	Ph.D.'s must have knowledge of latest technological advances in construction. From UASs to BIM to other latest technologies, something that companies might be interested to adopt...the companies expect the Ph.D. holders to have an idea about them and help the companies evaluate the right technologies needed for them.
CIP17	I think construction is going to be far more technology-based and data integration-based. Companies now are struggling to find technology-oriented workforce, and they're filling those roles with Ph.D.'s. So, being able to learn and use latest technologies will be critical competency for construction Ph.D.'s.
CIP05	There's a lot of cutting-edge research being done related to artificial intelligence and others in construction. Implementing that might need specialized personnel, which could be Ph.D. graduates. The companies are also realizing the importance of technologies and skills Ph.D.'s can bring in.

This indicates that construction Ph.D. students interested in both academic and industry careers are expected to have the ability to adapt and use latest technologies. For academic careers, it is important to be able do latest technology related research and also teach them in classes. The evolving technological advancements in the construction industry result in construction employers expecting competencies related to understanding and adapting to using technologies from construction-focused Ph.D. students. This indicates that having knowledge about the latest technologies, having knowledge on how to use them and implement them is an important skill that employers expect from construction-focused Ph.D. students interested in either academic or industry careers. The descriptive analysis (Table 28) further indicates that technology adaptability skills are considered slightly more important for industry careers (M=4.15) than academic careers (M=4.02).

Table 28. *Descriptive Statistics for Technology Adaptability for Academic and Industry careers*

Competency	**Academic Careers**			**Industry Careers**		
Sample Category	**Sample Size (N)**	**Mean**	**Standard Deviation**	**Sample Size (N)**	**Mean**	**Standard Deviation**
Faculty	65	3.88	0.966	66	4.06	0.985
Industry	NA	NA	NA	179	4.12	0.752
Ph.D. Graduates	25	3.92	0.862	23	4.22	0.736
Ph.D. Students	48	4.29	0.792	48	4.40	0.743
Total	138	4.02	0.903	316	4.15	0.810

4.4.7 Technical Competencies

The participants mentioned the importance of possessing technical skills related to construction for being successful in obtaining employment in academic and industry careers for construction Ph.D. students. As the faculty members will be expected to teach multiple courses during their career spanning over several years, it is important to be proficient in construction subject areas and related technologies. For industry careers, technical expertise is essential to support successful completion of projects. The important competencies required as perceived by the participants of this study are project management, financial management, cost control, and risk management. Table 29 presents quotes from participants

Table 189. *Quotes representing the technical skills required for Academic and Industry careers*

Participant	Quote
CIP01	One thing that Ph.D. graduates are expected to know is financial management and have financial responsibility within in construction, especially in this fiscally challenging environment that we're in and we'll continue to be in. Ph.D.'s will be expected to be exposed to budgets, net present value, future present value, forecasting, inflation, etc. You should know all of those critical financial impacts that would adversely affect a project, especially a two-year, three-year long-term capital project.
CIP12	For Ph.D. students interested in industry careers, skills in project planning, project coordination, earned value, financial management is important.
FP03	The Ph.D.'s should have basic technical skills. They must know constructability, project management, and other basic construction concepts to be employable in academia.
FP07	For careers in academia, I believe that they should know the different parts and pieces of the construction, fundamentals of construction, and advanced construction practices.
CIP13	I think to a great extent, domain knowledge about construction sites, managing risks, contracts, financial management, and cost control are important for both academia and industry careers.
FP05	Ph.D.'s should have skills in construction project management to improve productivity, efficiency, improve quality, and in addition to that, to be fiscally sound.
CIP16	Important technical competencies that Ph.D. students know are cost control, project management, and construction financial management.
CIP19	As a Ph.D. student, the things that I think should exist are a certain level of accounting, a certain level of business management, certain level of risk management, a certain level of global economic understanding. So economically, how does our business fit into the scheme of economics both regionally and globally?

This indicates that knowledge in financial management, cost control, risk management, and project management are essential for construction Ph.D. student careers in industry as they are expected to support betterment of construction productivity. However, construction Ph.D. students interested in academic career should also have basic knowledge in these areas as they would teach and research in those areas. The quantitative phase further inquired the importance of these technical competencies for construction Ph.D. students. The descriptive analysis reveals that financial management skills (Table 30) are more essential for industry careers (M=4.10) than academic careers (M=3.62), project management skills (Table 31) are more essential for industry careers (M=4.35) than academic careers (M=3.92), risk management skills (Table 32) are more essential for industry careers (M=4.23) than academic careers (M=3.70), and cost control knowledge (Table 33) is more essential for industry careers (M=4.16) than academic careers (M=3.52).

Table 30. *Descriptive Statistics for importance of financial management for Academic and Industry careers*

Competency	Academic Careers			Industry Careers		
Sample Category	**Sample Size (N)**	**Mean**	**Standard Deviation**	**Sample Size (N)**	**Mean**	**Standard Deviation**
Faculty	63	3.41	1.102	62	4.26	0.940
Industry	NA	NA	NA	179	3.97	0.814
Ph.D. Graduates	24	3.75	1.032	22	4.09	1.065
Ph.D. Students	46	3.83	0.950	47	4.38	0.874
Total	133	3.62	1.050	310	4.10	0.880

Table 31. *Descriptive Statistics for importance of construction project management for Academic and Industry careers*

Competency	Academic Careers			Industry Careers		
Sample Category	**Sample Size (N)**	**Mean**	**Standard Deviation**	**Sample Size (N)**	**Mean**	**Standard Deviation**
Faculty	63	3.83	1.056	62	4.48	0.695
Industry	NA	NA	NA	178	4.24	0.769
Ph.D. Graduates	24	3.79	0.721	22	4.32	0.780
Ph.D. Students	47	4.11	0.759	47	4.57	0.744
Total	134	3.92	0.910	309	4.35	0.760

Table 19 *Descriptive Statistics for importance of risk management for Academic and Industry careers*

Competency	Academic Careers			Industry Careers		
Sample Category	**Sample Size (N)**	**Mean**	**Standard Deviation**	**Sample Size (N)**	**Mean**	**Standard Deviation**
Faculty	62	3.61	1.014	61	4.25	0.722
Industry	NA	NA	NA	177	4.17	0.815
Ph.D. Graduates	24	3.67	1.007	22	4.32	0.894
Ph.D. Students	47	3.83	0.789	47	4.43	0.801
Total	133	3.70	0.937	307	4.23	0.803

Table 20 *Descriptive Statistics for importance of construction cost control for Academic and Industry careers*

Competency	Academic Careers			Industry Careers		
Sample Category	**Sample Size (N)**	**Mean**	**Standard Deviation**	**Sample Size (N)**	**Mean**	**Standard Deviation**
Faculty	63	3.56	0.929	62	4.26	0.767
Industry	NA	NA	NA	179	4.07	0.807
Ph.D. Graduates	24	3.46	0.779	22	4.09	0.750
Ph.D. Students	46	3.50	1.006	47	4.43	0.903
Total	133	3.52	0.926	310	4.16	0.818

4.5 Competencies Ranking by Careers and Participants

The academic and industry related competencies required by construction Ph.D. students as perceived according to each category of participants based on the mean score are provided below. Table 34 provides competencies required for academic employment of construction Ph.D. students ranked based on mean scores as perceived by each category of participants. Table 35 provides competencies required for industry employment of construction Ph.D. students ranked based on mean scores as perceived by each category of participants.

Table 34. *Ranking of Competencies of academic careers*

Rank	Ph.D. Students	Ph.D. Graduates	Faculty
1	Critical & Independent Thinking	Critical & Independent Thinking	Written communication
2	Oral communication; Written communication	Oral communication; Written communication	Oral communication
3	Technology Adaptability	Problem Solving	Critical & Independent Thinking
4	Networking	Networking	Problem Solving
5	Leadership	Technology Adaptability	Technology Adaptability
6	Project Management	Project Management	Project Management
7	Problem Solving	Financial Management	Networking
8	Financial Management; Risk Management	Risk Management	Risk Management
9	Cost Control	Leadership	Leadership
10		Cost Control	Cost Control
11			Financial Management

This indicates that critical & independent thinking, written and oral communication skills, and technology adaptability as the most important skills required by construction Ph.D. to be employable in academia.

Table 35. *Ranking of Competencies of industry careers*

	Industry	Ph.D. Students	Ph.D. graduates	Faculty
1	Problem Solving; Critical & Independent Thinking	Oral communication	Oral communication; Problem Solving	Oral communication
2	Oral communication	Problem Solving	Critical & Independent Thinking	Problem Solving
3	Written communication	Networking	Leadership	Written communication
4	Project Management	Project Management	Networking	Project Management; Leadership
5	Risk Management	Leadership	Written communication	Critical & Independent Thinking
6	Leadership	Risk Management; Cost Control	Project Management; Risk Management	Cost Control
7	Technology Adaptability	Technology Adaptability	Technology Adaptability	Financial Management
8	Cost Control	Financial Management	Financial Management; Cost Control	Risk Management
9	Financial Management	Written communication		Networking
10	Networking	Critical & Independent Thinking		Technology Adaptability

This indicates that problem solving, critical & independent thinking, oral and written communication, networking and leadership as most important skills required by construction Ph.D. students to be employable in construction industry. Identification of these skills will act as a guidance for current construction Ph.D. students to prepare better for careers of their choice, and informs construction Ph.D. programs to include training for these competencies in the doctoral curriculum to effectively prepare construction Ph.D. students for diverse career paths.

4.6 Research Question 2 Findings Summary

- This study identified communication skills – oral and written, problem solving skills, technology adaptability, critical and independent thinking, networking, leadership, knowledge of project management, construction financial management, construction cost control, and construction risk management as the important competencies for construction Ph.D. students to be employable in academia and industry
- For academic employment: critical & independent thinking, written and oral communication skills, and technology adaptability are ranked as the most important competencies by the study survey respondents
- For non-academic employment: problem solving, critical & independent thinking, oral and written communication, networking, and leadership are ranked as the most important competencies by the study survey respondents

4.7 Research Question 3 Findings

To answer this research question, a series of interviews were conducted with the four sample categories of participants including construction-focused Ph.D. students, construction-focused Ph.D. graduates, construction industry professionals, and construction faculty. Following the completion of the interviews, a survey questionnaire was used to collect data from a wider group of participants across all categories.

The investigation identified challenges for construction-focused Ph.D. students seeking employment in multiple career paths, roles/areas of employment in the construction industry that are suitable for construction-focused Ph.D. students, and resources and opportunities to prepare construction-focused Ph.D. students for a variety of career options. It is critical to identify the challenges since it will inform the study about aspects of existing construction-focused Ph.D. programs that need to be improved to better prepare construction-focused Ph.D. students for diverse career paths. Then, determining the roles/areas of employment available to construction-focused Ph.D. students helps define the training areas for which construction-focused Ph.D. programs should focus and invest resources. The resources and opportunities that are to be provided in a construction-focused Ph.D. program should then comprehend various ways that help prepare construction-focused Ph.D. students for a variety of career options.

4.7.1 Challenges for Ph.D. Students to be Prepared for Careers in Non-Academic Career Paths

This study investigated various challenges construction-focused Ph.D. students encounter in being prepared for and employed in academia as well as careers outside of academia. Some previous studies (e.g., Edwards, 2002; Hasrati, 2005; Gunnarsson et al., 2013; Winter et al., 2000) have highlighted a range of challenges Ph.D. students in other disciplines encounter to obtain employment that includes supervision related issues from an advisor, lack of required training, lack of resources, and inadequate understanding of skills required. This study identified a range of challenges including a lack of training and resources, lack of construction internship/industry experience, lack of support from an advisor, and perception of the construction industry that Ph.D. students are too theoretical and academic-oriented.

4.7.1.1 Perception of Construction Industry About Ph.D. Students. The perception of the construction industry that Ph.D. students are very academic and trained only on theoretical foundations is a challenge for construction-focused Ph.D. students to approach employers in the construction industry for employment. Table 36 shows statements from student and faculty participants regarding difficulty of construction Ph.D. students to get industry employment.

Table 216. *Quotes related to construction Ph.D. student difficulties in getting industry employment*

Participant	Quote
SP02	I have been trying for an internship every summer ever since I started my Ph.D. Companies turn me down just for one reason, I'm a Ph.D. student and am very academic and overqualified. They don't continue to talk to me when I tell them I'm PhD student.
SP07	Every time I approached a construction company, they behaved like I am unacceptable to work in the industry because I am a Ph.D. student. It's like a stigma they have, that Ph.D.'s cannot work in the industry.
SP03	Industry assumes all Ph.D. students want to go into academia. This is the reason they are hesitant to hire Ph.D. students.
FP01	Industry thinks Ph.D. students are extremely theoretical. I think that's the biggest problem. That should be changed.

Further, this study also interviewed construction industry professionals to investigate their perspectives regarding hiring construction focused Ph.D. students. Table 37 shows quotes from industry professionals. This informs the existence of resistance from the construction industry to

Table 227. *Construction industry perspectives about hiring construction Ph.D. students*

Participant	Quote
CIP02	The challenge with hiring Ph.D. students is…they're too theoretical. We come across several Ph.D. resumes that are too theoretical, and construction is not a theoretical industry. It's not a theoretical industry. It's not like economics. So that poses a challenge for us to hire Ph.D.'s.
CIP01	We wanted to hire Ph.D.'s at one point. But again, we asked ourselves "Aren't they too theoretical? Ph.D.'s doesn't know what's actually going on. They just know what a textbook tells.
CIP03	When we hire, we want them to stay with us for several years. Because hiring costs us and we invest on the candidates. But Ph.D. students might want to move to academia someday, which will not be a good investment for us.
CIP04	We do not know how to use Ph.D.'s. How different are they and how can they help us advance and progress as a company?

hire construction-focused Ph.D. students because of their perception that Ph.D. students are theoretical and academic in nature. This further explains that the challenge for Ph.D. students in terms of perceptions of the construction industry exists for three reasons. The first is the construction industry's perception that Ph.D. students are overly academic and only receive theoretical training rather than practical experience. Another factor is that construction employers believe that construction Ph.D. students want to work in academia and will eventually abandon their jobs in the industry. Additionally, some construction firms are not aware of ways Ph.D. students can support and contribute towards advancing companies. Additionally, this informs that there is a need to create awareness and change the perception of construction employers about how construction Ph.D. students can make a difference to the construction firms, about the training Ph.D. students receive, and their career aspirations.

4.7.1.2 Lack of Training and Resources. Another challenge construction-focused Ph.D. students often encounter in terms of being prepared for various career paths is the lack of training and resources. Regarding the training students receive for academic careers, students mentioned accordingly as presented in Table 38,

Table 38. *Quotes related lack of training and resources for academic careers*

Participant	Quote
SP08	I know I have to teach after I graduate. But I don't have an opportunity to teach and am not trained to teach. Where and how do I learn how to teach?
SP06	The first thing industry wants is some kind of field experience. Our Ph.D. program does not offer the ability to get that experience.

Therefore, evidence exists that construction Ph.D. students are not trained enough to gain the teaching skills required for academic employment and are not provided with required opportunities to finish internships indicating lack of training related to obtaining employment in the construction industry. This informs that the lack of opportunity to do an internship and insufficient opportunities to experience teaching are hindrance to the Ph.D. students' ability to prepare for industry employment and academic employment respectively.

Another aspect is the lack of support from universities in creating awareness to construction Ph.D. students about employment opportunities in the construction industry. Table 39 shows students' comments. These quotes show that construction-focused Ph.D. students

__Table 39.__ Quotes related to lack of awareness for industry employment

Participant	Quote
SP01	I have no clue about what an industry career has to offer me. What's the environment in industry? Because if I'm in academia, if I'm doing a Ph.D., I know that I have to write research papers, I have to do proposals, I have to write grants, etc. But I don't know what I should do in the industry. What am I expected to do? What skills should I have? So that's one of the challenges.
SP05	I have no idea about the non-academic career paths that are available to me. I believe the only career option that is ahead of me is academia.

are not provided with resources for non-academic career paths available to them. In addition to this, students mentioned their lack of understanding about the skills that they need so they are prepared for employment in the industry. The perspectives of students in this regard are mentioned in Table 40.

__Table 40.__ Quotes related lack of training and resources for industry careers

Participant	Quote
SP06	A big challenge is developing the skills that the industry needs. Ph.D. students are good at data collection, experimental design, etc. But what does construction industry employers expect from a Ph.D.? Knowing what they expect itself is a challenge, leaving aside developing those skills.
SP03	The biggest challenge is the awareness. What roles can Ph.D. students get or suitable in the industry is big question mark. What areas of employment in the industry should I focus on? There’s no help from my department or anyone else in this aspect.
SP08	One challenging aspect is what position you'll be applying for. In some cases, you would be in that situation where you are definitely not an entry-level person. But at the same time, you do not have the experience to justify having you as a senior person. What roles could you suit? Sometimes this becomes a challenge.

These comments imply a lack of understanding from construction focused Ph.D. students regarding the skills that are expected of them to be employable in the industry and the roles in the construction industry that are available to them. Ph.D. students feel there is no support from universities in providing resources and training to help them understand these available opportunities. Overall, inadequate teaching training, the inability of Ph.D. programs to identify and inform Ph.D. students of construction industry employment opportunities, and limited understanding of the skills required for industry employment are all challenges that hinder a Ph.D. student's preparation for industry employment. Construction-focused Ph.D. programs must understand the need to identify these challenges and address them to support Ph.D. students for multiple career paths.

4.7.1.3 Support from the Ph.D. Advisor. The students informed that one of the primary factors that supports or limits their preparation for careers outside academia is their advisors' support, or lack thereof as per the student quotes mentioned in Table 41. This information shows

Table 41. *Student quotes about advisor's support for industry careers*

Participant	Quote
SP06	My biggest challenge is the support from my advisor. If I tell my advisor that I am interested in industry career…he will abandon me.
SP07	My advisor says, 'No, you should go do an academic job. I don't support you for an industry job. I won't let you do an internship'

*that the support of the advisor is a major challenge and a cultural change on advising style is required for advisors. When asked about this, a faculty members mentioned as presented in Table 42.**Table 42.** Faculty quotes about advisor's support for industry careers*

Participant	Quote
FP07	On the academic side, we [faculty] often gauged on where our students go. There's no academic benefit to having a Ph.D. student go into industry. Most academicians say, 'What's the point of producing a Ph.D. that doesn't go in to become a professor somewhere?'
FP05	Academics (most advisers), they do not understand industry well. They understand academia well and so, they advise students to get employment in academia.

It is possible that advisors do not understand the construction industry well due to their lack of experience working in the construction industry. Advisors understand academia, so they advise their Ph.D. students to investigate employment in academia.

However, it is important to consider the various career aspirations of students, and advisors need to be aware of what the student expects to do once they graduate. If an advisor cannot support students' interest in the industry due to their lack of understanding about the industry, a potential solution to include a committee member who has industry experience or use a co-advisor from the construction industry.

4.7.1.4 Lack of Field/Job-Site Experience. Another important challenge for construction Ph.D. students to obtain employment in the industry is their lack of field/job site experience. The most cited factor by the industry professionals and Ph.D. graduates is the absence of industry/internship experience among the construction focused Ph.D. students as provided in Table 43.

Table 43. *Quotes related to Ph.D. students' lack of job site experience*

Participant	Quote
CIP01	For the person who doesn't have any field experience...that is the biggest challenge. I think experience in the industry is kind of irreplaceable. The universities don't have any guidance for that.
CIP02	Lack of experience would be a major hurdle because a lot of Ph.D. students don't have much working experience. They have a lot of book experience, theoretical experience, but not a lot of working experience, which is what we need and expect in the industry.
CIP03	Lack of actual field experience. Most of the Ph.D. candidates have a lot of theory but not practice, and that is a challenge.

This evidence signifies that construction employers expect construction Ph.D. students to have industry experience before considering them for employment. Regarding the reasons for placing such an emphasis on construction industry experience, a Ph.D. graduates working in the industry said as illustrated in Table 44.

Table 44. *Quotes related to importance of industry experience for construction Ph.D. students*

Participant	Quote
CIP12	The construction industry values experience. So, if you have been right out of undergraduate school, you went to the graduate school, and then you have a Ph.D., there's a lot that they will feel is missing.
CIP05	Especially those that don't have any industry experience when they're coming to that employment role as a Ph.D. student, I think that makes some employers

	shy away a little bit, just not knowing if it's going to be a good fit, whether that person will enjoy the position or do well in the position.

These quotes indicates that the construction industry expects Ph.D. students to have s industry experience before employing them. However, current Ph.D. programs do not provide an opportunity to obtain industry experience. Providing an opportunity for Ph.D. students to experience industry through internships will be helpful in preparing them effectively for careers in the industry.

4.7.2 Survey Findings – Challenges of Ph.D. Students for Alternative Career Paths.

Following the qualitative interviews, the survey questionnaire collected responses from all sample categories regarding their perceptions about the challenges construction-focused Ph.D. students encounter to attain careers in the construction industry. Figure 16 presents the quantitative findings.

The survey findings indicate that lack of construction industry's awareness, and construction industry's perception that there is no need for Ph.D.s in industry and that they're too academic are the important reasons perceived by all participants as important challenges for construction Ph.D. students to obtain employment in construction industry followed by the lack of construction industry experience Ph.D. students possess.

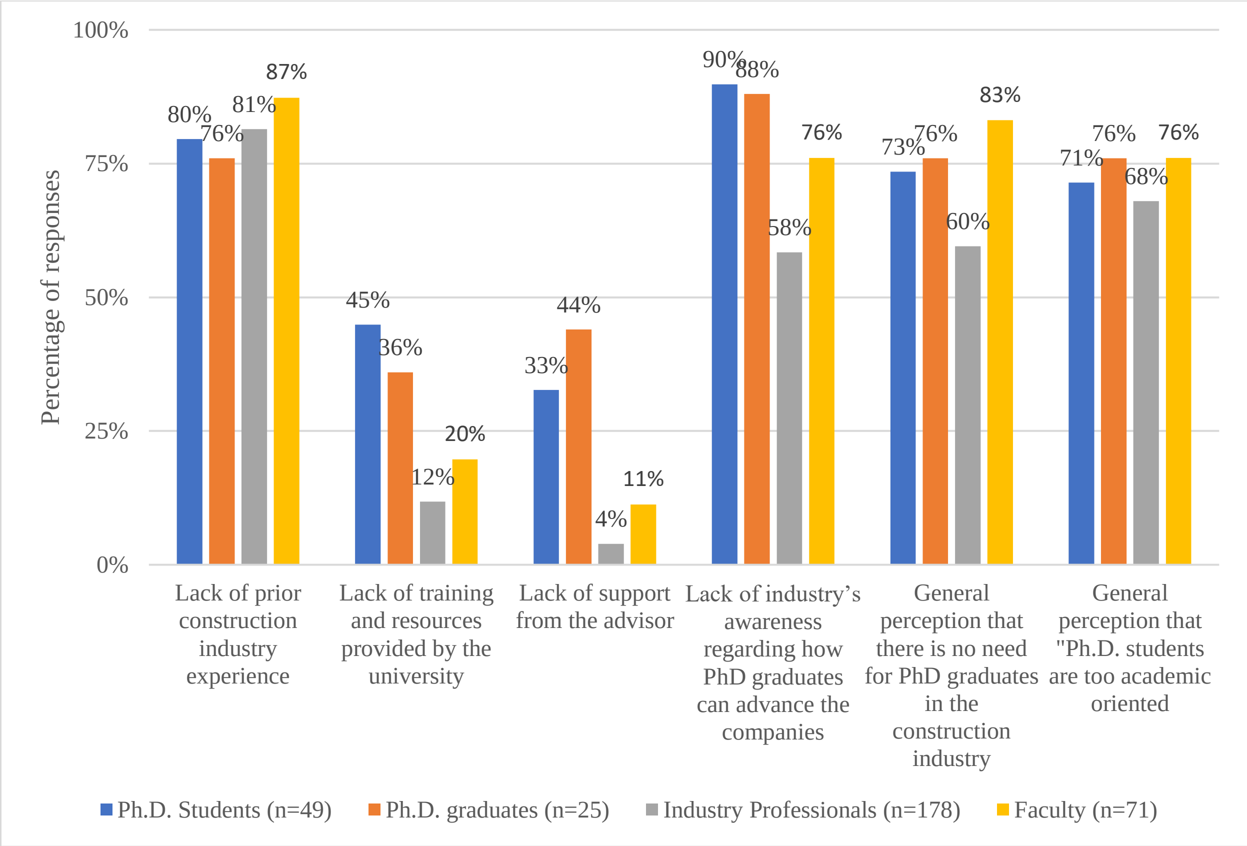

Figure 16. *Challenges for construction-focused Ph.D. students for employment in construction industry*

4.7.3 Roles/Areas in the Industry Where Ph.D. Students can be Employed

All industries play an important role in the employment of Ph.D. graduates and this role has been increasing in recent years (Stephen et al., 2004). Although there is no specific literature available about the construction industry, this study has demonstrated that the construction industry is interested in hiring Ph.D. graduates, provided they are prepared and trained for roles in the construction industry. Previous studies (Mewburn et al., 2018; Stephen et al., 2004) identified characteristics of firms and the roles that are suitable for Ph.D. graduates in the construction industry.

This study investigated the roles and areas of employment that are suitable for construction-focused Ph.D. graduates in the construction industry by interviewing two of the sample categories: construction industry professionals and construction-focused Ph.D. graduates working in the industry. This information will be of interest to current and future construction-focused Ph.D. students that are interested in preparing for careers in industry in addition to academia and academic faculty that are involved in the development and operations of current construction-focused Ph.D. programs or creating new construction-focused Ph.D. programs that include industry involvement. The areas of employment for construction-focused Ph.D. students identified in this study include technology and innovation, business process improvement, learning and development, and project management. Additionally, five Ph.D. graduate participants stated that there is no specific role or area of employment, and Ph.D. students must identify space they are apt in the industry based on their interests and abilities.

4.7.3.1 Technology and Innovation. Most of the construction industry professionals and Ph.D. graduate interview participants opined construction-focused Ph.D. students are suitable for roles in technology and innovations considering the technological advancements the construction is experiencing in the last few years. Table 45 includes quotes from participants that support the hiring of Ph.D. graduates into technology and innovation roles for construction firms.

Therefore, the construction industry perceives roles in construction technology and innovation that involve testing and implementing technological tools throughout the project life cycle as good fit for construction-focused Ph.D. graduates. Furthermore, industry professionals and Ph.D. graduate participants mentioned specific areas within technology and innovation realm, including filling positions in augment reality (AR), virtual reality (VR), building information modeling (BIM), and virtual design and construction (VDC).

It is important to understand that if companies are looking for typical BIM roles related to designing and developing models, they would not need a Ph.D. student. But, if companies are

__Table 45.__ Qualitative data supporting industry employment of Ph.D. graduates into technology and innovation roles

Participant	Quote
CIP02	Technology and innovation departments are suitable for Ph.D.'s. Everything is moving so quickly to improve productivity that contractors don't know what they should use and if it's going to be useful. That's where Ph.D.'s can help GCs evaluate technologies and help them in the adoption.
CIP01	Industry is going to a point where everybody acknowledges the fact that we need new technologies, processes, and workflows to improve what we have been doing for the last century. And if you look at most of the people with Ph.D.'s that are in the construction industry, they are in good positions of innovation, technology, processes, systems, operations.
CIP04	There's a lot of space right now in the construction technology world. I would say construction technology implementation, deployment, and innovation
CIP15	We currently and in the near future need experts in virtual reality, augmented reality, and mixed reality. So, a Ph.D. coming out and has expertise in the area of visualization would be a great fit.
CIP05	An area like BIM is where Ph.D. students will excel. We are looking for people who can help us advance BIM practices, do things differently, open new doors to innovation, this is where I see Ph.D. students playing a great role. I have seen several Ph.D. graduates taking up BIM roles in the industry.

interested in advanced BIM application, that is when Ph.D. graduates can be hired. Overall, the industry professionals believe roles in construction companies that involve the development and use of AR, VR, BIM and other emerging technologies are suitable for construction focused Ph.D. students.

4.7.3.2 Business Processes Improvement. The construction industry professionals and construction-focused Ph.D. graduates informed that there are opportunities for Ph.D. students in business process improvement groups within construction firms. Business process improvement groups look for areas of continuous improvement within a firm to improve the business process that contributes toward improving the productivity and enhancing operations. Then, when discussing about specific areas that would fit for Ph.D. graduates within business process improvement, Table 46 captures qualitative data that supports the employment of construction Ph.D. graduates into business process improvement roles.

Table 46. *Data supporting industry employment of Ph.D. graduates into business process improvement roles.*

Participant	Quote
CIP01	There are roles in improving business processes within the new digital execution model. There's a lot of things that just in the delivery of information, the delivery of technology, that I think Ph.D. construction students could lend tremendous amount of profit in these areas.
CIP03	In the construction domain, as a space with some soft boundaries, business processes related to workflow design, process design, systems, operations are the main areas where we hire construction Ph.D.'s. These roles contribute towards improving productivity and execution in construction.
CIP12	Data analytics is one area that is growing significantly that improves construction business process and changes the way we are doing business. It needs, in many cases, training in areas like mathematics. It needs that heavy training that is not common for construction program graduates and Ph.D. student can fill those positions.
CIP05	We've started to look at construction Ph.D. students with experience in data analytics, and data science to understand how they can help within our construction execution models and improve processes.
CIP02	We've just recently hired construction Ph.D. students that are data analytics experts in the last three years to improve our construction process and to help with the engineering and procurement process.
CIP02	I can't see a data or a computer science Ph.D., they're perfect for developing the software we need, but they don't understand what the application is for, and what it's going to be used for in the field, and what it could actually improve in the field. To them, it's just code.
CIP07	There's a lot of construction firms that require people to have construction knowledge and data analytics knowledge. That's when industry realized to look at construction Ph.D.'s working in data analytics area.

Overall, the data shows construction firms are looking for Ph.D. graduates that can improve business processes. They are interested in Ph.D.'s that have knowledge in improving business processes by using emerging fields such as data analytics and data science.

4.7.3.3 Learning and Development. The industry professionals who participated in this study mentioned construction Ph.D. students have opportunities available to them in Learning, training and development roles within the construction industry. Table 47 provides data to support the hiring of Ph.D. graduates into learning, training, and development roles.

__Table 47.__ Qualitative data supporting industry employment of Ph.D. graduates for learning and development roles

Participant	Quotes
CIP02	There are several roles in training and development that suit construction Ph.D.'s. There are several large companies that have learning department that look for Ph.D.'s to develop training for project managers on subjects like project management principles, the aspects of putting communications plans together, like a teaching role for project managers.
CIP04	I think definitely a lot of the learning and development side of the industry is very conducive for an academic experience.

4.7.2.4 Project Management and Consulting. The participants mentioned that construction Ph.D. students also have opportunities in construction project management domain as demonstrated by the quotes provided in Table 48.

__Table 48.__ Qualitative data supporting industry employment of Ph.D. graduates in project management roles

Participant	Quote
CIP 11	If Ph.D.'s have internship experience while working towards Ph.D. degree, they can become assistant project manager or assistant construction project manager.
CIP 08	The place for Ph.D.'s is more around the consulting realm where if the company is big enough, they can just call Ph.D.'s in a time of crisis or if they want to implement a new project management practice.

4.7.3 Survey Findings – Roles for Construction Ph.D.'s in Construction Industry

Following the interviews, the questionnaire survey as well gathered participants perception regarding roles/areas of employment for construction Ph.D.s in the construction industry. Figure 17 presents the results. The survey findings indicate that roles in technology and innovation are most relevant to construction Ph.D. graduates followed by roles in business process improvement and project management.

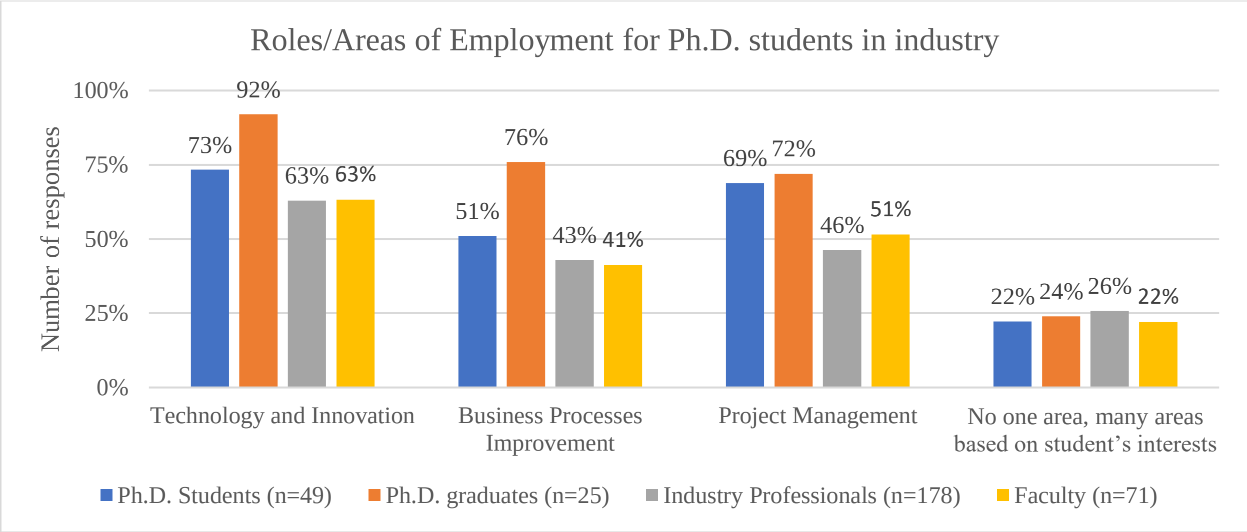

Figure 17. *Roles/Areas of Employment for construction Ph.D.'s in the construction industry*

4.7.3 Opportunities/Resources

The study investigated participant's opinions regarding various opportunities and resources that should be provided to construction-focused Ph.D. students in order to prepare them for careers in industry and academia. This includes providing resources related to construction industry engagement and interactions, opportunity to complete construction industry internship, ability to perform research that balances both theoretical foundations and applications. The following sections present each of those findings followed by the last section that presents perceptions of participants about various ways Ph.D. program models could prepare construction Ph.D. students for diverse careers.

4.7.3.1 Industry Engagement and Interaction. The study participants that belong to construction Ph.D. students, construction Ph.D. graduates, and construction faculty categories mentioned providing opportunities for Ph.D. students to interact and engage with construction industry is important to prepare Ph.D. students for careers in the industry in addition to academia according to the quote illustrated below (Table 49). This indicates that Ph.D. students are not

Table 239. *Need for Ph.D. students to interact with industry*

Participant	Quote
SP07	Ph.D. students should be given an opportunity to meet and interact with industry folks just as undergraduate students. That is when industry notices us, otherwise visibility of grad students is poor.

provided with sufficient opportunities to be noticed by construction industry employers. When inquired about ways to provide this opportunity for Ph.D. students, a faculty member mentioned the following (Table 50):

Table 50. *Quotes related to ways to provide industry engagement opportunities for Ph.D. students*

Participant	Quote
FP07	We have our graduate students, both master's and Ph.D.'s come into our industry advisory council and interact with companies at certain points during the annual advisory council meetings. Our graduate students also do a research poster session where we invite our industry advisory council members to judge and engage with the students.
FP01	We invite the industry professionals to give guest lectures in our Ph.D. classes. We, then have a session where Ph.D. students, faculty, and industry professionals brainstorm and discuss about research ideas.

This indicates that providing opportunities for Ph.D. students to interact with industry is important, and construction programs achieve that by developing mentoring programs exclusively for Ph.D. students, organizing industry-academia brainstorming research sessions, and allowing Ph.D. students to present at industry council meetings. This helps Ph.D. students to build network within the construction industry and identify opportunities that align with the industry needs. Also, this informs Ph.D. students about the non-academic career paths that are available to them. Additionally, this also creates construction industry awareness about the research that is performed by construction Ph.D. students bridging the disconnect between industry and academic research. Attending industry related conferences also helps Ph.D. students engage and make connections with the industry as per the quotes from faculty and Ph.D. graduate participants mentioned in Table 51.

Table 51. *Quotes related to benefits of Ph.D. students' industry engagement*

Participant	Quote
FP07	One of my students that went to an industry job, they found a conference where it was all industry people and presented the work there. And they had people contacting afterwards about, "Hey, how can we do this? What can we do to implement this?", which eventually resulted in an industry position.
CIP11	I worked with the construction industry to get my data, and I worked more like a consultant than an academician in this process. That helped me engage with the industry and make required connections.
CIP09	My advisor collaborates with industry for research. What happens is that the industry members sponsor money, so that he can hire Ph.D. students and do research. But in the meantime, industry members also participate in the research. The research go to their sites and collect data from their sites. So, the industry is a part of the research. As a Ph.D. student, I could learn and engage with industry folks through this model. I think people who are advocating for this kind of research programs are becoming successful.

This indicates performing research that involves construction industry helps Ph.D. students understand industry, learn from industry and build their network in the industry. This ultimately prepares and enhances their employment opportunities in both academia and construction industry.

4.7.3.2 Industry Internship. The majority of participants indicated that it is critical to provide Ph.D. students with the opportunity to complete an internship in the construction industry during their Ph.D. journey in order to prepare them for both academic and industry employment as per quotes from Table 52. This informs that internship provides the dual advantage of preparing the Ph.D. students for both industry and academic careers. Talking specifically about how internships prepare construction Ph.D. students for careers in the industry, participants (Table 53) said the following:

Table 52. Quotes related to importance of industry internships for Ph.D. students

Participant	Quote
CIP05	Having an internship program for the Ph.D. students would solve a lot of problems for construction Ph.D. students. You experience industry that helps you either get a job in industry or learn real world construction and be a good teacher in the classroom.
FP01	I would recommend Ph.D. students to have internships. We have more international students in our Ph.D. programs, and they usually do not have U.S. construction industry experience. Having the internships helps them know how construction industry here works. If they move into academia, they have the experience available to them that helps them become better educators. And the experience obviously helps to go them into industry. Each track [academic and industry], having internship or experience in the industry is valuable.

Table 53. Quotes related to industry employment preparation through industry internships for Ph.D. students

Participant	Quote
CIP20	I did six or seven internships during the entirety of my Ph.D. program. That gave me a huge advantage when it came to interviewing for industry positions. I think getting the actual real-world experience definitely helps you in that next career jump. I think construction Ph.D. programs should have some mandatory internships.
FP03	One of my Ph.D. students that graduated last year joined a position in the industry. And the way that they secured their job is, they had an internship with that company over the summer. We worked with them with data collection on that student's dissertation, and then they liked the results, and they liked how the student was thinking about it, and then they hired them right after their PhD.

This informs that completing internships during Ph.D. programs prepares and enhances their ability to attain industry employment. Internships will allow construction industry to know Ph.D. student abilities better, which then makes it an easy decision for construction companies to hire or not to hire the Ph.D. student. This improves construction industry employment prospect of Ph.D. students. In addition to being prepared for employment in the industry, internships also provide industry insights and real-world construction experience to Ph.D. students as mentioned by participants (Table 54).

Table 54. *Quotes related impact of internships of construction Ph.D. students*

Participant	Quote
CIP20	If they [Ph.D. students] have no experience, if they've just gone from undergrad to master's to PhD, then the biggest thing that I would recommend is get an internship over the summer. They need to see what construction is like, be on a job site and see interactions between people, between materials, in order to understand progress.
SP01	My department allows us to do an internship, and I have done two internships that were very helpful to gaining industry insights. That also helped me realize my interest and potential in an industry job.
CIP14	If the advisers are okay with Ph.D. students doing an internship over the summer, it is a good opportunity which helps build relationships with the industry and provides chance for them to decide what career they like.
SP03	My advisor advises all his students to do an internship. This helps us, one, to realize our interests. Two, it helps us understand the needs of industry and develop a study around it. My dissertation study is developed from my internship experience.

In addition to learning about industry, internships also open new doors for Ph.D. students as they help them realize newfound interests and hidden potential. This also indicates that Ph.D. student internships bridge industry-academia research gap as these students while they work through their internships identify research needs of the construction industry. Internships not only help in preparing Ph.D. students for industry employment, but also enhance their ability to become better teachers and be better prepared for positions in academia. Talking specifically about how internships help Ph.D. students for academic career preparation, participants mentioned (Table 55).

Table 55. *Quotes related to academic employment preparation through industry internships for Ph.D. students*

Participant	Quote
FP06	When we explain things to the students, if you explain them practically, "this is what and how it happens on the site, this is how I handled it", and include your experiences...you can make a lot of impact than just telling what's in the textbook
SP01	My internship experiences this summer was really eye-opening experience for me. Now, I make several examples from my internship experience for my students, and I'm applying them in my classes. I feel more confident now in the classroom and better prepared for my academic career than ever before.

This explains how internships assist Ph.D. students become better teachers by allowing them to experience actual construction experience, which eventually prepares them for careers in academia. Despite the importance of internships, the student participants identified attaining internships is challenging due to various factors that were presented earlier in this dissertation. Therefore, the author inquired participants for ways to provide internship opportunities for Ph.D. students. The participants mentioned the following (Table 56):

Table 56. *Quotes related to different ways to provide internship opportunities for construction Ph.D. students*

Participant	Quote
FP04	New professors go as in during the summer to be as an intern to know how the industry works through faculty internship programs. Why not PhD students? Internships for Ph.D.'s in their first, second, or third year must be advocated with industry.
SP03	The construction academic departments should create awareness and request the industry, at least 5 to 10 companies to hire Ph.D. students as interns.
CIP05	My company offers programs such as Ph.D. co-ops, Ph.D. student residency programs that are similar to internships that combine both field and research aspects.

The kind of programs that combine both field and research components might appeal to construction industry and faculty members. Internships bring together the worlds of industry and research, making Ph.D. students well-rounded and allowing them to see things through different lenses. Overall, this informs the importance of providing internship opportunities to construction focused Ph.D. students to improve to employability in diverse career paths.

4.7.3.3 Coursework. Preparing students for workforce readiness through courses has been a traditional practice in higher education. Higher education programs must weave coursework that is relevant to career preparation of students (Ciarocco, 2018). Therefore, to identify coursework that prepares construction focused Ph.D. students for diverse career options, this study interviewed construction industry professionals and construction Ph.D. graduates working in the industry. The study identified courses such as advanced Building Information Modelling, construction finance and accounting, data science, data analytics, augmented reality, and virtual reality are important to be offered to prepare construction focused Ph.D. students for careers in the construction industry as demonstrated by the following quotes (Table 57) from construction industry professionals and construction Ph.D. graduate participants.

Table 57. *Quotes related to important coursework in construction Ph.D. programs for multiple career path preparation*

Participant	Quote
CIP15	An advanced BIM class is essential. But just not much as BIM design, it should include advanced applications such as overlaying schedules (4D), developing and organizing site layouts, etc. So, BIM and all its applications would be interesting to learn and be prepared for employment in industry.
CIP05	A course on construction finance is extremely important. My boss at the first job after my Ph.D. expected me to read numbers, understand ledger and other financial data. We are never taught that at school, but it is important.
CIP13	There should be one to two finance classes that should be a part of the core curriculum in construction Ph.D. programs, because it's very important.
CIP12	To be successful in industry, you should have the financial engineering knowledge, from a business approach, because you're going to be always asked, "How can we save on that? How can we reduce the cost of this process?". So, a financial course is preferred.
CIP02	Apart from traditional construction courses, I do feel that an introduction to data science is important considering how the construction industry is expected to transform in the near future.
CIP06	If you're not in technology, there's no future. So, a class in emerging technologies for construction is essential. Talk about applications of AD/VR, data analytics, etc. in that class. This prepares Ph.D. students not just for industry roles, but also future research in academia.

The courses that are identified important for construction academic career preparation are grant writing, academic writing, and teacher training. This is demonstrated by the following comment (Table 58).

Furthermore, the participants identified the coursework related to professional development of construction focused Ph.D. students in both academic and industry career paths.

This includes coursework in communication skills and leadership as demonstrated by the following quotes (Table 59).

Table 58. *Academic career preparation courses for construction Ph.D. students*

Participant	Quote
FP04	I think professional development courses related to grant writing, academic writing and industry writing are crucial for Ph.D. students career preparation. And a course dedicated to teaching is essential.

Table 59. *Professional development courses for construction Ph.D. students*

Participant	Quote
FP06	I think having a leadership class or a good management class would be beneficial to both sides because even if you go the industry or academic route, you're going to have to be a leader. And in that class, maybe they could cover things like technology adoption and change, managing change in organizations.
FP03	A course focusing on soft skills, leadership, science communication, stakeholder management is currently missing, and it is important to include in construction Ph.D. programs.
CIP13	I think a class on communication is extremely important. How to manage relationships in the business, let it be academia or industry through effective communication must be taught to Ph.D. folks.

4.7.3.4 Theoretical Research vs Applied Research. Theoretical and applied research are two types of research. Theoretical research usually results in long-term improvements, whereas applied research focuses on short term fixes. The primary goal of theoretical research is to improve understanding, contribute to the body of knowledge, and make long-term advancements. Theoretical research places less emphasis on achieving immediate results. Applied research, on the other hand, focuses on achieving immediate results in solving a problem (Van Scotter & Culligan, 2003). Construction is an applied industry (Gunderson & Gloeckner, 2006), and the construction industry expects academia to perform research that is applied in nature and that solves immediate challenges of the construction industry (Bigelow et al., 2016). The construction industry professionals opined that they expect Ph.D. programs to encourage students to perform applied research. The Ph.D. graduates informed applied research prepared them and helped them attain positions in the construction industry. However, construction faculty opined theoretical research is essential to advance the discipline as a whole. This section presents the varying views of the study participants regarding theoretical and applied research, as well as how it impacts the career preparation of construction-focused Ph.D. students.

Regarding construction industry's expectations for Ph.D. students' and their research, participants mentioned the following (Table 60):

Table 60. *Quotes related to industry expectations from Ph.D. students' research*

Participant	Quote
CIP12	Construction industry does not read Ph.D. academic papers. What a Ph.D. in construction is expected to do is solve real-world construction industry problems. You do that, you're considered for employment. Otherwise, they think you're too academic.
CIP04	We want research that can be applied to solve our challenges. With that type of research, a lot of times you get to see your research put into place fairly quickly, and you get to see benefits from it. That's what construction industry wants as it is very motivating just to see it help the industry.

This informs that construction industry is interested in applied research that solves challenges currently being encountered by the industry. The Ph.D. students that perform research that is relevant to industry problems are considered potential candidates for employment within the construction industry. Confirming this, Ph.D. graduate and faculty participants said the following (Table 61):

Table 61. *Quotes related to industry's applied research expectations from Ph.D. students'*

Participant	Quote
CIP06	My research was on the empirical applied side where I was using a lot of real-world construction data, talking to a lot of people in the industry, understanding their pain points, and developing solutions for those issues. My advisor helped me throughout this process, the industry liked my research immensely, and by the time I finished, I had industry [employment] offer that I grabbed immediately.
FP07	One of my recent Ph.D. students that went to industry did their research on an industry-focused, applied project. She was doing case studies and presented it to construction industry, they loved it and helped her get a job in the industry.

This indicates that applied research in Ph.D. programs tends to impress construction industry, as well as prepare and improve the potential of construction Ph.D. students for industry employment. However, there is a different perspective from some faculty regarding performing applied research during a Ph.D. program. Table 62 presents the perspective of a faculty member leaning more towards theoretical research.

Table 24. *Quote related to importance of theoretical research in Ph.D. education*

Participant	Quote
FP04	Ph.D. degree, it requires contribution to knowledge. Theoretical foundation is important, which results in advancements. Ph.D. programs must produce knowledge. Applied research may solve industry challenges but doesn’t result in advancements for construction discipline. Theoretical research prepares you for a strong academic career.

This indicates theoretical research is important for preparing Ph.D. students for careers in academia. This also demonstrates the significance of conducting theoretical research for a Ph.D., despite the construction industry's preference for applied research. Adding a new perspective to this, industry and Ph.D. graduate participants said (Table 63).

Table 63. Quotes related to connecting theory with practice in construction Ph.D. students' research

Participant	Quote
CIP01	Construction is an applied field. For faculty and Ph.D. students, it is important to figure out ways to take their theoretical research and make it more applied. This will prepare students for careers in the industry.
CIP18	I did a traditional academic dissertation built on theoretical foundations related to claims and delays. But I was not interested in an academic job. So, I developed an industry practitioner guide or recommended practices on construction delays and claims, which is what that lead me to an industry position that I am today.
CIP13	They [Ph.D. students] should definitely provide a connection between industry and theoretical research they do. That will not only prepare them for careers in industry, but also support their careers in academia.
CIP15	Applied research is as well important for Ph.D. students who are interested in academia. Even if you're going to live in the realm of theoretical research as an academician, it's important to understand how construction industry works because regardless of the research, some level of your job is typically going to be teaching. And being able to make the connections from the textbook to the real world is really useful in the classroom."

This implies that connecting Ph.D. theoretical research with construction industry is important for Ph.D. students' career opportunities both in the construction industry and academia. Overall, this presents two contradicting views that theoretical research is required to contribute to the body of knowledge.

In contrast, applied research prepares Ph.D. students for career paths in industry and academia. Further, academic participants mentioned (Table 64), This informs that a balance of theoretical and applied research during Ph.D. journey prepares Ph.D. students for both academic and industry career paths.

Table 64. *Quotes related to importance of balancing theory and practice in Ph.D. research*

Participant	Quote
FP04	I think a little bit of balance of theoretical and applied research is important. The theoretical, the foundational work, that's how we get advancement. But that's something after 20-25 years. What our industry values is how can the research help them now? So, for our construction Ph.D. students to prepare for

	multiple career paths, the ability to look at both theoretical research and applied research is what helps.

This informs that Ph.D. students and faculty members must identify research topics that balance both theory and practice in order for the Ph.D. students to be prepared for multiple career paths.

When asked about ways to perform research that balances theory and practice, a construction faculty (Table 65) mentioned the following:

Table 65. Quotes regarding ways to balance theoretical and applied research in construction

Participant	Quote
FP03	My student that got job offers in both academia and industry did research that was a combination of both theoretical and applied research. The first half of it was a bit more theoretical. The second half of it was looking at more of the practical application. The applied side provided some specific guidance for practitioners versus the theory on the first part. This combination seem to be the most effective for preparing students effectively for both career paths. ”

When asked about best ways to advise Ph.D. students’ research based on the student’s career interests, a faculty members mentioned the following (Table 66):

Table 66. *Quotes related to advising Ph.D. students’ research based on their career interests*

Participant	Quote
FP05	If a PhD student is interested in industry, then directing that student toward applied research is beneficial for that student, in terms of being able to work with industry, being able to connect research type analysis to implementation.
FP04	My student that went to industry, they weren't sure when they started. So, I mentored them to do a little bit of both theory and application here. The student that went to academia always wanted to be in academia. I advised them a highly theory-based and that was a good fit. So, I think whether it focuses on applied or theoretical will depend on the student and what their career goals are.

This informs that a balance between theory and practice is important in construction research. If theory and practice are at the extremes of a spectrum, construction focused Ph.D. students research must aim to be somewhere in the middle. If the research is extremely applied, if there is no theory involved, that wouldn’t be research. There needs to be theoretical foundation to be able to do research. Some research is more skewed towards theoretical side, some more skewed towards the applied side. Research that is in the middle is what is required in construction to train Ph.D. students for both academic and industry careers. Overall, for construction Ph.D. that are interested in academic careers, theory focused research is a good fit whereas a bit of applied research also helps building a sustainable career in academia. To prepare construction Ph.D. students for both academic and industry careers, research that balances both theory and application is highly advised.

4.7.4 Preparing construction Ph.D. students for multiple career paths

This study investigated various ways to prepare construction Ph.D. students for both academic and industry career paths. The participants informed current models adopted by various universities, construction departments and construction faculty members in addition to other ideas. Participants' quotes are listed in Table 67.

Table 67. *Quotes related current models preparing construction Ph.D. students for multiple career paths*

Participant	Quote
SP08	My advisor founded a safety alliance and collaborates with industry for research. The Ph.D. students engaged with the research alliance actively work with industry members. The Ph.D. students that graduated from this set up are spread across university and industry positions successful.
CIP09	My professor created a consortium of construction companies, where the construction companies that are part of the consortium provide funding for applied research. The consortium meets twice a year to discuss research needs. Several students that graduated from this consortium work in industry and academia.
CIP01	If faculty can work with the industry, and identify the current problems of industry, and involve Ph.D. students to develop research around that, it will provide an opportunity to research and also interact with industry, thereby preparing for both industry and academic employment.

This indicates that Ph.D. students that work on research studies that are collaboratively developed and funded by industry are prepared for multiple career paths. Furthermore, faculty collaborations with industry for research purposes are important in preparing Ph.D. students for multiple career paths. Talking about ways to prepare students for multiple career paths, participants added as shown in Table 68.

__Table 68.__ Quotes regarding different ways to prepare construction Ph.D. students for multiple career paths

Participant	Quote
CIP02	If universities and construction industry come together to develop collaborative Ph.D. programs, it will be fantastic. The Ph.D. students can be prepared for both paths.
CIP05	Industry-Academia collaboration is a key piece. I think internships aimed at Ph.D. students could be the first step in that journey. I think another way to do it is with some co-op opportunities with research residency programs at the construction companies. Schools and companies should discuss this and introduce collaborative programs.

This informs that there is interest within the construction industry towards industry-academia collaborative construction Ph.D. programs. The construction academic departments should look towards developing programs such as research residency or a research co-op.

Furthermore, faculty members expanded how industry-university collaborative Ph.D. programs can be developed (Table 69). This indicates that a collaborative research program

__Table 69.__ Quotes related to industry-university collaboration in construction Ph.D. education

Participant	Quote
FP02	A potential solution could be having Ph.D. students working with companies, potentially on an internship with some kind of split model where it's 20 hours of research embedded within the organization focused on solving problems within the organization, and then 20 hours of work experience. This provides both research and work experience, preparing them for both industry and academia.
FP01	I think universities and construction companies should collaboratively develop Ph.D. models where there is space for more applied research. For example, if a company was looking at implementing lean methodologies, and this was what the student's research was on. And so, the student went to the company, helped them adopt lean while also studying things like barriers to adoption. So, there was then a theoretical component to the lean literature, but also a tangible benefit for the company in their transition.

focusing on research and work experience could be an effective model to prepare Ph.D. students for both industry and academic career paths. The participants mentioned other professional development programs that currently prepare Ph.D. students for multiple career paths (Table 70). This indicates that professional development opportunities such as science communication, etc.

should also be provided to construction Ph.D. students in order to prepare them for careers in both academia and industry.

Table 70. *Quotes related to professional development programs for preparing construction Ph.D. students for multiple career paths*

Participant	Quote
FP06	We have programs offered from the graduate school that cater to both academic and industry paths. We have “preparing future professoriate” and then we have “preparing the future professional” paths. And within those tracks, they've got several courses that talk about pedagogy, diversity and inclusion, communicating science, and several more.
FP05	Our university has a program called A2i for Ph.D. students interested in industry careers. It's called Accelerate to Industry. Students can meet with the industry personnel

4.7.5 Quantitative Data Results

The survey questionnaire collected participant responses regarding various ways to effectively prepare construction Ph.D. students for multiple career paths. The participants were provided with statements related to preparing construction Ph.D. students for multiple careers (identified from the qualitative interviews) and were asked to provide their agreement (strongly disagree = 1, disagree = 2, neither disagree nor agree = 3, agree =4, strongly agree = 5) with each of the statement. The statements, the responses, and descriptive statistics are provided below.

4.7.5.1 Statement 1: Industry – Academia Collaboration. Figure 18 presents participant responses for statement 1. The majority of all the respondents either agree or strongly agree that collaborations between industry and academia are important in preparing construction Ph.D. students for careers in both academia and industry.

Table 71 presents descriptive statistics results for Statement 1, which indicates that all sample categories of participants perceive that it is important for academia to collaborate with industry when preparing Ph.D. students for multiple career paths.

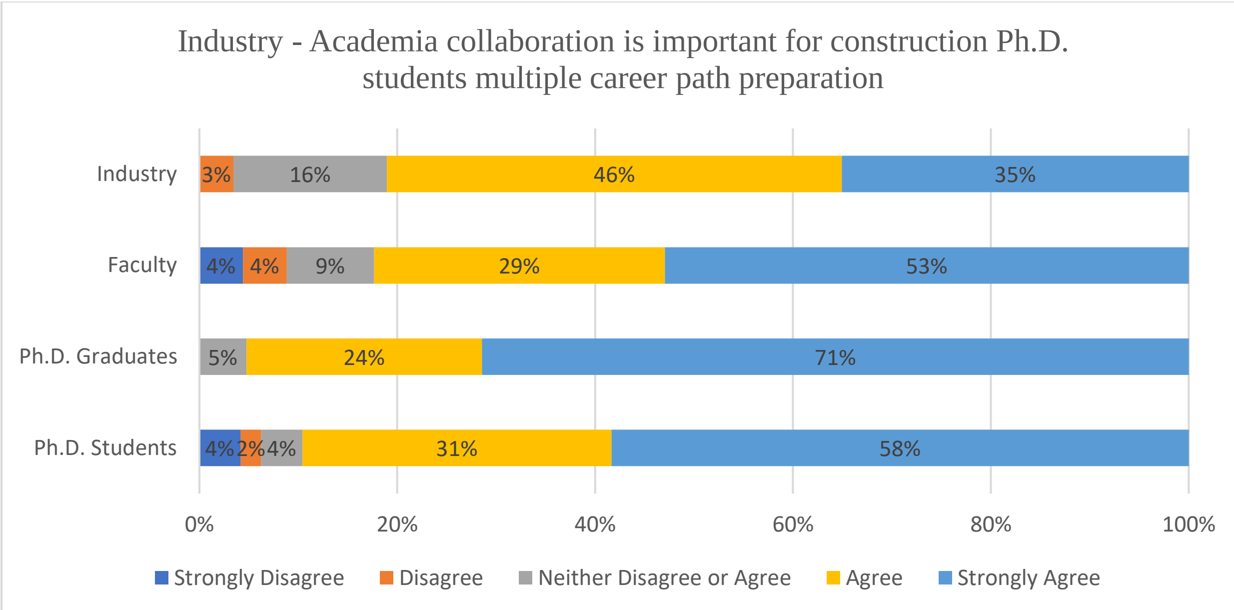

Figure 18. *Industry - Academia collaboration is important for construction Ph.D. students multiple career path preparation*

Table 71. *Descriptive Statistics for Statement 1*

Sample Category	Mean	N	Std. Deviation
Faculty	4.22	68	1.077
Industry	4.12	179	.784
Ph.D. Graduates	4.67	21	.577
Student	4.57	49	.866
Total	4.25	317	.874

4.7.5.2 Statement 2: Balancing Theoretical and Applied Research. Figure 19 presents participant responses for statement 2: Performing research that balances both theoretical and applied research orientations prepare construction related Ph.D. students for multiple career paths. A significant number of participants (90% Ph.D. students, 86% Ph.D. graduates, 79% faculty, and 79% construction industry professionals) either agree or strongly agree that performing research that balances theoretical and applied concepts prepares construction Ph.D. students for both careers in industry and academia.

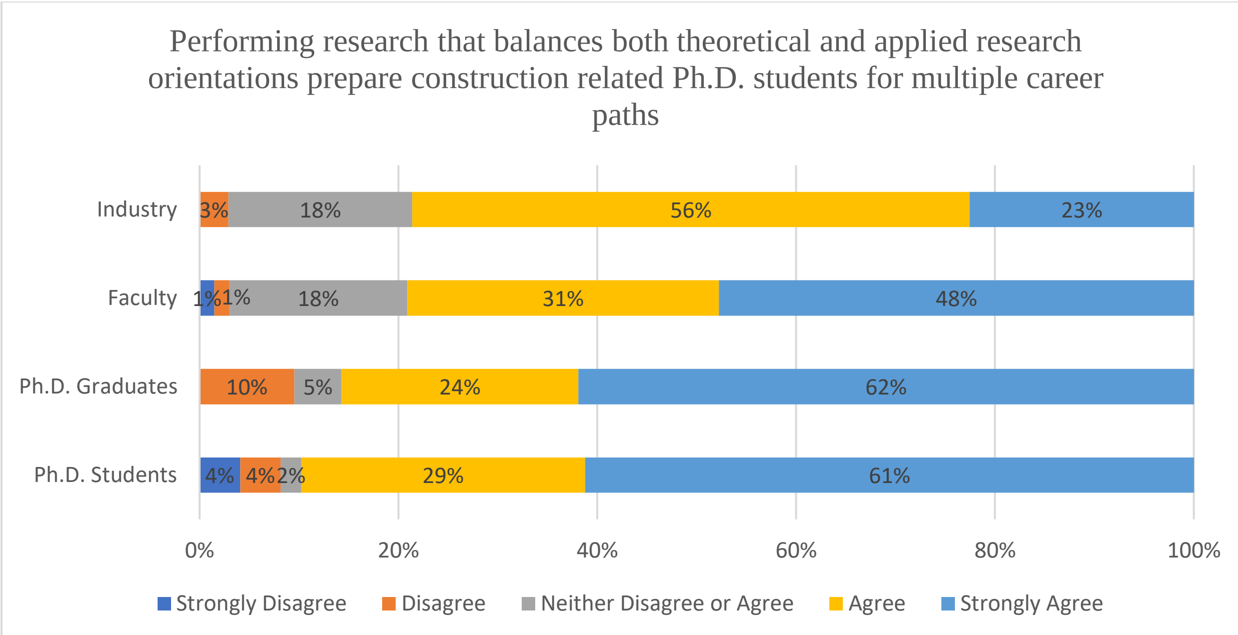

Figure 19. *Performing research that balances both theoretical and applied research orientations prepare construction related Ph.D. students for multiple career paths*

Table 72 presents descriptive statistics results for statement 2, which indicates that Ph.D. students and Ph.D. graduates that are currently working in the industry believe the most that performing research balances both theory and applied concepts prepares students for both academic and industry careers. On the other hand, industry professionals believe the least, and this could be because several of the industry participants does not have good idea about theoretical and applied research.

Table 72. *Descriptive Statistics for Statement 2*

Sample Category	Mean	N	Std. Deviation
Faculty	4.18	68	.976
Industry	3.98	179	.715
Ph.D. Graduates	4.38	21	.973
Student	4.39	49	1.017
Total	4.11	317	.857

4.7.5.3 Statement 3: Field Experience for Academia Careers. Figure 20 presents participant responses for statement 2: Having field experience is crucial for construction Ph.D.

graduates' success in academic employment. A significant number of participants (72% Ph.D. students, 95% Ph.D. graduates, and 79% faculty) either agree or strongly agree that having field experience helps construction Ph.D. graduates’ success in academic employment.

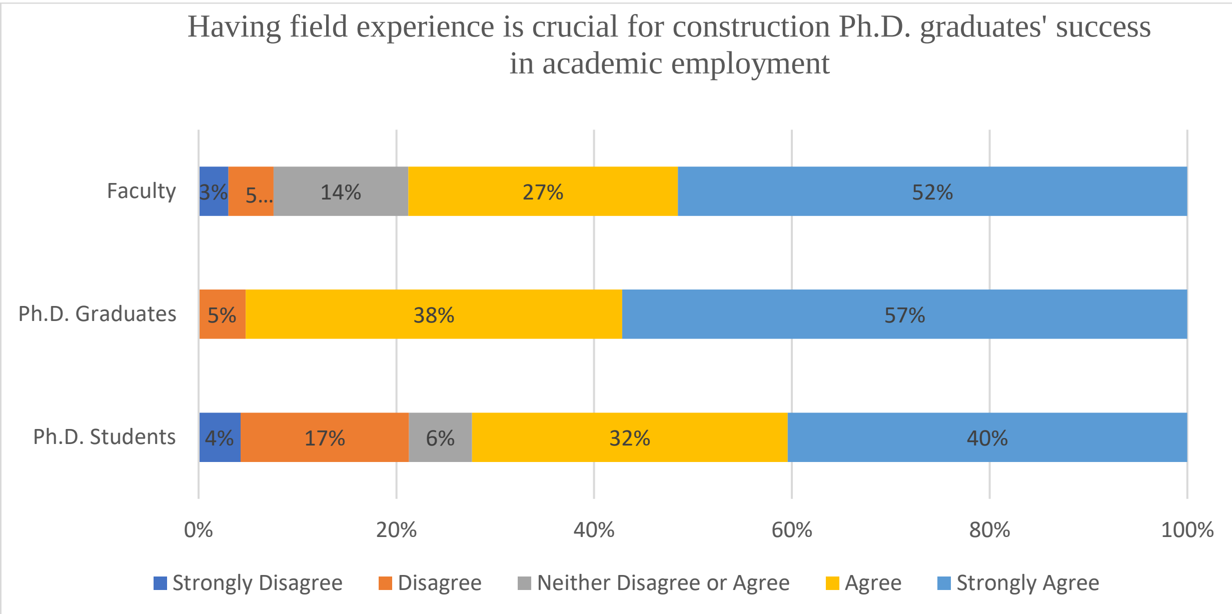

Figure 20. *Having field experience is crucial for construction Ph.D. graduates' success in academic employment.*

Table 73 presents descriptive statistics results for statement 3, showing that that Ph.D. graduates firmly believe that field experience is important for success in academic careers. The faculty participants perceive more than Ph.D. students that field experience is important in academic career success.

Table 73. *Descriptive Statistics for Statement 3*

Sample Category	Mean	N	Std. Deviation
Faculty	4.13	67	1.153
Ph.D. Graduates	4.48	21	.750
Student	3.87	47	1.244
Total	4.10	135	1.145

4.7.5.4 Statement 4: Field Experience for Industry Careers. Figure 21 presents participant responses for statement 4: Having field experience is crucial for construction Ph.D.

graduates' success in industry employment. The majority of all the sample category participants (90% students, 95% Ph.D. graduates, 91% faculty, and 96% industry professionals) either agree or strongly agree that having field experience is crucial for construction Ph.D. graduates' success in industry employment.

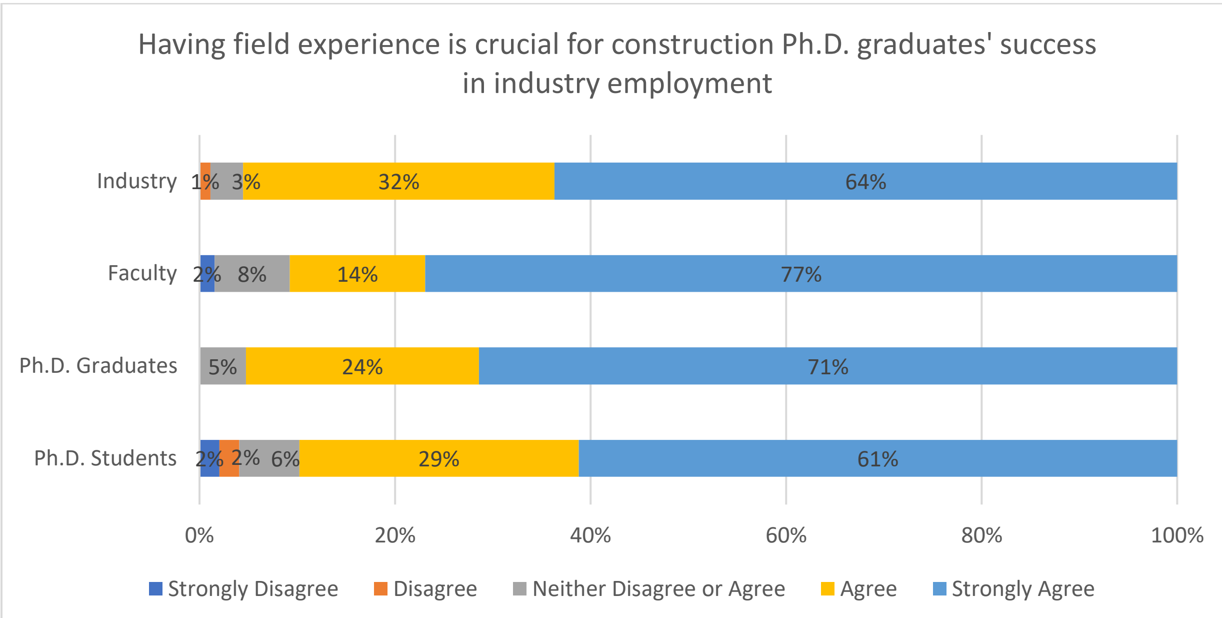

Figure 21. *Having field experience is crucial for construction Ph.D. graduates' success in industry employment*

Table 74 presents descriptive statistics results for statement 4. The results indicates that all categories of participants strongly believe field experience is crucial for a Ph.D. graduates' success in construction industry career.

Table 74. *Descriptive Statistics for Statement 4*

Sample Category	Mean	N	Std. Deviation
Faculty	4.58	67	.940
Industry	4.58	179	.616
Ph.D. Graduates	4.67	21	.577
Student	4.45	49	.867
Total	4.57	316	.734

4.7.5.5 Statement 5: Awareness of Construction Industry Employers. Figure 21 presents participant responses for statement 5: Awareness must be created to construction employers regarding advantages and importance of employing construction Ph.D. graduates in the construction industry. The majority of all categories of participants (85% students, 86% Ph.D. graduates, 77% faculty, and 72% industry professionals) either agree or strongly agree that awareness must be created to construction employers regarding importance of employing construction Ph.D. graduates in the industry.

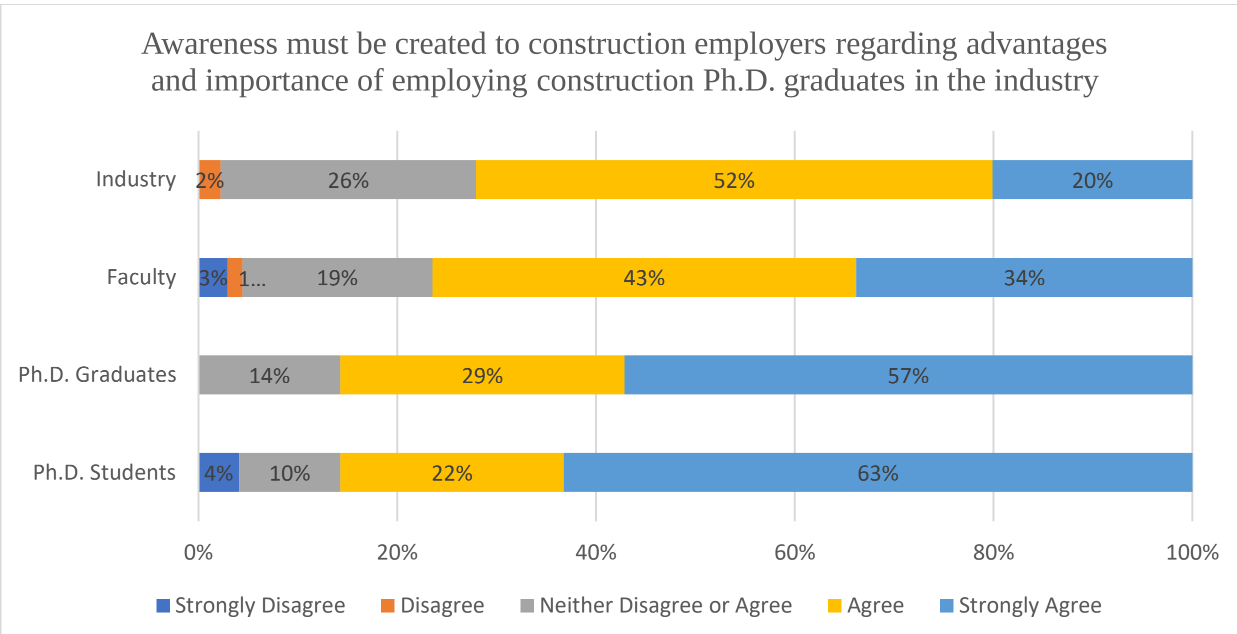

Figure 22. *Awareness must be created to construction employers regarding advantages and importance of employing construction Ph.D. graduates in the construction industry.*

Table 75 presents descriptive statistics results for statement 5. These results inform that construction industry professionals perceive the least need to create awareness about importance of hiring Ph.D.'s in the construction industry, whereas the Ph.D. students and Ph.D. graduates working in the industry see the greatest need to create the awareness. This could be because of the general perception that industry professionals hold since a long time that there is no need for Ph.D.'s in the industry. The mean score of 3.90 (SD = 0.73) still indicates a significant agreement among the industry professionals which is good sign regarding the gradually changing perception of industry professionals about the construction Ph.D. graduates. Further efforts by academics in this direction could yield good results in the future.

Table 75. *Descriptive Statistics for Statement 5*

Sample Category	Mean	N	Std. Deviation
Faculty	4.03	68	.930
Industry	3.90	179	.735
Ph.D. Graduates	4.43	21	.746
Student	4.41	49	.977
Total	4.04	317	.843

4.7.5.6 Statement 6: Industry Participation in Ph.D. Research. Figure 22 presents participant responses for statement 6: "To prepare construction Ph.D. students for multiple career paths, the students' Ph.D. dissertation committee should have a co-advisor from construction industry". Here, the majority of all categories of participants (58% students, 62% Ph.D. graduates, 58% faculty, and 81% industry professionals) either agree or strongly agree that Ph.D. dissertation committees should have a co-advisor from the construction industry.

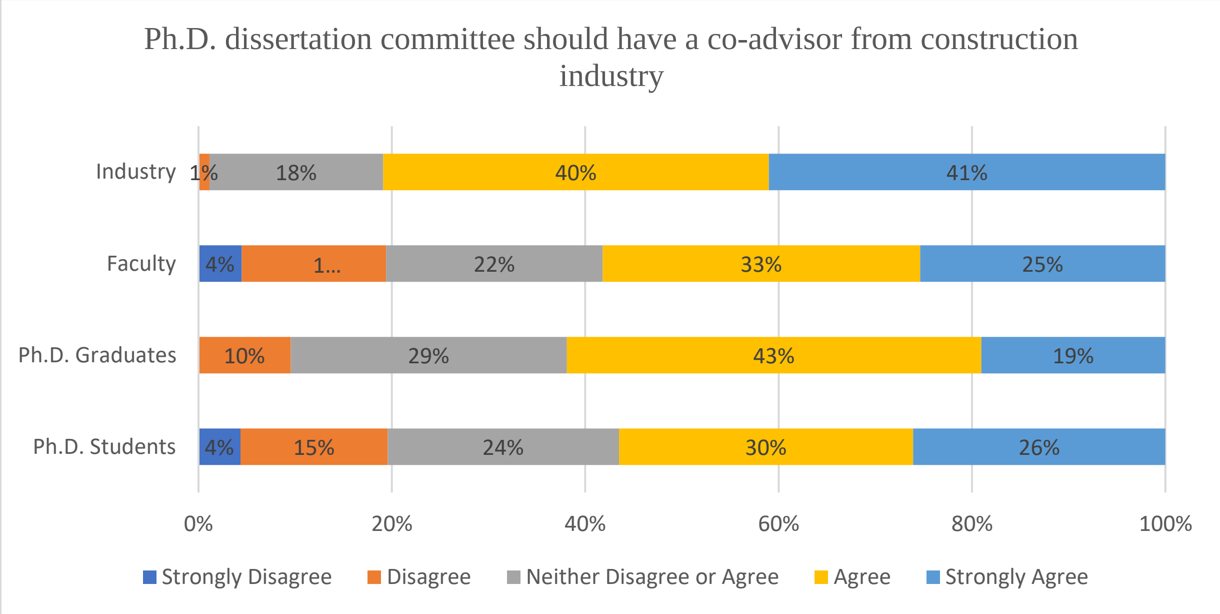

Figure 23. *Ph.D. dissertation committee should have a co-advisor from construction industry*

Table 76 presents descriptive statistics results for statement 6. The results show that construction industry professionals are interested in serving on Ph.D. dissertation committees and believe their participation helps prepare students for multiple career paths. However, faculty, Ph.D. graduates and Ph.D. students does not believe as much as industry professionals believe that having a co-advisor form industry helps Ph.D. students prepare for multiple career paths. This could be because they feel susceptible by the opinion difference from industry professionals and maybe they believe the research will be skewed too much towards the applied side rather than the theoretical side.

Table 76. *Descriptive Statistics for Statement 6*

Sample Category	Mean	N	Std. Deviation
Faculty	3.54	68	1.227
Industry	4.21	178	.771
Ph.D. Graduates	3.71	21	.902
Student	3.59	46	1.166
Total	3.94	313	1.003

4.8 Research Question 3 Findings Summary

This study identified challenges related to construction-focused Ph.D. students seeking employment in the construction industry, roles/areas of employment in the construction industry that are suitable for construction-focused Ph.D. students, and resources and opportunities to be provided for construction-focused Ph.D. students to be prepared for a variety of careers. The challenges related to employment of construction Ph.D. students in nonacademic careers identified in this study include perception of industry professionals that Ph.D. students are too academic, lack of construction field experience, lack of support provided by advisor, lack of resources provided by the academic department, and lack of awareness of non-academic career paths available to Ph.D. students. The areas of employment within the construction industry that suit construction Ph.D. students are roles in innovation and technology adoption and development, learning and training, project management, and business process improvement. The resources that should be provided to construction Ph.D. students to prepare for careers in academia or industry include providing opportunities to engage and interact with construction industry, participating in internship(s), offering coursework that appeals to construction industry, performing research that balances both theory and practice, and developing industry-university collaborative Ph.D. programs.

4.9 Research Question 4 Qualitative Findings

To answer this research question, interview data was collected from all categories of participants (students, faculty and industry professionals). The students pool consisted of students that are currently pursuing a construction-focused Ph.D. degree. The faculty pool consisted of faculty members that either currently advise or have advised construction-focused Ph.D. students in the past. The industry professionals pool consists of construction-focused Ph.D. graduates working in the construction industry and other construction industry professionals. In the interviews, the student participants were asked about potential benefits to the student community, the faculty were asked about potential benefits to the academic community, while the industry professionals were asked about the potential benefits to the construction industry. The findings are presented below.

4.9.1 Potential Benefits to Ph.D. Students

The student participants stated several benefits regarding preparing construction-focused Ph.D. students for multiple career paths in academia and industry such as having the flexibility to experience both academic and industry opportunities, ability to have prepared for alternative career path, potential to enhance employability especially outside academia, having an opportunity to network in a wider environment, and the ability to become a better teacher (in the future) as illustrated by the information presented in Table 77.

Table 77. *Qualitative data supporting training of Ph.D. students for multiple career paths*

Participant	Quote
SP08	Just by doing a Ph.D., you’re not qualified to be an academic or an industry expert. A Ph.D. program that prepares and provides resources for multiple career paths will give an opportunity to learn and experience both industry and academia directions. Experiencing both results in identifying our strong skills and informs pros/cons in both careers. This helps deciding which path is a good fit.
SP02	Preparing for multiple careers by experiencing industry internships as well as teaching classes, you would feel, ‘I can see a career here, or I cannot see a career here’
SP04	Preparing for both industry and academic careers provides pathways into a variety of careers and encourages students who might otherwise drop out due to misaligned career aspirations.
SP06	I think preparing the student for multiple career paths gives them flexibility in their career choice. There's nothing worse than getting down a path in your education and realizing that's not what you want to be. Leading a program where you have the opportunity to explore academia, or industry, or some combination therein opens the doors to really infinite opportunities across for students.

The data in Table 77 suggests that preparing construction-focused Ph.D. students for careers in both academia and industry assists students in understanding what diverse career paths have to offer and identifying the career that is a good fit for them. Additionally, the data shows multiple career preparation provides Ph.D. students with the flexibility to pursue a career of their choice rather than just academia. Furthermore, it enables students to make a career-related decision with complete awareness of what various career choices have to offer.

The student participants informed that multiple career path preparation improves ability of construction focused Ph.D. students to obtain a job in areas other than academia, as illustrated by quotes in Table 78. This indicates that construction focused Ph.D. students find benefit in being prepared for multiple career paths as it provides more career opportunities and increases their chances of employability. Furthermore, it also enhances their confidence to be successful in life.

__Table 78.__ Qualitative data supporting training of Ph.D. students for multiple career paths

Participant	Quote
SP06	Being prepared for both academic and industry careers will enhance my employability, and the job prospects will be higher. I will anyway be prepared for an academic position. But the open truth is, we don't have enough academic positions available and its very competitive in academia. So, now, I can also get a job in the industry, the potential to become successful increases.
SP03	It [preparing construction focused Ph.D. students for academic and industry career paths] increases your marketability
SP07	Firstly, it [preparing construction focused Ph.D. students for academic and industry career paths] gives great confidence. I would not be scared about not getting a job in academia if there are not enough positions available. I can go to the industry. Secondly, the experience you gain by being prepared for both careers is invaluable. The more experience you have, the better your exposure is, and you can be a better person. That's a great value to any student.

Another trend of responses that has been observed was regarding the impact it could create on becoming better teachers as shown in Table 79. The information from Table 79 implies that diverse career paths preparation helps construction focused Ph.D. students become better teachers. Additionally, it is beneficial to construction education as a whole in preparing and providing opportunities for construction-focused Ph.D. students to pursue diverse career paths. The industry related skills and exposure Ph.D. students could obtain during their Ph.D. studies will be invaluable as construction educators. This contributes to the inclusion of industry exposure, case studies, and projects into construction classes, resulting in more industry-prepared undergraduates. Additionally, a multiple career preparatory Ph.D. program in construction helps students develop network outside academia, meet industry leaders and make connections with them which in turn is beneficial to them in obtaining opportunities for future employment. Additionally, this also eases their ability to obtain project related data from the construction industry for doctoral research.

Table 79. *Qualitative data supporting training of Ph.D. students for multiple career paths*

Participant	Quote
SP 01 (finished Ph.D. internship; uses those experiences in classes)	[preparing construction focused Ph.D. students for academic and industry career paths] is extremely beneficial to all [construction focused Ph.D.] students. I bring my internship experience to my classroom. When I teach classes after joining as an assistant professor, I plan to bring my industry internship experiences and case examples to my students. This happens only because I am provided with the opportunity now, during my Ph.D. Otherwise, I cannot spend years in the industry before tenure track position. That pushes me three years away from my goal.
SP 08	"Most tenure track professors in our construction programs are "academics". They do not understand the actual industry, typically. The professors who do not understand industry explain how to schedule but doesn't explain how to schedule without getting in trouble. One professor with industry knowledge explains risks involved, what can go wrong, what can go right in scheduling, and those kinds of things. The big benefit of preparing [construction focused Ph.D.] students for multiple career paths is producing tenure track professors with industry knowledge and experience.
SP 04	One challenge I faced for my dissertation was collecting industry data. Industry has a lot of data, but they were not willing to give me the data. This kind of Ph.D. program can develop strong ties with industry, where they will then trust us and provide us access to data that supports construction research.
SP 07	I struggled to obtain data from industry for my Ph.D. No company was willing to help, because they don't trust us. My advisor couldn't help. In cases like this, I think it will be helpful to have a Ph.D. program that provides resources for industry careers. We can have access to data and develop better research that helps [construction] industry.
SP 09	A Ph.D. program that prepares students for academic and construction industry career gives a wider exposure by creating an environment to network with not only academic folks, but also industry leaders. This can result in gaining insights about career opportunities outside academia.

4.9.2 Potential Benefits to Academia

The faculty participants stated several aspects that would benefit academia by preparing construction focused Ph.D. students for multiple career paths in academia and industry such as creating workforce that can link theory to practice, stimulate research environment in construction, ability for construction academia to understand the research needs of construction industry, ability to develop more number of applied research studies, develop more research collaborations and partnerships with industry, and attract wider section of students to pursue construction focused Ph.D. degrees as illustrated by the following quotes in Table 80 and 81.

Table 80. *Qualitative data supporting training of Ph.D. students for multiple career paths*

Participant	Quote
FP08	[preparing construction focused Ph.D. students for academic and industry career paths] provides an opportunity for construction academia to build more and better relationships, collaborations, and partnerships with the construction industry.
FP06	This builds better collaborations between academia and construction industry. It provides an environment for construction faculty to better understand the needs of construction industry and develop research around those needs.
FP07	A program of this kind attracts construction industry to collaborate with academia which might persuade the construction industry to start making investments in academic research, and R&D specific to construction industry.
FP04	The benefit to universities is that they make more connections with the construction industry, through which they have access to industry research grants and funds. If a professor cannot get an NSF grant, they can still get a $10,000 grant from a construction company to do research for them, only because they have the relationship with them.

This indicates that developing programs that prepare construction Ph.D. students for multiple career paths would enhance university relationships with construction industry and provide the opportunity for construction faculty to develop relationships with industry, and access research funds to develop research relevant to construction firms.

Table 81. *Qualitative data supporting training of Ph.D. students for multiple career paths*

Participant	Quote
FP01	By preparing construction focused Ph.D. students for academic and industry career paths, we will have more applied research projects in construction, which is always good. Any connection to industry broadens our [academia] understanding of the industry. Having a Ph.D. program, where you have blended students, students who are academic bound versus students who are industry bound, they're going to teach each other things that are valuable to their work.
FP03	Preparing [construction focused] Ph.D. students for industry and academic career paths will be great, programs will be able to develop students that have greater awareness about the construction industry who are better prepared to use their transferable skills. They can act as an interface between the construction industry and academic departments who can link theoretical knowledge to construction practice more easily.

This informs that preparing Ph.D. students for multiple career paths would result in developing research that balances both theory and application, and also help connect theory with practice which ultimately results in improving knowledge and understanding of construction academia.

4.9.3 Potential Benefits to Industry

All respondents from industry were interested in the idea of preparing Ph.D. students for careers in both academia and industry. They further opined it is very beneficial to construction industry in several ways such as providing advanced workforce for future innovations in construction industry, advance and progress construction industry as a whole, gain access to university research, stimulate research environment in the industry, and increase communication between construction industry and academic research as illustrated by the following quotes in Table 82, and 83.

Table 82. *Qualitative data supporting training of Ph.D. students for multiple career paths*

Participant	Quote
CIP18	The industry will have access to Ph.D. level candidates, and this provides an opportunity to address a lot of the challenges that construction industry faces through research. It improves the communication between construction industry and academia. This builds a contact path between construction companies and academia.
CIP07	Through programs like this, we will have access to highly qualified work force that that has know-how of latest technologies, suitable and trained for managerial, executive, and leadership roles. They will advance future innovation and cutting-edge research in our industry.

This informs that preparing construction Ph.D. students for multiple career paths will bridge the research gap between industry and academia as the Ph.D. students will work towards developing research for industry’s need, through which they will act as communication channels between industry and academia. This will result in enhancing university-industry research collaborations, which is a great need in the construction sector (Bigelow et al, 2016).

Additionally, the construction industry will also gain access to advanced work force that have advanced skills and knowledge in latest technologies.

Table 83. *Qualitative data supporting training of Ph.D. students for multiple career paths*

Participant	Quote
CIP05	This entire thing [construction focused Ph.D. students prepared for academic and industry careers] will provide us [construction industry] the opportunity to advance and progress the industry as a whole.
CIP16	The advanced opportunity for the industry itself is progression. It's a move towards future-proof solutions. We cannot continue to build the same way we have for the past however many hundreds of years. We need to build better. Ph.D.'s can create that improvement and show better ways to operate and innovation. So, it is beneficial and spurs an environment full of innovation in the construction industry.
CIP02	[preparing construction focused Ph.D. students for academic and industry career paths] gives us an access to university research relevant to our [construction] industry. And the construction focused Ph.D. will actually bring a lot more ideas to the constructor than the constructor is currently thinking because you've been exposed probably to more innovation, and more technology, and the future of execution.

This indicates that preparing construction Ph.D. students for multiple careers will ignite the spark of innovation among construction firms and contributes towards advancing construction industry.

4.10 Research Question 4 Quantitative Findings

The quantitative survey questionnaire gathered responses from a wide range of respondents including the four sample categories: construction focused Ph.D. students (n=50), faculty working in construction programs (n=72), construction focused Ph.D. graduates (n=25), and construction industry professionals (n=179).

Figure 24 shows perceived benefits by students. The results indicate that current construction focused Ph.D. students perceive enhancing research partnerships between academia and construction industry and providing more career options to students as major benefits of preparing construction Ph.D. students for multiple career paths followed by their belief that it enhances construction industry's ability to innovate and improves ability to incorporate industry experiences and examples in construction curricula.

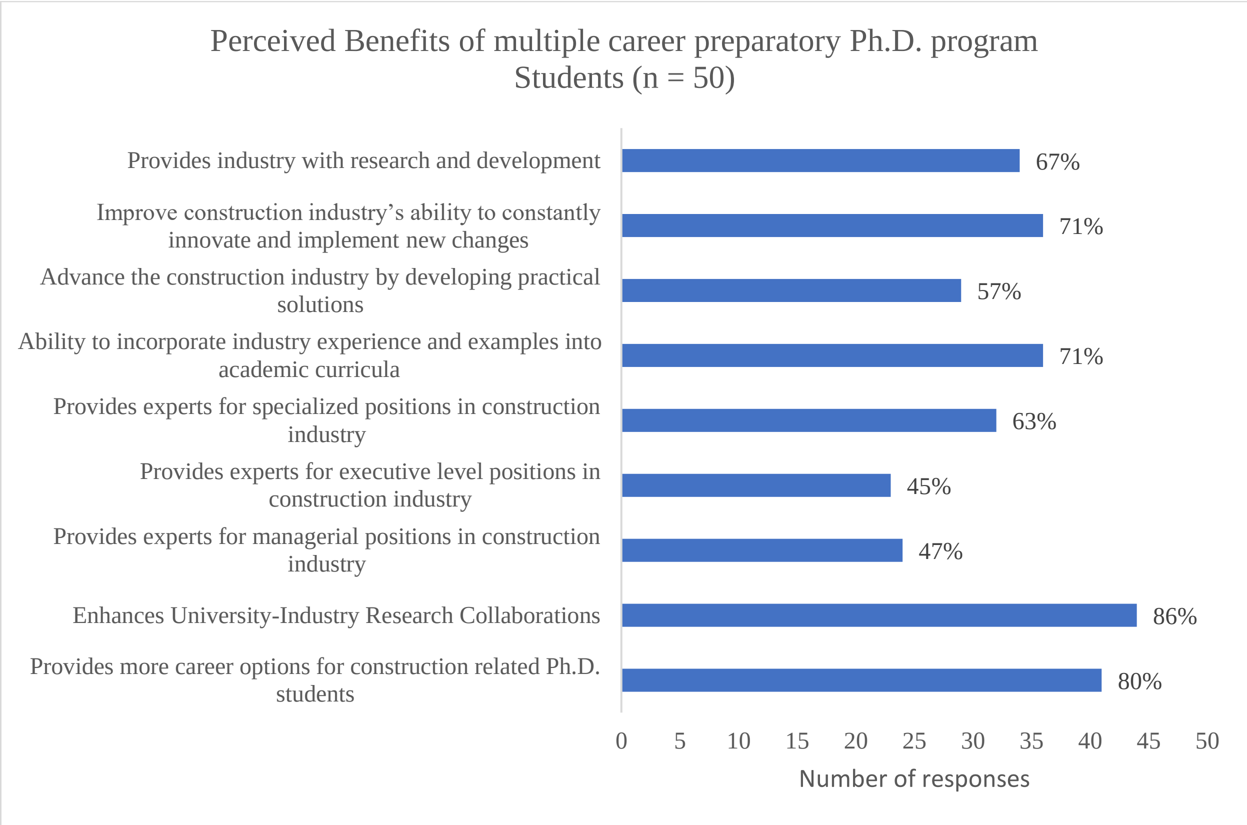

Figure 24. *Perceived Benefits of multiple career preparatory Ph.D. program - Students*

Figure 25 shows perceived benefits by construction industry professionals. The construction industry professionals consider that improving construction industry's ability to innovate as well as implement new changes, and ability to provide more career options to construction Ph.D. students as the most important benefits of a Ph.D. program that prepares Ph.D. students for multiple career paths. The other two important benefits as perceived by industry are providing construction industry with research and development services and ability to incorporate examples and project case studies into academic curricula.

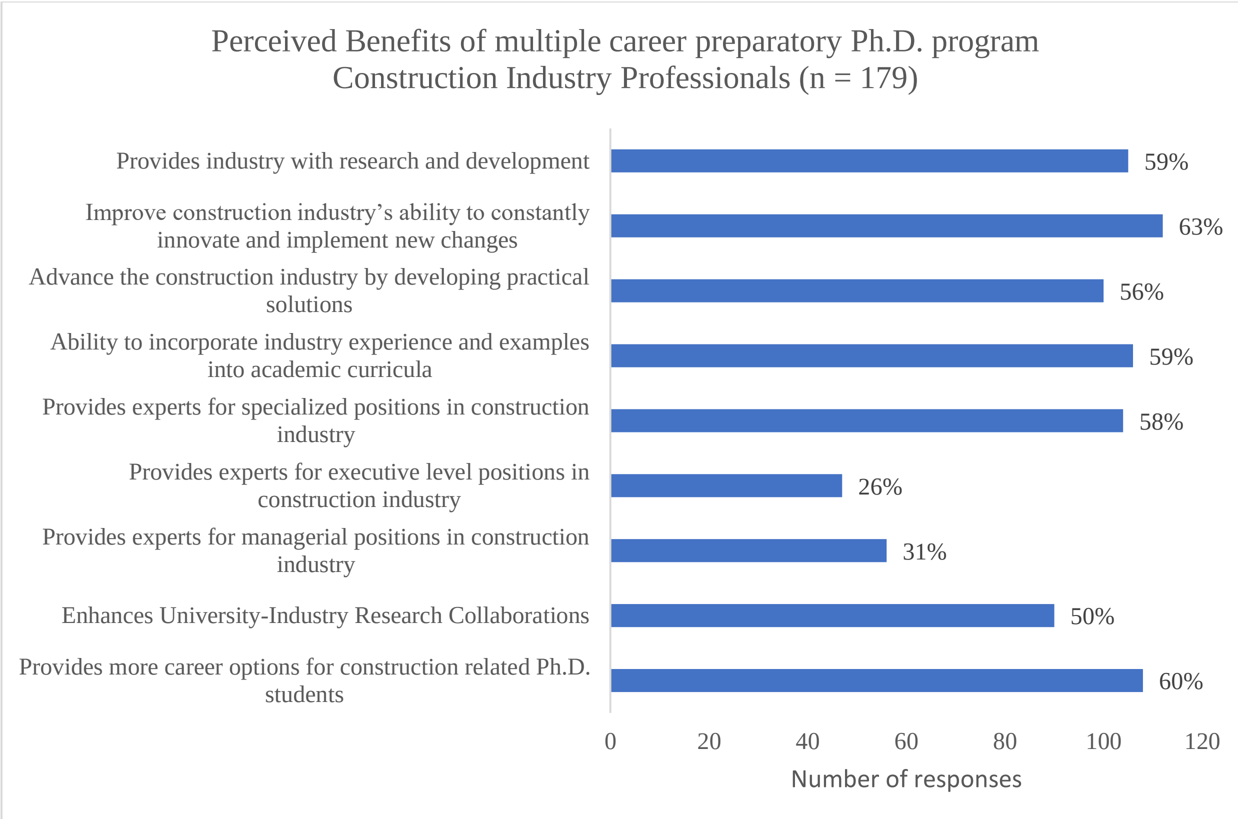

Figure 25. *Perceived Benefits of multiple career preparatory Ph.D. program – Construction Industry Professionals*

Figure 26 shows perceived benefits by construction faculty. The construction faculty perceived providing more career options to construction Ph.D. students and enhancing the university-industry research relationships as the most important benefits of preparing construction Ph.D. students for multiple career paths.

Figure 27 shows perceived benefits by Ph.D. graduates working in the industry. The Ph.D. graduates working in the construction industry opined similar to that of construction faculty as they indicated that providing more career options to construction Ph.D. students, enhancing the university-industry research relationships, and ability to incorporate examples and project case studies into academic curricula as major benefits.

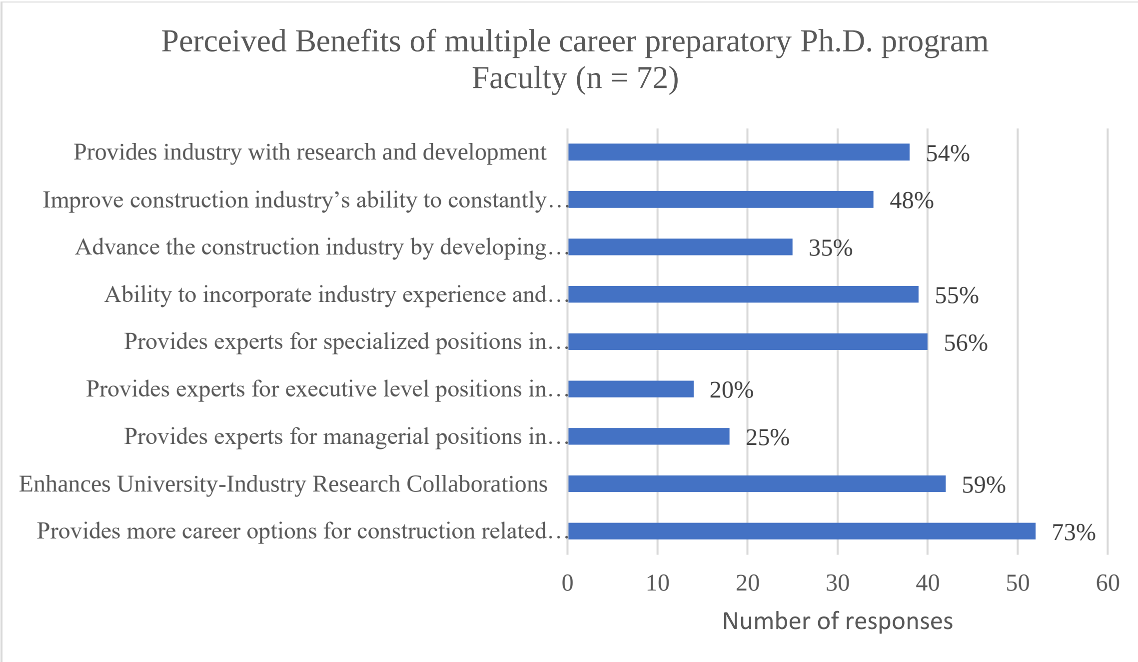

Figure 26. *Perceived Benefits of multiple career preparatory Ph.D. program – Faculty*

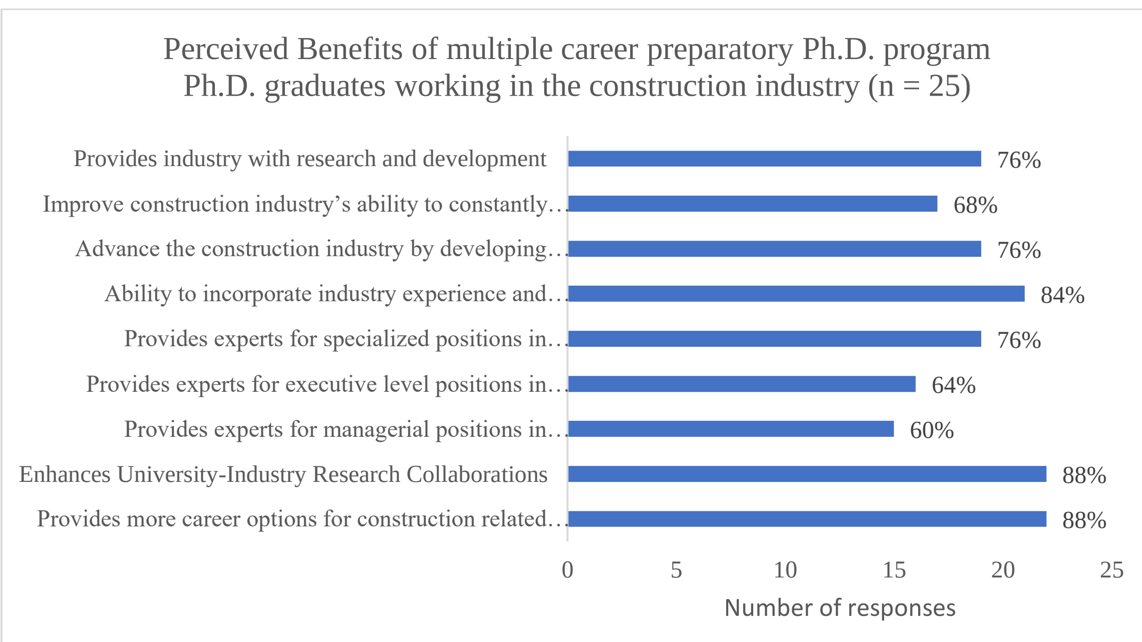

Figure 27. *Perceived Benefits of multiple career preparatory Ph.D. program – Ph.D. graduates working in the construction industry*

4.11 Research Question 4 Findings Summary

The noteworthy potential benefits of preparing construction focused Ph.D. students for both academic and construction industry career paths as perceived by all participants of this study include providing more career options for construction related Ph.D. students, enhancing university-construction industry research collaborations, providing experts managerial, executive and specialized positions in construction industry, incorporating industry experience and examples into academic curricula, advancing the construction industry by developing practical solutions, improving construction industry's ability to constantly innovate and implement new changes, and providing construction industry with research and development.

CHAPTER 5: DISCUSSION

This study provides evidence on the perceptions of construction Ph.D. students, construction Ph.D. graduates, construction faculty, and construction industry professionals regarding

1. the need for preparing construction Ph.D. students for multiple career paths (academia and industry),
2. factors that influence career choice of construction Ph.D. students,
3. competencies and skills identified as essential for employment in construction academia and construction industry,
4. training for construction Ph.D. students to employable in both academia and industry, and
5. benefits of preparing construction Ph.D. students for multiple career paths.

By examining a mixed methods study (qualitative interviews and quantitative questionnaire) with 37 interviews and 329 survey responses, this study uncovers the most salient factors associated with career preparation of construction Ph.D. students and offers a set of strategic factors and recommendations for construction Ph.D. programs including faculty advisors, program directors as well as implications for current and prospective construction Ph.D. students. In this chapter, the author discusses the study's findings within the context of construction Ph.D. programs.

5.5 Need for Multiple Career Path Preparation in Construction Ph.D. Programs

Increasing evidence is emerging that STEM Ph.D. students are showing interest in non-academic career paths (Roach & Sauermann, 2017), however it is not clear if construction Ph.D. students also show interest in non-academic career paths (such as industry). This study informs that a notable percentage (48%) of construction Ph.D. students are interested in construction industry careers, similar to Ph.D. students from other STEM disciplines. Additionally, notable percentage of respondents from all categories (86% students, 96% Ph.D. graduates, 75% faculty, and 69% industry professionals) opined it is important to train construction Ph.D. students for careers in industry in addition to academia, indicating a strong perception of all stakeholders. Despite such interest in preparing construction Ph.D. students for industry career paths, it is identified that only a small percentage (30%) of construction Ph.D. programs prepare students for industry career paths. This aligns with previous studies (Loriaux, 2019; St. Clair et al., 2017) that revealed a gap between Ph.D. student career needs and training available to them by universities for careers outside academia. However, it is identified that most of the construction Ph.D. programs (74%) prepare Ph.D. students well for academic careers. Considering the construction Ph.D. students interest in preparing for multiple career paths versus the training available to them, the authors suggest the construction Ph.D. programs better understand student needs and prepare them for multiple career paths within construction academia and industry. This resonates with other studies recognizing the need to prepare Ph.D. students for a variety of academic and non-academic career paths (Loriaux, 2019; National Academies of Sciences, 2014). Thereby, the construction Ph.D. programs must take initiatives to accommodate career needs of construction Ph.D. students by providing relevant opportunities and resources over the course of Ph.D. program to train them for multiple career paths.

5.6 Factors Influencing Construction Ph.D. Students Career Choice

One of the objectives of this study was to contribute to the body of knowledge by examining factors associated with the career decisions of construction Ph.D. students through the lens of Social Cognitive Career Theory. Understanding the factors for construction Ph.D. students' decision making can inform practice for individuals, organizations, and professions. It was identified in this study that construction Ph.D. students show interest in both academic and industry careers, and there are several factors that influence these career interests.

The interviews indicated that construction Ph.D. students that like teaching, mentoring, and that are confident about writing and publishing successfully showed interest in academic careers. In congruence, the survey findings indicated that majority of the students that like teaching, research and that are confident about their success in academia showed interest in academic careers. This aligns with previous studies (Lambie et al., 2014) that informed Ph.D. students with higher levels of self-efficacy related to writing, publishing, and research inclined towards academic careers. The construction Ph.D. students that have lower levels of self-efficacy related to teaching responsibilities and have higher interest in industry related responsibilities showed interest in industry careers.

This study identified that strong career interests and goals influence career choice of construction Ph.D. students. The Ph.D. students that have interests and goals related to teaching and research showed interest in academic careers, whereas Ph.D. students that have strong interest in latest construction technologies, interested in contributing towards advancement of construction industry showed interest in industry careers. This is supported by previous studies (Carrico et al., 2017) that students choose career paths that holds their career interests and goals.

Another factor that seemed to influence a construction Ph.D. students' career choice identified as per this study is lack of enough academic positions available. Some previous studies (Roach & Sauermann, 2017) also informed that Ph.D. students are inclining towards other career paths mainly due to diminishing academic opportunities.

This study identified that internship experience impacts career choice of construction Ph.D. students. Some students reported that their internship experience in the construction industry made them realize their interest and suitability for industry careers which resulted them in choosing industry careers. However, some students informed that internship experience helped them realize that they are not a good fit for industry roles, which influenced them more towards careers in academia. This informs that construction Ph.D. students must be exposed to internships to enable them an informed decision of their future career (Manathunga et al., 2012). Supporting that, Mangematin (2000) have studied doctoral students in engineering, and his findings indicate that experiences during the Ph.D., particularly working or finishing internships with industry influence career trajectories of Ph.D. students.

Furthermore, the interview and survey findings identified that Ph.D. students interested in flexible working schedule show interest in academic careers. Previous studies (Frintner et al., 2018; Waaijer, 2017) found that flexible working schedules were frequently reported as contributing factors behind Ph.D. students' consideration for academic careers. The construction Ph.D. students also indicated that salaries influence their career choice. Most construction Ph.D. students that preferred careers in the industry indicated that higher salary in the industry as a reason. This indicates that salaries in academia must be revised accordingly.

The results from this study also point out that support from advisor is an important factor that influences the career choices of construction Ph.D. students. The student participants informed that lack of support from their advisor related to non-academic career choice influence their decisions, and a notable percentage of student respondents in the survey mentioned that the support from their advisor fuels their interest in academic career choice. This finding supports the evidence from other studies (Fuhrmann, 2016; Gaule & Piacentini, 2018) that support from faculty advisors influence Ph.D. students career choice. This indicates that support of advisor is important, and advisors must find out the construction Ph.D. students preferred career choice and support them in that direction.

The findings of this study also suggest that lack of awareness about non-academic career paths, lack of availability of opportunities and resources for construction Ph.D. students related to non- academic career paths also influence career choice of construction Ph.D. students. This finding confirms existing gap in career support for Ph.D. students career interests beyond academia (Thiry et al., 2015). Additionally, this indicates the need to prepare and provide opportunities for Ph.D. students for both academic and industry careers (Heflinger & Doykos, 2016).

Overall, the findings suggest that construction Ph.D. students' decision to pursue an academic or nonacademic career path may be attributed to their self-efficacy beliefs (e.g., ability to teach, research, publish, perform tasks in industry), outcome expectations (e.g., flexible work schedules, salaries), contextual influences as well as environmental factors (e.g., impact of internship, support from advisor). To develop systematic training and support systems that assist construction Ph.D. students in preparing for academic and non-academic careers, construction Ph.D. programs are encouraged to recognize the changing career preferences of students and realign goals in doctoral education.

5.7 Construction Ph.D. Student Competencies for Academic and Industry Employment

This study explored the competencies for construction Ph.D. students desired for their careers in academia and construction industry. The qualitative phase of the study identified various competencies that are required to be employable, whereas quantitative phase identified the ranking of competencies deemed important for construction Ph.D. students' employability in academic and industry careers. Results of this study indicate that the highest rated competencies that are important for construction Ph.D. students to be employable in academia are written and oral communication skills, critical and independent thinking skills, and technology adaptability skills. All categories of participants rated written communication skills as the most important competency required by construction Ph.D. students for academic employment. However, the order of ranking of competencies mentioned above varied between participants.

The highest rated competencies deemed as essential for construction Ph.D.'s interested in construction industry careers are problem solving, critical & independent thinking, oral and written communication, networking, and leadership. The top important competencies that are commonly required for both academic and industry employment of construction Ph.D. students are written and oral communication skills, critical & independent thinking, and problem-solving skills as perceived by all categories of participants.

Communication skills including both oral and written communication skill has been quoted by every participant in the interviews emphasizing its importance for construction Ph.D. students interested in both academic and industry employment. The survey respondents in the quantitative phase also rated communication skills as the highest rated skill for construction Ph.D. students interested in both academic and industry employment. This indicates that communication skills are important for both categories of construction Ph.D. students that are interested in academic and industry employment respectively. This in in agreement with previous studies (Denecke et al., 2017; Durette et al., 2016; Mitic & Okahana, 2021; Sekhon, 1989) that indicated communication skills are extremely important for Ph.D. students' careers in both academic and non-academic career paths. The type of communication skills required by construction Ph.D. students in academic employment varies from the type of communication skills required by construction Ph.D. students interested in industry employment.

Communication skills related to writing grants, publishing papers, teaching classes, presenting research to academic audience are important for construction Ph.D. students that are interested in academic careers. Communicating ideas clearly and in an appealing way to a diverse audience who may not have relevant technical background is particularly important for construction Ph.D. students that are interested in industry careers. For students that are interested in industry careers, communicating research in a way that is more accessible to a nonacademic audience is important as they're expected to translate research into practical application for industry audience. It is important to train Ph.D. students on both academic and non-academic related communication skills (Ortega & Kent, 2018). Construction Ph.D. students that are interested in academic careers must be encouraged to develop scholarly communication skills by providing opportunities such as presenting at conferences, and teaching classes. Construction Ph.D. students that are interested in industry careers must be provided with opportunities to develop translatable communication skills that translate their research and coursework into simple ways of communication that are accessible to non-academic and industry audience (Rudd et al., 2008).

To effectively prepare construction Ph.D. students for both academic and industry careers, Ph.D. programs must provide opportunities for students to develop both scholarly communication skills and translatable communication skills. For example, the Ph.D. program must encourage construction Ph.D. students to present at conferences aimed at practitioners and other non-technical audiences in addition to the regular academic conferences. By diversifying the communication skillset of construction Ph.D. students, Ph.D. programs can ensure preparing more well-rounded construction Ph.D. graduates.

Construction Project Management skills have also been identified commonly as one of the important competencies (although not a top competency) required by both Ph.D. students interested in academic and industry careers, in this study. Specific to industry careers, more than half survey respondents in every category rated roles in project management as a potential area of employment for construction Ph.D. graduates. Additionally, analysis of roles taken up by construction Ph.D. graduate participants in this study immediately after graduation (from Table 5 in Chapter 3) indicates that 9 (CIP07, CIP10, CIP11, CIP12, CIP14, CIP17, CIP18, CIP19, and CIP20) out of 16 participants started careers in project management related roles. Skills in construction project management are important for academic careers as well because core coursework in any construction program include courses such as construction planning, scheduling, cost control, project management. Other studies (Edum-Fotwe & McCaffer, 2000) related to graduate student competencies in construction have earlier identified construction project management as an important competency for employment.

The findings indicate that significant emphasis is placed on critical and independent thinking competency for construction Ph.D. students interested in both academic and industry employment. The ability to think independently to develop scientific and researched solutions for various academic problems and industry challenges is key for Ph.D. student interested in either of the career paths. This is because both academic and industry employment after completing Ph.D. expects individuals to identify and solve problems, which needs critical independent thinking skills to succeed. This is in agreement with previous studies (Morrison et al., 2011; LaPidus, 2001) that identified critical independent thinking ability as an important competency for Ph.D. graduate in any field.

The construction industry professionals and Ph.D. graduates valued problem solving skills as an important competency for construction industry employment of Ph.D. students indicating the emphasis placed by industry professionals on problem solving competency for Ph.D. graduates. The industry's belief that Ph.D.'s are problem solvers, and that Ph.D.'s have the ability to find solutions for their challenges may be the reason for industry professionals rating problem solving competency as much equally as communication skills. Previous studies (Cumming, 2010; Metcalfe, 2006) also support that problem solving skills are important for STEM Ph.D. students' employment in the industry. However, problem solving skills are important for employment in construction academia as well because the primary responsibility of any role in academia after finishing Ph.D. (Asst. Prof, Post doc) will require an individual to identify and solve problems through various research methods.

Networking skills has been identified as an important competency for construction Ph.D. students interested in industry employment. The qualitative interviews identified various ways how industry networks helped construction Ph.D. students obtain industry employment. This was supported by the quantitative findings that networking is important skill for industry employability over academic employability. The skill of developing networks with non-academic employers has been identified as an important aspect in doctoral education to enhance employability according to previous studies (Kyvik & Olsen, 2012; Sinche et al., 2017). This is especially important for construction Ph.D. students because it is not usual for construction industry to hire Ph.D. students, and networking with the industry professionals is the first step for construction Ph.D. students to showcase their research and other industry relevant skills to impress potential employers for prospective employment options.

Overall, it is important to provide opportunities to improve communications skills, problem solving, critical thinking, and networking skills for construction Ph.D. students to improve their employability in academic and industry careers.

5.8 Preparation of Construction Ph.D. Students for Both Academic and Industry Employment

The qualitative interviews identified that performing research that balances theory and application relevant to construction industry's needs is crucial in preparing construction Ph.D. students for diverse career paths. All the Ph.D. graduates that are currently working in the construction industry that participated in the study mentioned that they had both theoretical and applied research aspects relevant to challenges faced by construction industry in their doctoral research. Further, they also mentioned that applied research is valued by construction employers, and several Ph.D. graduate participants also said their applied research studies helped them obtain employment in the construction industry. Faculty participants also mentioned that their advisees that were interested in both academic and industry employment worked on research that balanced both theory and application, which prepared them for both academic and industry employment. The quantitative results align with the qualitative findings that 90% of students, 86% of Ph.D. graduates, and 79% of faculty and industry respondents opined it is important to balance both theory and application relevant to construction industry challenges in doctoral research to prepare students for diverse careers in construction. This indicates that all categories of participants opine performing research that balances theory and application prepares construction Ph.D. students for diverse career paths. This is in alignment with previous studies (Porter & Phelps, 2014; Van Scotter & Culligan, 2003) that informed it is important to train Ph.D. students from applied disciplines to perform research that is a good mix of both theory and application to train them effectively for diverse career paths.

Given that a notable number of construction Ph.D. students are interested in non-academic career paths, and more than half Ph.D. students in STEM disciplines willing to work in non-academic work environments (Desjardins, 2012; NSF, 2017), it is important integrate academic (theoretical) and non-academic (applied) research contexts into the Ph.D. education.

Internships also play in important role in preparing construction Ph.D. students for both industry and academic employment. The qualitative participants informed that completing internships in the construction industry improves the chances of employment in the construction industry, provides Ph.D. students with real world construction perspective, and provides the ability for students to understand if industry employment is a good fit for them. The survey further identified that 95% of Ph.D. graduate respondents, 91% of faculty respondents, 96% industry professionals, and 90% of Ph.D. student respondents opine that internship/field experience is crucial in preparing construction Ph.D. graduates' for industry employment. Talking about importance of internships for academic employment, participants said internships play an important role in preparing construction Ph.D. students for academic careers as students gets a chance to experience construction firsthand and bring those perspective into their classrooms thereby improving their teaching effectiveness. The survey further identified that 95% of Ph.D. graduate respondents, 79% of faculty respondents, and 72% of Ph.D. student respondents opine that internship/field experience is crucial in preparing construction Ph.D. graduates for academic employment. This indicates that internships and experience play an important role in preparing construction Ph.D. students for diverse career paths. This corroborates with several previous studies that identified the importance of internships in Ph.D. students career preparedness. Parilla and Hesser (1998) emphasized the importance of internships in providing an academically rigorous experience for Ph.D. students diverse career path preparation. Jones and Warnock (2014) highlighted that internship improved the employability of Ph.D. students in applied disciplines. Lee (2008) emphasized that industry internship based experiential learning opportunities in Ph.D. education facilitates acquisition of communication, networking, financial management and leadership skills for Ph.D. students (some important competencies identified in this study for multiple career path preparation of construction Ph.D. students). Realizing the importance of internships in Ph.D. education, some universities in the European such as the technical university of Munich mandated internship for all Ph.D. students and provides the required funding and strategies (Jones & Warnock, 2015).

Experiential opportunities such as residency are provided for graduate students in other applied disciplines such as medicine and law (McLachlan et al., 2004). Similarly, this research finding suggests that providing experiential opportunities in the form of internship is crucial in construction Ph.D. students' success. Especially considering that majority of the construction Ph.D. students are international students, providing them an opportunity to complete internship increases their understanding about U.S. construction industry practices that further enhances their employability. Incorporating internships will allow for construction Ph.D. students learn from those experiences, be trained and prepared for various career paths, and reflect on those experiences to evaluate their skills to opt for an apt career choice.

Furthermore, several qualitative participants informed that industry-university research collaborations play an important role in preparing construction Ph.D. students for diverse career paths. Some students that are currently pursuing construction Ph.D. at university-industry research collaboration centers informed that several past Ph.D. students that graduated from these centers have performed research that is rich in both theory and practice, had opportunities to network both in industry and academia, and are working in various construction firms and construction academic departments across the country based on their career interests indicating that university-industry research collaborations enhance professional development of construction Ph.D. students as well as their employability. Supporting the same, the survey respondents (89% students, 95% Ph.D. graduates, 82% faculty, and 81% industry professionals) either agreed or strongly agreed that university-industry research collaborations enhance construction Ph.D. students' employability in diverse career paths. This aligns with a finding from a study by Brochner and Sezer (2020) that concluded employability of construction Ph.D. students graduated from university-industry collaborative Ph.D. setting in Sweden is twice as likely as regular Ph.D. students. A study by Mougerou (2005) on career success of science and engineering Ph.D. students indicated that graduates that collaborate with industry during Ph.D. education have better employment prospects in diverse career paths than Ph.D. students who do not collaborate with industry. Another study by Martinelli (2001) also indicated that career prospects of Ph.D. students in France depend particularly on links developed with industry during the Ph.D. The author suggests construction Ph.D. programs to consider involving construction industry collaborations in both research and professional opportunities to better prepare construction Ph.D. students for diverse careers.

Integrating learning opportunities relevant to both academic and non-academic settings such as offering coursework relevant to industry employment, encouraging internships in industry environment, applied or industry engaged research experiences, embedding research balancing theory and practice are important in Ph.D. education (Porter & Phelps, 2014).
The author suggests making it a priority to include applied use-inspired aspects relevant to construction industry's needs in doctoral research while including relevant theories to prepare construction Ph.D. students for diverse career paths. The author also notes that applied research

focus should by no means be the only available Ph.D. pathway, but the construction Ph.D. programs should consider encouraging students to perform research that has direct relevance to construction industry and its challenges, while also continuing to encourage theoretical contributions.

The opportunities to be provided, and the type of research to be performed discussed here are equally applicable for those interested in academic employment as they are for those interested in non-academic careers. For example, completing an internship is valuable not only for Ph.D. students interested in industry careers but also for Ph.D. students interested in academic careers as it increases their ability to bring industry examples into the classroom thereby helping them become better teachers.

The author is not advocating for consideration of a construction Ph.D. program for industry employment, rather opines that relevance of Ph.D. should not be limited to a particular professional context (academic careers). Furthermore, construction doctoral programs should consider integrating diverse career path preparatory components discussed in this study into their curriculum to improve employability and career preparedness of Ph.D. students. When this becomes ingrained in the culture of doctoral education, doctoral students are encouraged to explore diverse career paths by participating in a variety of learning opportunities, expanding their networks, and developing skills beyond just research. It eventually allows them to make informed career decisions.

5.9 Benefits of Preparing Construction Ph.D. Students for Multiple Career Paths

According to the findings from this study, the construction Ph.D. students, construction Ph.D. graduates, construction faculty and construction industry considered that engaging construction Ph.D. students in a multiple career path Ph.D. program is beneficial in multiple ways as it is advantageous to all stake holders such as construction Ph.D. students, construction academia and construction industry.

The findings suggest that preparing construction-focused Ph.D. students for careers in both academia and industry assists students in understanding what diverse career paths have to offer and identifying the career that is a good fit for them. Additionally, this offers students the flexibility to pursue a career of their choice rather than just academia. Furthermore, it enables students to make a career related decision with complete awareness of what the career choice has to offer. This resonates with findings from Schnoes et al. (2018) and Van Wart et al. (2020) that resources to prepare for diverse career paths during a Ph.D. program provides an opportunity for Ph.D. students to asses their fit for various career paths and make informed career decisions.

This study also identified the employability of construction Ph.D. students can be improved by preparing them for multiple career paths as they would be exposed to diverse opportunities and also develop their network within both academia and industry. The finding that 80% student participants, 73% faculty participants, and 60% industry participants believe a multiple career path Ph.D. program provides more career options and improves employability of construction Ph.D. graduates indicates that significant portion of study participants view this as an important benefit. This corroborates with a study conducted by the Danish Agency for Science Technology and Innovation (2013) that identified students enrolled in multiple career path Ph.D. program in Denmark showed higher chances of employability than students enrolled in a traditional Ph.D. program. A study by Bröchner & Sezer (2020) also concluded that construction Ph.D. students enrolled in a Ph.D. program that prepares students for both academic and industry career paths are employable twice as likely as regular Ph.D. students.

Additionally, multiple career path preparation also results in creating better teachers for construction academia. The industry related skills and exposure Ph.D. students could obtain during their Ph.D. studies will be invaluable as construction educators. The Ph.D. students that gain industry relates skills and competencies, and exposure during Ph.D. program will be able to effectively translate their experiences into classrooms by bringing industry examples and their experiences into curricula thereby becoming effective and better teachers. This is in line with a finding from McCuen (2007) and McCuen et al. (2019) regarding the importance of industry exposure for construction faculty. About 71% of student participants, 59% of industry professionals, and 55% of faculty opting for this indicates that ability to incorporate industry experience and examples in classrooms as an important benefit of preparing Ph.D. students for multiple career paths as perceived by participants. Construction is an applied discipline (Gunderson & Gloeckner, 2005), and it important for construction faculty to have industry exposure to bring their experience into the classroom, however there is no scope currently to attain the industry exposure for Ph.D. students (future educators) (McCuen et al., 2019). Preparing the Ph.D. students for multiple career paths by providing opportunities to have industry exposure addresses this issue and creates effective educators for construction academia that can bring industry relevant experiences and examples into construction curricula.

Enhancing university-industry research collaborations has been rated by 86% of the students, 59% of faculty, and 50% of industry participants indicates this as an important benefit to both academia and industry as considered by all categories of participants. The student participants consider this an important benefit than industry and faculty participants. The construction academia and construction industry are disunited in terms of research needs and collaborations (Bigelow et al., 2016), and a multiple career path Ph.D. program could address this problem by bringing construction academia and construction industry closer in terms of research. Overall, this signifies that preparing construction Ph.D. students for multiple career paths would enhance university-construction industry research collaborations. This is in alignment with findings from previous studies (Assbring & Nuur, 2017; Wallgren & Dahlgren, 2007) that mentioned multiple career path Ph.D. programs strengthened relationships between academia and industry.

Although more percentage of students (73%) rated enhancing construction industry's ability to constantly innovate and implement new changes, the industry professionals (63%) also see it as an important benefit when compared to faculty participants (48%). This is supported by a study by Bröchner and Lagerqvist (2016) that informs that university-industry collaborations through preparing Ph.D. students for multiple career paths contributes to improving the ability of construction industry to enhance construction innovations.

Overall, preparing construction Ph.D. students for diverse career paths is advantageous to all stakeholders (construction Ph.D. students, construction academia, and construction industry).

CHAPTER 6: STRATEGIC FACTORS FOR IMPLEMENTATION

The goal of this research study is to provide guidance for construction Ph.D. programs to train Ph.D. students for multiple career opportunities in the construction industry and academia. This considers a comprehensive list of aspects developed from the analysis of interview and survey data collected from current construction Ph.D. students, construction Ph.D. graduates working in the construction industry, construction industry professionals, and construction faculty working in construction academic programs at higher education institutions in the United States. The underlying hypothesis for the strategic factors is that creating awareness and supportive construction Ph.D. programs will result in preparing construction Ph.D. students effectively for careers in the construction industry in addition to academic careers and also improve university-construction industry collaborations.

6.1 Strategic Factors

6.1.1 Balance of Theoretical and Applied Research

To prepare construction Ph.D. students for careers in the construction industry in addition to academia, the research component of Ph.D. studies should culminate in a doctoral dissertation that balances both theoretical and applied research. The construction industry appreciates applied research that aids in addressing the industry's challenges, and values individuals that perform applied practical research (Chapman, 2001). In addition, theoretical contributions and advancements are an important component of doctoral education and are highly valued in academic careers (Corley & Giola, 2011; Dissertation Essentials, 2022). Therefore, a balance of both theoretical and applied research appeals to both academic and industry employers. Every construction Ph.D. graduate who is currently working in the construction industry and took part in this study stated that their doctoral dissertation included an applied research component and involved industry through the research completion.

Although a number of faculty members are well placed and inclined to advise their Ph.D. students to perform theory-practice balanced research, many faculty members are not prepared to offer meaningful support to their students interested in this kind of theory-practice balanced research. Therefore, it is recommended that an industry professional serve on the Ph.D. dissertation committee or serve as a mentor to the Ph.D. student's research study, thus reducing the need for faculty members to be experts in non-academic/industry related application of the research. This will help bring the industry perspective to the research as well as help students understand how their research can be applied in the construction industry. Incorporating industry into research expands the contribution of the research to the construction body of knowledge and influences practical applications and future investigations. Therefore, performing research that balances theory and construction industry application helps to prepare Ph.D. students for academic and construction industry careers.

6.1.2 Ph.D. Students Training

Along with rigorous academic research training, universities must prepare construction Ph.D. students to think beyond the narrow confines of their research dissemination as publications and presentations and toward real-world application of their research in the construction industry. There is a need to educate construction Ph.D. students on the importance of communicating their research in the context of practical construction industry applications (London School of Economics, 2017). Additionally, it is critical for construction programs to recognize that construction industry-specific training is necessary for Ph.D. students and improvements must occur to create the norm in construction Ph.D. education of producing expertise for both academia and the industry. Specific training helps to bridge the gap between

Ph.D. education and the construction industry by increasing opportunities for construction Ph.D. students to work in the construction industry in addition to academia, which enhances the construction sector as a whole.

6.1.3 Networking and Communication

Construction-related Ph.D. programs must encourage construction Ph.D. students to communicate, network, and build relationships within both academia and the construction industry. The construction Ph.D. students that are interested in industry careers must be able to connect their research to industry practices and communicate their findings in an industry-relevant manner. For example, developing an "industry recommended practices guide" from doctoral research is typically well-received by the industry. In addition to academic journal publications, it is advisable to disseminate research outcomes in industry/trade journals that are circulated and read among the construction industry leaders. For Ph.D. students interested in academic careers, attending academic conferences to present their research and developing an academic research network is crucial. Similarly, construction Ph.D. students should attend and present at industry-affiliated conferences to develop their industry-related networks. Universities and higher education institutions must encourage Ph.D. students to attend both academic and industry conferences. Several Ph.D. graduates that participated in this study informed that presenting the research in a way that is relevant to the construction industry and making connections at industry conferences helped them obtain employment in the construction industry. The ability to communicate and network with both industry and academia not only prepares Ph.D. students for careers in both industry and academia but also results in developing an entrepreneurial spirit based on their research quotient and industry interactions. (Phillips, 2010).

6.1.4 University Incentives for Faculty

Universities should create incentives to recognize faculty that develop research collaborations with the construction industry. The publishing mentality prevalent in academia may lead Ph.D. advisors to push their students toward traditional academic careers and discourage students interested in non-academic careers (Porter & Phelps, 2014). To address this, Ph.D. advisors must be encouraged to be adaptable to any path the Ph.D. student chooses. This study identified that there is no encouragement for faculty if their Ph.D. student prefers employment paths other than academia. Recognition of Ph.D. students' careers in the construction industry motivates Ph.D. advisors to encourage their students for alternative career paths (such as industry) in addition to academia. Universities must recognize the importance of being able to employ Ph.D. students in various career paths rather than traditional academic paths and invest in them (Awasthy et al., 2020). As several doctoral students that participated in this study indicated, it is important for construction faculty to recognize how their behaviors can serve as direct learning sources that influence the career choices of construction Ph.D. students (Fuhrmann et al., 2011; Gibbs & Griffin, 2013).

6.1.5 Ph.D. Alumni Support and Connections

The construction Ph.D. programs need to maintain connections with their alumni that graduated and work in the industry and academia. The universities should develop Ph.D. student mentorship programs where Ph.D. alumni working in academia and the construction industry can serve as mentors to the current cohort of Ph.D. students to guide them respectively as per their interest in academic and industry employment. The universities should consider inviting Ph.D. alumni working in the construction industry and academia as guest speakers to provide insights about each of the career paths. Additionally, the connections with construction Ph.D. alumni working in the industry provide an opportunity for faculty to understand construction industry challenges and understand ways to work together to solve those challenges through Ph.D. dissertation research. This is in line with a finding from a study conducted by Chartered Accountants Australia and New Zealand association (2017) that states Ph.D. alumni connections with associated industries help universities learn and re-learn strategies to train future Ph.D. students for diverse career paths.

6.1.6 University-Construction Industry Collaboration

Currently, the construction industry and academia are somewhat disunited in terms of understanding and developing research that solves the challenges of the construction industry (Bigelow, 2016). To address this, it is important to consider developing university-industry collaborative Ph.D. education. Higher education construction programs need to create a platform where the construction industry reaches out to academia to discuss their challenges and ideas and where academia can then suggest potential research. This corroborates with recommendations from a research report (Paulson, 1976) titled, "Goals for basic research in construction", sponsored by the Stanford construction institute, that states it is important to develop research related working relationships between the construction industry and university programs for the wellbeing of graduate education and positive impacts to the construction industry. Suggested ideas for the university-industry collaborative platforms that encourage doctoral education include:

1) Construction faculty can work towards creating applied research programs or centers by collaborating with construction firms. Through applied research, faculty can work with construction firms to understand their business challenges and develop research studies around those challenges. Ph.D. students then perform these research studies, which helps the Ph.D. students understand real-world construction aspects, and trains them to develop research that balances both theoretical and applied aspects. This prepares Ph.D. students

for both industry and academic career paths as well as strengthens industry-academia relationships.

2) Construction Ph.D. programs can work towards developing construction research consortiums that include construction firms. The consortium members would meet and discuss common challenges that are faced by the industry that need specific research investigation. The interested consortium members can contribute funds towards such studies. The Ph.D. students can be funded through the consortium to research and develop solutions for these challenges through balancing theoretical and applied research. Ph.D. students then interact with the construction industry frequently, which enhances their networking with the industry and potentially opens employment opportunities in the industry in addition to academia.

University-industry collaboration for research would not only prepare Ph.D. students for multiple career paths but also enhance the relationship between academia and the construction industry (Assbring & Nuur, 2017). Establish working research relationships between universities and employers, and the creation of collaborative and mutually beneficial research projects should become more commonplace (Jones & Warnock, 2015) in construction Ph.D. education.

6.1.7 Construction Industry Awareness

This study identified more than 100 construction Ph.D. graduates that are working in the construction industry and contributing to solving issues and advancing construction practices. Industry participants in this study also mentioned how their perception changed after working with construction Ph.D. graduates regarding different ways Ph.D. graduates can make a difference to construction businesses. Therefore, construction Ph.D. programs must demonstrate the importance of employing Ph.D. students and their research in advancing and contributing towards the success of the construction industry. Construction programs must make it a priority to develop case studies about their Ph.D. alumni regarding how they impact their construction employers. These case studies can be presented at industry advisory board meetings. Industry Advisory Boards at construction programs constitute members from construction firms that work towards a goal to help academic departments to review the curricular content, strengthen the connections between students and industry representatives, help with the recruitment and placement of graduates and interns, provide financial support, and help support the construction higher education program as needed (Hauck, 2016). The construction Ph.D. students and their advisors should be allowed to present their research to construction companies during the industry advisory board meetings. The actions such as developing Ph.D. graduate case studies, and opportunities to showcase graduate research at industry advisory board meetings could result in enhancing industry awareness about the importance of Ph.D. graduates and instigate inquisitiveness among the construction industry employers towards Ph.D. graduates, which could improve Ph.D. graduates' chances of finding employment in the construction industry.

6.1.8 Internship Opportunities for Construction Ph.D. Students

Internships are traditionally not a part of Ph.D. education. However, construction is an applied industry similar to medicine or law, where industry experience is much valued. Therefore, construction Ph.D. programs need to consider requiring students to complete an internship(s) in the construction industry to gain first-hand experience of construction. Construction academic Ph.D. programs should help to facilitate internships for construction Ph.D. students by developing a strategy that includes elements of marketing and industry relevance to attract construction employers towards Ph.D. students and vice versa. Some areas within the construction industry that employers show interest to hire Ph.D. students involve working with advanced technologies (e.g., virtual design in construction, data analytics), and advanced project controls. There are faculty internships/residency programs developed to provide industry experience to faculty members. Similarly, construction academic Ph.D. programs must invest efforts in collaborating with the construction industry to develop exclusive internship positions for construction Ph.D. students based on the needs and requirements of employers. The Ph.D. faculty advisors should understand the importance of internships for Ph.D. students to their education and support Ph.D. students to pursue industry internships. Internships help Ph.D. students build non-academic skills, gain construction experience, learn workplace competencies, and help to set a stage for potential full-time employment opportunities in the construction industry as potential employers would get a chance to know Ph.D. students (Jones & Warnock, 2015). Additionally, internships also provide a rigorous academic experience for Ph.D. students (Parilla & Hesser, 1998), that prepares them to be effective teachers by allowing them to bring their experience into classrooms, thereby helping to prepare them for careers in academia (Jones & Warnock, 2015). Therefore, completing construction internships is useful for both academic and industry career path inclined Ph.D. students.

6.1.9 Industry Track and Academic Track

Construction academic Ph.D. programs should consider offering industry career and academic career tracks informally. Opportunities and resources should be provided to Ph.D. students to help them decide which employment path to follow. For example, during the first three semesters of a construction Ph.D. program, students should be provided with an opportunity to teach and to complete a construction industry internship. This will allow the Ph.D. student to gain experience in both career paths and will aid them in identifying a career path that is a good fit for them. The Ph.D. students that are interested in the academic career path should then invest more time in learning how to teach, co-teaching classes with their advisors, and mentoring undergraduate students in addition to their research. Ph.D. students that are interested in industry career paths should then make it a priority to complete additional internships and perform research that has applications and directly impacts the construction industry. Overall, Ph.D. students must develop research that balances both theory as well as practice and complete an industry internship. Gaining industry experience through internships enhances construction Ph.D. students' ability to teach better by using real-world experiences (prepares them for academic employment) and also improves industry exposure and employability (prepares them for industry employment). Although the academic and industry career tracks inform students about activities and resources for potential employment, it is expected that the recommendations provided here would prepare construction Ph.D. students for both academic and industry employment.

6.1.10 Coursework

Construction academic Ph.D. programs should consider including coursework that is relevant to the construction industry with assistance from industry partners. Coursework that includes emerging construction technologies, construction finance, and construction and business management are considered important for Ph.D. students by construction employers. Ph.D. students need to take coursework that has direct applications in the construction industry. Additionally, as academic research is also moving in the direction of advanced and emerging topics, completing this coursework will be helpful for academic research and teaching careers.

6.1.11 Research & Development (R&D) Investments

Considering the economic significance of the construction industry, the R&D investments and culture in the construction industry are surprisingly small. In the U.S., construction is one of the least R&D-intensive industries. It is advisable for the federal, state, and local governments to support centrally funded construction research institutions, joint industry-academia collaborations, and technology centers (similar to the Construction Industry Institute at the University of Texas, the US Department of Transportation's University Transportation

Center (UTC) Program, and construction research establishments such as the Development Fund of the Swedish Construction Industry collaborative Ph.D. program in Europe). These programs could be a good model for construction Ph.D. students to work on applied research projects relevant to the construction industry, which thereby prepares them for academic and industry employment opportunities.

6.2 Implementation Guidelines

1) Provide opportunities related to both industry and academic career experiences in the first three semesters of the Ph.D. program such as finishing an industry internship, preparing lessons, and teaching a course. This may be accomplished through volunteer opportunities, credit-based industry internships, credit-based teaching opportunities, or graduate assistantships. In the subsequent semesters, provide an opportunity for Ph.D. students to choose either an industry career track or an academic career track.
2) Develop Ph.D. alumni mentorship programs by identifying and contacting Ph.D. alumni working in the construction industry. Ph.D. students interested in industry careers should be assigned to a Ph.D. graduate mentor working in the industry. The Ph.D. students interested in an academic career have their Ph.D. advisors that act as mentors.
3) Organize outreach events with Ph.D. alumni such as webinars, meetings, panel discussions, etc. which helps Ph.D. students that are unsure about their career choice (industry or academia) to understand opportunities available, the pros and cons of both industry and academic career paths.
4) Organize professional development courses (e.g., industry communication skills workshop, academic writing skills workshop, industry/academia networking skills) relevant to the success of Ph.D. students in both construction academia and industry.

5) Encourage construction Ph.D. students to source on their own and pursue industry internship(s) of their interest. The construction Ph.D. students may have an idea regarding what they would like to accomplish during their internship and/or the organization they would like to pursue an internship with. Identify these aspects and facilitate opportunities by connecting construction firms and Ph.D. students. Some Ph.D. students might not be inclined to take this approach, and they should be supported by construction academic departments to source an internship. Additionally, develop Ph.D. internship opportunities with support from Ph.D. alumni. It is important to note that internship not only prepares Ph.D. students for industry employment but also trains them in becoming effective teachers for academic careers.
6) The Ph.D. advisors must be encouraged to support and allow Ph.D. students to pursue opportunities in their choice of career path. It is important to encourage Ph.D. students towards both industry and academic careers.
7) Organize events such as construction graduate student research showcases, graduate student research presentations, and invite industry advisory board, Ph.D. alumni and other industry connections from the construction Ph.D. program to attend.
8) Initiate research conversations with industry advisory board members, and organize events where construction industry members, faculty, and Ph.D. students can discuss challenges faced by industry and brainstorm research collaborations to address those challenges. This results in developing research that balances both theory and practice, as well as acts as a starting point for future research collaborations with the construction industry.

9) Develop relations with Innovation Groups at large construction firms to identify the latest construction trends and include relevant curricula in the coursework required for construction Ph.D. students.

CHAPTER 7: CONCLUSIONS & FUTURE RESEARCH

The dissertation research findings contribute to Ph.D. education in regard to effectively preparing construction Ph.D. students for diverse career paths. The construction Ph.D. students, and construction Ph.D. programs will benefit from this study as the findings provide recommendations to prepare students for diverse career paths. This chapter discusses the theoretical as well as practical contributions, limitations, and future research opportunities.

7.1 Theoretical & Literature Connections and Contributions

The findings from this research added to prior research in terms of theoretical application and research design in relation to construction doctoral students' career decision making.

One of the primary strengths of this study lies in its research design. Using a variety of research methods, this study provides a comprehensive understanding of the dynamics of construction doctoral students decision making. Most studies only include Social Cognitive Career Theory, whereas the research design in this study combined Social Cognitive Career Theory and Experiential Learning Theory to understand construction doctoral student career decision making and developing guidance for multiple career path preparation. Most empirical research related to doctoral education employ either qualitative or quantitative method, which often times does not provide sufficient insights as to why or how doctoral students career decision making is influenced. This study adopted a mixed method (qualitative followed by quantitative) approach to support empirical research related to construction focused doctoral student's career decision making and effective preparation for diverse career paths, through use of different research design and theories. This study further developed understanding of construction focused doctoral students' career decision making factors, which never existed in the literature before, thereby contributing to the literature. Additionally, this study connected the findings related to construction focused doctoral students' career decision making with career decision making of doctoral students from other majors to inform that the career decision making factors of construction doctoral students are similar to doctoral students in other disciplines.

In accordance with earlier studies (Quimby & O'Brien, 2004; Gibbs & Griffin, 2013), this research recognizes that SCCT is an effective theory to understand the career choice of Ph.D. students. Additionally, the findings of this study provided evidence that SCCT factors such as self-efficacy beliefs, outcome expectations, goals and interests, and other contextual/environmental influences play an important role in construction focused doctoral students' career choice similar to doctoral students in other disciplines (Lent et al., 1994). This study also identified additional contextual influences such as support from advisor, immigration challenges, impact of internship, and academic culture as important contextual factors that impact construction Ph.D. students career decision making. Furthermore, this study adds to a growing body of knowledge that explores how doctoral students, specifically construction doctoral students make career choices, and what competencies are required to enhance their employability.

Another contribution of this study is the theoretical integration of Social Cognitive Career Theory and Experiential Learning Theory in career decision making. This study adds to the literature and body of knowledge on theory convergence by addressing the need for comprehensive theoretical understanding (Patton & McMaho, 2014) of how doctoral students career decision is made. As study demonstrated that experiential learning opportunities such as construction industry internships, construction industry experiences, practical teaching/research experiences influence career decisions of construction doctoral students, it contributes new theoretical knowledge that occupational engagements during doctoral journey impacts career decision making.

7.2 Practical Contributions

This study provides practical implications and recommendations for construction Ph.D. students, faculty members advising construction Ph.D. students, and construction Ph.D. programs to maximize the competencies of construction focused Ph.D. students and prepare them effectively for both careers inside and outside academia.

According to the findings of this study, occupational engagements (e.g., experiential learning activities) such as construction internship, teaching experience during Ph.D. program facilitates career choice decision making of construction Ph.D. students. Providing exposure and firsthand experiences related to industry and teaching helps Ph.D. students understand their fit, interest, and also prepares them for both industry and academic career paths. This suggests the importance of providing a range of first-hand experiences (internships and teaching opportunities) during a Ph.D. program to prepare Ph.D. students for multiple career paths. This finding indicates a practical implication for construction Ph.D. programs to include both internship and teaching opportunities as a part of the Ph.D. program.

The Ph.D. students that are interested in industry related career paths expressed concern about lack of information regarding skills and competencies they need to acquire to be prepared. This study identified various competencies that are required by construction Ph.D. students to be employable in academic and industry careers. This practically contributes to create awareness in the development of construction Ph.D. students such that they understand the skills required to be acquired by them in obtaining employment of their career choice.

The findings from this study provide important practical insights related to non-traditional career path interests of construction Ph.D. students. Often times, an academic career is expected as career outcome of Ph.D. students (Curtin et al., 2016). Other studies (Seo et al., 2017; Wendler et al., 2012) informed that Ph.D. students consider careers outside academia as not just alternative careers but also primary career choices. However, there was no data related to construction Ph.D. students. This study practically informs that construction Ph.D. students are interested in career paths outside academia both as alternative career choice and preferred career choice. This further informs the construction Ph.D. programs to recognize the importance of preparing Ph.D. students for multiple career paths.

Additionally, this study also identified the practical benefits of preparing construction Ph.D. students for multiple career paths which additionally supports the other findings of this study (why it is important to prepare to Ph.D. students for multiple career paths and how it is beneficial).

This study provided construction Ph.D. students, and construction Ph.D. programs with practical recommendations, strategic factors and implementation guidance to train construction focused Ph.D. students for both academic and industry career paths.

7.3 Study Limitations

Throughout the research, several checks and balances were implemented to ensure that the conclusions were reliable and validated. The current study did, however, uncover some limitations that could inform future research and help to improve the quality of related work.

The first limitation is related to the smaller number of qualitative participants from construction industry professional's category. Although, the study had 37 qualitative participants across construction Ph.D. students, construction Ph.D. graduates, construction faculty, and construction industry professionals, the number of participants from construction industry professional's category is just five. This causes a concern regarding capturing construction industry professionals' perceptions sufficiently. The quantitative phase gathered good number of responses from construction industry professionals, however majority of them are from general contractors and construction consultants. The perspective of construction technology firms (such as Autodesk, Bentley, etc.) where a good number of construction Ph.D.'s are hired is missing in this study in both qualitative and quantitative phases.

Another limitation to this study is that majority of the Ph.D. students, Ph.D. graduates, and faculty participants during qualitative phase are all from few academic institutions (about eight) posing a concern that perceptions from other institutions issuing construction focused doctorate degrees in the U.S. are not captured. Having data from those institutions might strengthen or dilute the findings, which is still important to include. The researcher tried contacting participants from these universities, but there was no response/interest from them.

7.4 Suggested Future Research

- One challenge international Ph.D. students mentioned was that employers were not interested in hiring Ph.D. students as they're not interested in sponsoring visa. A future study focusing on how international construction Ph.D. students contributed to construction industry, and how valuable they're in building the construction economy may be warranted.
- The research participants indicated the importance of setting up industry-university collaborations in preparing construction focused Ph.D. students for multiple career paths. An exclusive future study focusing on resources required to set up the university-industry collaborative model in construction can be taken up. However, such collaborations in other sectors such as automobile, software, etc. have identified several challenges (Garousi et al., 2016). A future study focusing on identifying challenges and potential pitfalls of such industry-university collaborations specific

construction doctoral education and thereby developing best practices for industry-university collaboration in construction doctoral education can conducted

- The construction Ph.D. graduates that are currently working in the construction industry mentioned about their struggles, experiences, and strategies in their path to obtain an employment in the industry. A future study focusing on identifying the construction focused Ph.D. students experiences and strategies will be helpful in preparing construction Ph.D. students for construction industry employment.
- It was evidently clear that the perception of construction industry that there is no need for Ph.D. graduates in the construction industry is one of the major challenges for construction Ph.D. graduates in getting an industry employment. On the other hand, several construction industry professionals mentioned how Ph.D. graduates made a difference to their business and contributed towards advancing the construction industry. This implies a need to develop a future study that investigates and develops case studies regarding different ways construction Ph.D. graduates contributed to the advancement and success of construction business.
- This study recognized concerns regarding the preparedness of some construction faculty regarding their ability to advise to train Ph.D. students to effectively balance theory and application in the research and communicating the research in a language that is relevant to the construction industry. To address this, a potential future study can explore the skillsets required by faculty in construction programs to effectively prepare and advise Ph.D. students for multiple careers.

7.5 Conclusions Summary

This study contributes to the literature, particularly in the construction focused Ph.D. education context, by identifying factors that influence construction focused Ph.D. students career choices, competencies required by construction focused Ph.D. students to be employable in multiple career paths (academia and industry). The study also provided a recommendations framework for construction Ph.D. programs regarding how to prepare construction Ph.D. students for multiple career paths as well as identified benefits in preparing construction Ph.D. students for multiple career paths.

The findings indicate that construction focused Ph.D. students are equally interested in industry related career choices alongside academia similar to students in other STEM doctoral programs. The factors such as interest in teaching and research, passion for student mentoring and engagement, flexibility in working hours, support from advisor, unawareness about non-academic opportunities, and satisfaction obtained from teaching influence construction focused Ph.D. students for careers in academia. The factors such as better salaries, ability to make a difference and advance construction industry, disinterest in academic culture, lack of enough academic jobs, no support from advisor, and discouraging academic funding climate influence construction focused Ph.D. students for careers in the industry.

The competencies that are important for employment in academia identified by students and faculty members include communication skills – written and oral, critical and independent thinking, multi-tasking, people management, construction related technical competencies such as estimation, scheduling, data analysis, inter-disciplinary knowledge, and networking skills. The competencies that are important for construction focused Ph.D. students to obtain employment in industry as identified by faculty, students, industry professionals and Ph.D. graduates include communication skills – written and oral, networking, construction related technical competencies such as estimation, scheduling, people management, leadership, problem solving, latest technology adaptability, critical thinking, data analytics, management competencies such as financial management, quality management, safety management, quality management, and risk management.

The different ways construction Ph.D. students can be prepared for multiple career paths is by providing opportunities to engage and interact with construction industry, provision to complete internship(s), offer coursework that appeals to construction industry, ability to perform research that balances both theory and practice, and develop industry-university collaborative Ph.D. programs.

The benefits of preparing construction Ph.D. students for multiple career paths is multi-faceted as it benefits students, academia, and industry. These benefits include providing more career options for students, providing industry with research and development, improving construction industry's ability to constantly innovate and implement new changes, advance construction industry by developing practical solutions, ability to incorporate industry experience and examples into academic curricula, and enhance university-industry research relationships and collaborations. Additionally, this study opens doors for future research on preparing construction focused Ph.D. students for multiple career paths.

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APPENDIX A – LIST OF DOCTORAL PROGRAMS OFFERING CONSTRUCTION EMPHASIS IN THE U.S.

University	Ph.D. Title	Department
New York University	Ph.D. Civil Engineering (Construction Management and Engineering)	Civil Engineering
SUNY College of Environmental Science and Forestry	Ph.D. in Sustainable Construction Management	Sustainable Resources Management
Stevens Institute of Technology	Ph.D. Civil Engineering (Construction Materials)	School of Engineering & Science
Clemson University	Ph. D. Planning, Design & the Built Environment	College of Architecture, Arts & Humanities
Clemson University	Ph.D. Civil Engineering (Construction Management and Engineering)	Civil Engineering
Georgia Tech	Ph.D. in Building Construction	School of Building Construction
University of Tennessee, Knoxville	Ph.D. Civil Engineering (Construction Engineering)	Civil Engineering
University of Florida	Ph.D. in Construction Management	College of Design, Construction, and Planning
Virginia Tech	Ph.D. in Environmental Design & Planning	Building Construction
Virginia Tech	Ph.D. Civil Engineering (Construction)	Civil Engineering
North Carolina State University	Ph.D. Civil Engineering (Construction Engineering)	Department of Civil, Construction, and Environmental Engineering
Florida International University	Ph.D. Civil Engineering (Structural, Construction & Geotechnical)	Department of Civil and Environmental Engineering
Auburn University	Ph.D. in Building Construction	School of Building Science
Indiana State University, University of Central Missouri, Bowling Green State University, and East Carolina University consortium	Ph.D. in Technology Management (Construction Management)	
Michigan State University	Ph.D. in Planning, Design and Construction	School of Planning, Design and Construction

University	Ph.D. Title	Department
Purdue University Polytechnic Institute	Ph.D. in Technology (Construction Management)	
Purdue University	Ph.D. Civil Engineering (Construction Engineering and Management)	School of Civil Engineering
Michigan Technological University	Ph.D. Civil Engineering (Construction Engineering and Management)	School of Civil Engineering
Marquette University	Ph.D. Civil Engineering (Construction Engineering)	Department of Civil, Construction, and Environmental Engineering
Eastern Michigan University	Ph.D. in Technology (Construction Management)	Engineering & Technology
Illinois Institute of Technology	Ph.D. Civil Engineering (Construction)	School of Civil Engineering
University of Illinois Urbana Champaign	Ph.D. Civil Engineering (Construction Management)	School of Civil Engineering
University of Illinois Chicago	Ph.D. Civil Engineering (Construction Engineering and Management)	School of Civil Engineering
Iowa State University	Ph.D. Construction Engineering and Management	Civil, Construction and Environmental Engineering
North Dakota State University	Ph.D. Civil Engineering (Construction)	Department of Civil and Environmental Engineering
University of Nebraska-Lincoln	Ph.D. Construction Engineering and Management	School of Architectural Engineering and Construction
Louisiana State University	Ph.D. in Engineering Science (Construction Management)	College of Engineering
The University of Oklahoma	Ph. D. Planning, Design, and Construction (Construction Science)	College of Architecture (Department of Planning, Design, and Construction)
The University of Texas at San Antonio	Ph.D. in Civil Engineering: Construction Science and Management	Department of Construction Science
Texas A&M University	Ph.D. in Civil Engineering: Construction Science and Management	Department of Civil and Environmental Engineering
Colorado State University	Ph.D. in Civil & Environmental Engineering with a focus in Construction Engineering Management	Department of Civil and Environmental Engineering
Colorado State University	Ph.D. in Education, Equity, and Transformation with a focus in Construction Management	School of Education

University	Ph.D. Title	Department
University of Colorado, Boulder	Ph.D. in Civil Engineering: Construction Science and Management	Department of Civil, Environmental and Architectural Engineering
University of New Mexico	Ph.D. in Engineering (Construction Engineering and Management)	Civil, Construction and Environmental Engineering
University of Nevada at Las Vegas	Ph.D. in Civil Engineering: Construction	Department of Civil and Environmental Engineering & Construction
Arizona State University	Ph.D. in Construction Management	School of Construction
Oregon State University	Ph.D. in Civil Engineering: Construction	School of Civil and Construction Engineering
Stanford University	Ph.D. in Sustainable Design & Construction	Civil and Environmental Engineering
University of Washington	Ph.D. in the Built Environment	College of Built Environments
Washington State University	Ph.D. Interdisciplinary Sciences (Construction)	School of Design and Construction

APPENDIX B – COLORADO STATE UNIVERSITY IRB APPROVAL

PROTOCOLS

kuali

#2462 - Needs Assessment for Collaborative Doctoral Education in Construction Management

Protocol Information

Review Type	Status	Approval Date	Continuing Review Date
Exempt	**Exempt**	**Sep 09, 2021**	**--**
Expiration Date	Initial Approval Date	Initial Review Type	
Sep 08, 2026	**Sep 09, 2021**	**Exempt**	

Feedback

Approval Comment

Initial exempt determination has been granted on September 9, 2021 to recruit with the approved recruitment and consent procedures. The above-referenced research activity has been reviewed and determined to meet exempt review by the Institutional Review Board under exempt §46.104(d)(2)(ii) of the 2018 Requirements. This study has no funding.

APPENDIX C – PILOT INTERVIEWS AND SURVEYS FEEDBACK

Table 84. *Interviews questions changes after pilot interviews feedback (sample)*

Area of Questions	Before Pilot Interviews	After Pilot Interviews
Career choice	None (Add one more question)	What challenges construction focused Ph.D. students have, in order to obtain an employment in the construction industry? *This helps answer RQ:3, as the challenges should be first identified to propose unique ways to address those challenges, and then promote as well as train Ph.D. students for multiple careers.*
Multiple career path preparation	What opportunities/resources do you think should be provided to prepare students for careers in both academia and industry?	What resources, in your opinion, are required to be provided by the academic institutions to prepare construction focused Ph.D. students for careers in construction industry? And What resources, in your opinion, are required to be provided by the academic institutions to prepare construction focused Ph.D. students for careers in construction academia? *Separated questions based on feedback*

Table 85. *Pilot survey feedback and full survey changes (sample)*

Area received feedback	Before feedback	After feedback
Construction Industry Professionals survey (wording)	Do you think it is important to train Construction Management Ph.D. students for both academic and industry employment opportunities?	Do you think it is important to prepare construction focused Ph.D. students for career in the construction industry in addition to academic careers?
All participants (survey instructions)	In which of the following ways do you think preparing CM Ph.D. students for multiple career paths will be beneficial?	In which of the following ways do you think preparing construction Ph.D. students for multiple career paths (academia and construction industry) will be beneficial? (Please select all that apply)

APPENDIX D – QUALITATIVE INTERVIEW QUESTIONS FOR STUDENTS & PH.D. GRADUATES

The current doctoral education landscape is much different today than previous years. Traditionally, Ph.D. students pursue academic employment opportunities. However, this trend is slowly changing, as doctoral students are now showing interest in other career pathways such as industry careers. In addition to that, the employment scenario is changing as well. For every construction academic position, universities are receiving around 100 applications, meaning that annually there are not enough academic positions available. In such a scenario, it is extremely important to train doctoral students for various career paths in academics and the construction industry to take advantage of these talented individuals. The construction industry is currently experiencing workforce shortage and going through digital transformation by implementing new technologies such as unmanned aircraft vehicles (UAVs), automation, artificial intelligence, and augmented reality/virtual reality (AR/VR), which indicates the need for new emerging workforce skills. Other industries such as automotive, manufacturing, software have leveraged the advantage of Ph.D. level researchers to progress further. The construction industry on the other hand typically does not emphasize research and may not take full advantage of doctoral education to contribute towards development and innovation. This is an appropriate time for the construction industry to collaborate and leverage doctoral education to support the digital construction transformation and address the workforce challenges. It is important for universities to realize that the Ph.D. candidates can meet the emerging and future digital era construction workforce skill needs if they are provided with relevant training and preparation in a Ph.D. program. The National Science Foundation and National Academies of Sciences, Medicine and

Engineering have been stressing the importance of training Ph.D. candidates for multiple career pathways, yet there is very minimal attention from universities and industry in this aspect for construction management Ph.D. programs. Preparing doctoral students for multiple career pathways is then advantageous to students, the construction industry, and academia. Students have access to more employment opportunities, industry gains access to cutting edge research relevant to their challenges and finds potential human talent, whereas academia has access to data, resources, and funds to produce research relevant to industry. This research aims to develop a Ph.D. program that prepares students for multiple career paths in construction and seeks your perspectives regarding the same.

Interview Questions for construction Ph.D. students who are working in construction industry after graduation

CAREER CHOICE

1) What is your motivation for pursuing a Ph.D. in Construction Management?
2) After finishing your Ph.D., you chose an industry position over academia. Can you tell us what events/factors inspired you to find a career in the construction industry instead of an academic position?
3) Did your career choice preference change during your Ph.D. journey? Why or Why not?
4) What are some of the challenges that construction management Ph.D. students have in order to be employable in the construction industry?

CONSTRUCTION INDUSTRY

5) How do you see construction industry transforming in the next 5-8 years? How does this affect the type of training/skillsets that construction management Ph.D. students will need to have?
6) What do you see as cutting-edge areas in construction that construction management Ph.D. programs should consider integrating into their training?

MULTIPLE CAREER PATH PREPARATION

7) Did your Ph.D. in Construction Management prepare you for both construction industry and academia career paths? If yes, please describe how your Ph.D. program trained you for both academic and industry employment. If No, please describe how you achieved a position in industry despite no training from your program?
8) What knowledge and skills do you think construction Ph.D. students should possess to be successful in academic careers?
9) What knowledge and skills do you think construction management Ph.D. students should possess to be successful in industry careers?

10) What are some ways you think current construction management Ph.D. programs can prepare students for both academia and industry employment? What opportunities and resources should it provide?
11) What courses should be offered in construction management Ph.D. programs to better prepare construction Ph.D. graduates for both academic and construction industry employment?
12) What are some potential steps that could be taken by academic programs, professional organizations, and industry employers that could support construction management Ph.D. students that want to pursue careers in the construction industry?

FINAL THOUGHTS

13) What worked well in your construction management Ph.D. program that prepared you for an industry employment?
14) What areas could be improved in your construction management Ph.D. program?
15) What benefits could a multiple career focused university-industry collaborative Ph.D. education model create to construction management Ph.D. students?
16) Any final thoughts or lessons learned that you would like to share with us that helps in developing a Ph.D. program in Construction Management that prepares Ph.D. students for industry and academia career paths?
17) Do you know of anyone that would be interested in participating in this study? If so, can you provide their contact information?

<u>Interview Questions for construction Ph.D. graduates working in the industry</u>

CAREER CHOICE

1) What is your motivation for pursuing a Ph.D. in Construction Management?
2) What are your career goals and interests?
3) Post completion of your Ph.D., there are multiple career paths such as industry, academia, etc. What is your preference and Why?
4) What factors influence you more towards Academia/Industry career choice?
5) Did your career choice preference change during your Ph.D. journey? Why or Why not?
6) What are some of the challenges that construction management Ph.D. students have in order to be employable in the construction industry?

CONSTRUCTION INDUSTRY

7) How do you see construction industry transforming in the next 5-8 years? How does this affect the type of training/skillsets that construction management Ph.D. students will need to have?
8) What do you see as cutting-edge areas in construction that construction management Ph.D. programs should consider integrating into their training?

MULTIPLE CAREER PATH PREPARATION

9) Does your Ph.D. in Construction Management prepare you for multiple career paths within construction industry and academia? If yes, please describe how your Ph.D. program trains you for both academic and industry employment? If No, does that impact your career choice? How?
10) What skills do you think construction Ph.D. students should possess to be successful in academic careers?
11) What skills do you think construction Ph.D. students should possess to be successful in industry careers?
12)

a. To be successful at an academic job in construction management, what are your expectations on the Ph.D. educational training that you should receive? (KSAs).

or/and

b. To be successful at an industry job in construction management, what are your expectations on the Ph.D. educational training that you should receive? (KSAs).

13) What courses should be offered in construction management Ph.D. programs to better prepare construction Ph.D. graduates for both academic and construction industry employment?
14) What are some ways you think current construction management Ph.D. programs can prepare students for both academia and industry employment? What opportunities and resources should it provide?
15) What are some potential steps that could be taken by academic programs, professional organizations, and industry employers that could support construction management Ph.D. students that want to pursue careers in the construction industry?

FINAL THOUGHTS

16) What works well in your Ph.D. program that prepares you for both academic and industry employment?
17) What doesn't work well and must be improved in your Ph.D. program? What is something you want to change in your Ph.D. program?
18) What benefits could a multiple career focused university-industry collaborative Ph.D. education model create to construction management Ph.D. students?
19) Any final thoughts/comments you want us to know that helps us in developing a Ph.D. in Construction Management program that prepares Ph.D. students for multiple career paths?
20) Do you know of anyone that would be interested in participating in this study? If so, can you provide their contact information?

APPENDIX E – QUALITATIVE INTERVIEW QUESTIONS FOR FACULTY

The current doctoral education landscape is much different today than previous years. Traditionally, Ph.D. students pursue academic employment opportunities. However, this trend is slowly changing, as doctoral students are now showing interest in other career pathways such as industry careers. In addition to that, the employment scenario is changing as well. For every construction academic position, universities are receiving around 100 applications, meaning that annually there are not enough academic positions available. In such a scenario, it is extremely important to train doctoral students for various career paths in academics and the construction industry to take advantage of these talented individuals. The construction industry is currently experiencing workforce shortage and going through digital transformation by implementing new technologies such as unmanned aircraft vehicles (UAVs), automation, artificial intelligence, and augmented reality/virtual reality (AR/VR), which indicates the need for new emerging workforce skills. Other industries such as automotive, manufacturing, software have leveraged the advantage of Ph.D. level researchers to progress further. The construction industry on the other hand typically does not emphasize research and may not take full advantage of doctoral education to contribute towards development and innovation. This is an appropriate time for the construction industry to collaborate and leverage doctoral education to support the digital construction transformation and address the workforce challenges. It is important for universities to realize that the Ph.D. candidates can meet the emerging and future digital era construction workforce skill needs if they are provided with relevant training and preparation in a Ph.D. program. The National Science Foundation and National Academies of Sciences, Medicine and Engineering have been stressing the importance of training Ph.D. candidates for multiple career pathways, yet there is very minimal attention from universities and industry in this aspect for construction management Ph.D. programs. Preparing doctoral students for multiple career pathways is then advantageous to students, the construction industry, and academia. Students have access to more employment opportunities, industry gains access to cutting edge research relevant to their challenges and finds potential human talent, whereas academia has access to data, resources, and funds to produce research relevant to industry. This research aims to develop a Ph.D. program that prepares students for multiple career paths in construction and seeks your perspectives regarding the same.

<u>Interview Questions for construction faculty working with departments that prepare construction Ph.D.'s for multiple career paths</u>

CONSTRUCTION INDUSTRY

1. How do you see construction industry transforming in the next 5-8 years? How does this affect the type of training/skillsets that construction management Ph.D. students will need to have?
2. What do you see as cutting-edge areas in construction that construction management Ph.D. programs should consider integrating into their training?

CM Ph.D. MULTIPLE CAREER PATH TRAINING

3. We understand that construction management Ph.D. graduates from your department take up employment in construction industry. How has your program help prepared Ph.D. students for employment in the construction industry?
4. How is your department preparing Ph.D. students for both academic and industry career paths?
5. In your perspective, what opportunities/resources should universities provide to prepare construction management Ph.D. students for careers in both academia and industry?
6. How should universities provide these opportunities/resources to construction management Ph.D. students?
7. Based on your experience, what are some challenges in training construction management Ph.D. students for employment outside of academia?

KNOWLEDGE AND SKILLS

8. What core competencies in terms of knowledge and skills should construction Ph.D. students possess to be employable in academia?
9. What core competencies in terms of knowledge and skills should construction management Ph.D. students possess to be employable in the construction industry?
10. How are Ph.D. students gaining academic career related knowledge and skills in your construction management Ph.D. program?
11. How are Ph.D. students gaining industry career related knowledge and skills in your construction Ph.D. program?

CM Ph.D. PROGRAM STRUCTURE

12. What courses should be offered in construction management Ph.D. programs to better prepare construction Ph.D. graduates for both academic and construction industry employment?
13. What are some ways you think current construction management Ph.D. programs can prepare students for both academia and industry employment? What opportunities and resources should it provide?
14. What are some potential steps that could be taken by academic programs, professional organizations, and industry employers that could support construction management Ph.D. students that want to pursue careers in the construction industry?

FINAL THOUGHTS

15. What are some lessons learned through development, implementation and future plans for your construction Ph.D. program?
16. What benefit could a multiple career focused university-industry collaborative Ph.D. education model create to construction management academia?
17. Do you have any additional comments, thoughts, or suggestions for construction Ph.D. programs to provide preparation for both academic industry careers?
18. Do you have any documentation that you can provide that is associated with this research?
19. Do you know of anyone that would be suitable and interested in participating in this study? If so, can you provide their contact information?

<u>Interview Questions for construction faculty working with departments that prepare construction Ph.D.'s for traditional academic career paths</u>

1. Do you think, the Ph.D. you pursued, graduated from gave you the skills and resources to be employable in construction industry?

CONSTRUCTION INDUSTRY

2. How do you see construction industry transforming in the next 5-8 years? How does this affect the type of training/skillsets that construction management Ph.D. students will need to have?
3. What do you see as cutting-edge areas in construction that construction management Ph.D. programs should consider integrating into their training?

CM Ph.D. MULTIPLE CAREER PATH TRAINING

4. What are your thoughts about preparing construction management Ph.D. students for academic as well as industry career paths?
5. In your department, do you have construction management Ph.D. students showing interest or previous Ph.D. students that preferred career paths outside academia (industry)? Please explain.
6. In your perspective, what opportunities/resources should universities provide to prepare construction management Ph.D. students for careers in industry?
7. In your perspective, what opportunities/resources should universities provide to prepare construction management Ph.D. students for careers in academia?
8. How does your department offer these opportunities and resources for construction management Ph.D. students?

9. Based on your experience, what are challenges for construction management Ph.D. students to be trained for positions outside of academia? (e.g., construction industry).

KNOWLEDGE AND SKILLS

10. What core competencies in terms of knowledge and skills should construction management Ph.D. students possess to be employable in academia?
11. What core competencies in terms of knowledge and skills should construction management Ph.D. students possess to be employable in the construction industry?
12. How can construction management Ph.D. programs better prepare Ph.D. students on the knowledge and skills required for academic employment?
13. How can construction management Ph.D. programs better prepare Ph.D. students on the knowledge and skills required for industry employment?

CM Ph.D. PROGRAM STRUCTURE

14. What courses should be offered in construction management Ph.D. programs to better prepare construction Ph.D. graduates for both academic and construction industry employment?
15. What are some ways you think current construction management Ph.D. programs can prepare students for both academia and industry employment? What opportunities and resources should it provide?
16. What are some potential steps that could be taken by academic programs, professional organizations, and industry employers that could support construction management Ph.D. students that want to pursue careers in the construction industry?

FINAL THOUGHTS

17. What are some lessons learned through development, implementation and future plans for your construction Ph.D. program?
18. What benefits could a multiple career focused university-industry collaborative Ph.D. education model create to construction management academia?
19. Do you have any additional comments, thoughts, or suggestions for construction Ph.D. programs to provide preparation for both academic industry careers?
20. Do you have any documentation that you can provide that is associated with this research?
21. Do you know of anyone that would be interested in participating in this study? If so, can you provide their contact information?

APPENDIX F – QUALITATIVE INTERVIEW QUESTIONS FOR INDUSTRY

The current doctoral education landscape is much different today than previous years. Traditionally, Ph.D. students pursue academic employment opportunities. However, this trend is slowly changing, as doctoral students are now showing interest in other career pathways such as industry careers. In addition to that, the employment scenario is changing as well. For every construction academic position, universities are receiving around 100 applications, meaning that annually there are not enough academic positions available. In such a scenario, it is extremely important to train doctoral students for various career paths in academics and the construction industry to take advantage of these talented individuals. The construction industry is currently experiencing workforce shortage and going through digital transformation by implementing new technologies such as unmanned aircraft vehicles (UAVs), automation, artificial intelligence, and augmented reality/virtual reality (AR/VR), which indicates the need for new emerging workforce skills. Other industries such as automotive, manufacturing, software have leveraged the advantage of Ph.D. level researchers to progress further. The construction industry on the other hand typically does not emphasize research, disunited from academia, and may not take full advantage of doctoral education to contribute towards development and innovation. This is an appropriate time for the construction industry to collaborate and leverage doctoral education to support the digital construction transformation and address the workforce challenges. It is important for construction industry to recognize the importance of academic research and doctoral education to support innovation and bring potential Ph.D. talents into construction industry. It is important for universities to realize that the Ph.D. candidates can meet the emerging and future digital era construction workforce skill needs if they are provided with relevant training and preparation in a

Ph.D. program. The National Science Foundation and National Academies of Sciences, Medicine and Engineering have been stressing the importance of training Ph.D. candidates for multiple career pathways, yet there is very minimal attention from universities and industry in this aspect for construction management Ph.D. programs. Preparing doctoral students for multiple career pathways is then advantageous to students, the construction industry, and academia. Students have access to more employment opportunities, industry gains access to cutting edge research relevant to their challenges and finds potential human talent, whereas academia has access to data, resources, and funds to produce research relevant to industry. This research aims to develop a Ph.D. program that prepares students for multiple career paths in construction and seeks your perspectives regarding the same.

Interview Questions for firms currently hiring construction Ph.D.'s

CONSTRUCTION INDUSTRY

1. How do you see construction industry transforming in the next 5-8 years? How does this affect the type of training/skillsets that construction management Ph.D. students will need to have?
2. What do you see as cutting-edge areas in construction that construction management Ph.D. programs should consider integrating into their training?

DOCTORAL ATTRIBUTES

1. We know that your firm employs construction management Ph.D. graduates. What are the roles that they perform? What knowledge and skills did they possess that made them a good fit for your company?
2. What are the attributes you look for while hiring a construction management Ph.D. graduate?
3. What deficiencies do you encounter in construction management Ph.D. graduates?
4. In your experience, what skills should a construction management Ph.D. graduate possess? What are specific areas of knowledge and skills that construction Ph.D. graduates should possess in order to work in industry?

DOCTORAL TRAINING

1. What training do you think construction management Ph.D. students should obtain to gain the required skills to work in the construction industry?
2. How can construction companies collaborate with academia for preparing construction management Ph.D. students for careers in industry?
3. What are some potential steps that could be taken by academic programs, professional organizations, and employers that could support construction management Ph.D. students that want to pursue careers in construction industry?

4. Based on your experience, what are some challenges for construction management Ph.D. students to be employed in the construction industry?

CM Ph.D. PROGRAM STRUCTURE

5. What courses should be offered in construction management Ph.D. programs to better prepare Ph.D. graduates for construction industry employment?

FINAL THOUGHTS

6. What benefit could a multiple career focused university-industry collaborative Ph.D. education model create to construction management industry?
7. Do you have any additional comments, thoughts, or suggestions for construction Ph.D. programs to provide preparation for industry careers?
8. Do you know of anyone that would be interested in participating in this study? If so, can you provide their contact information?

<u>Interview Questions for firms who do not hire Ph.D.'s but interested in this idea</u>

CONSTRUCTION Ph.D. CAREERS IN INDUSTRY

1. How do you see construction industry transforming in the next 5-8 years? What are your thoughts about hiring construction Ph.D. graduates for the rapidly transforming construction industry?
2. Would you/your firm consider hiring a construction Ph.D. graduate? Why? Why not? Please explain.
3. If you decide to hire a construction Ph.D. graduate, what competencies (knowledge and skills) do you want him/her to possess?
4. What roles within your company do you think the construction Ph.D. graduates can fill in? What roles/responsibilities do you think construction Ph.D. graduates would be apt to perform in the construction industry?
5. Are there specific areas of knowledge and skills that you think construction Ph.D. graduates should possess to be able work in construction industry? Please explain.

DOCTORAL TRAINING

6. What training do you think construction management Ph.D. students should obtain to gain the required skills to work in the construction industry?
7. Can you think of innovative ways that construction companies can collaborate with academia for construction Ph.D. student's training?
8. What are some potential steps that could be taken by academic programs, professional organizations, and employers that could support construction management Ph.D. students that want to pursue careers in construction industry?

CM Ph.D. PROGRAM STRUCTURE

9. What courses should be offered in construction management Ph.D. programs to better prepare Ph.D. graduates for construction industry employment?

FINAL THOUGHTS

10. What benefits could a multiple career focused university-industry collaborative Ph.D. education model create to construction management academia and industry?
11. Do you have any additional comments, thoughts, or suggestions for construction Ph.D. programs to provide preparation for industry careers?

12. Do you know of anyone that would be interested in participating in this study? If so, can you provide their contact information?

APPENDIX G – QUALITATIVE INTERVIEW PROTOCOL

- Thank participant for participating in the research
- Introduction
    - Names
    - Designation and role
    - Project details: Needs Assessment for multiple career path preparation in construction management
- Inform Consent
    - Did the participant get a chance to look it over?
    - Clarification and verbal consent
        - You have the right to refrain from any questions or to stop the interview at any time.
        - You may ask to withhold any or all of the previous questions
        - Your identification will remain confidential, and your name will not appear on any forms or in the research
        - Is it ok if this interview is recorded?
        - Any questions?
- Begin and perform the interview
    - Refer to Interview Questions and ask one by one.
    - Use probing and clarifying questions
    - Have follow up questions, but not more than necessary.
    - Take notes on body language and how participant responds to questions
    - Thank participant after each main question is answered
- Interview Over
    - Thank participant for his/her time
    - Provide contact details of researcher to allow participant to contact if he/she has any questions
    - Let them know about the member checking process and next steps of the research

APPENDIX H – QUANTITATIVE SURVEY QUESTIONNAIRE

1. Please select who you are:
   ☐ Ph.D. Student pursuing Construction Management

   ☐ Ph.D. Graduate (Construction Management) working in construction industry

   ☐ Faculty at a university offering Construction Management degrees

   ☐ Construction Industry Professional

STUDENT

A. GENERAL INFORMATION

1. Title of your Ph.D. Degree:

2. Current Year of Ph.D.

3. University/College Name

4. Your Ph.D. dissertation topic

5. Did you possess construction industry experience prior to starting your Ph.D. studies?
   ☐ Yes. Please briefly describe your experience: ____________

   ☐ No

6. What is your student status?
   ☐ Domestic Student

   ☐ International Student

7. What was your primary motivation for pursuing a Ph.D. in construction management?
   ☐ Develop expertise in construction to pursue a high-level construction industry position

☐ Develop a career in academia as a faculty member

☐ Other (Please mention): ____________________

8. What was your employment prior to starting your Ph.D. in construction management?

9. What do you expect your employment to be once you complete your construction management Ph.D.? (Please select all that apply)

☐ Academia

☐ Industry

☐ Anything that comes my way

☐ Other (Please specify):

10. Please rank your career choice post completion of your Ph.D. in the order of your preference

Academia: ________

Industry: _______

Anything that comes my way: _______

Other (Please specify): __________

B. CAREERS BEYOND ACADEMIA

11. How prepared are you for an employment in construction academia?

☐ Well prepared

☐ Largely prepared

☐ Somewhat prepared

☐ Not prepared

12. How prepared are you for an employment in construction industry?

☐ Well prepared

☐ Largely prepared

☐ Somewhat prepared

☐ Not prepared

13. Do you have a good understanding of the non-academic career paths available for you and your areas of expertise within Construction Management?

☐ Yes

☐ No

☐ Not sure

14. Are your provided with adequate resources, opportunities and preparation to get an employment in the construction industry post completion of your Ph.D.?

☐ Yes

☐ No

☐ Not sure

15. Are your provided with adequate resources, opportunities and preparation to get an employment in the construction academia post completion of your Ph.D.?

☐ Yes

☐ No

☐ Not sure

16. Do you think it is important to train Construction Management Ph.D. student for both academic and industry employment opportunities?

☐ Yes

☐ No

☐ Not sure

☐ Other (Please specify):

17. What are some roles/areas of employment within construction industry you think are apt for CM Ph.D. graduates?

☐ Technology and Innovation (Building Information Modelling, etc.)

☐ Business Processes and Business Development

☐ Project Management

☐ No one area, many areas based on student's dissertation

☐ Other (Please specify):

18. What are the challenges that construction management Ph.D. students face to obtain employment in construction industry ?

    ☐ lack of prior construction industry experience

    ☐ lack of training and resources provided by the university

    ☐ lack of support from the advisor

    ☐ lack of interest from construction companies

    ☐ lack of industry's awareness regarding how PhD graduates can advance the companies

    ☐ industry's negative perception that there is no need for PhD graduates in the industry

    ☐ immigration challenges

    ☐ Not sure

    ☐ Other (Please specify):

C. INDUSTRY – UNIVERSITY COLLABORATIVE CM Ph.D.

19. Do you believe preparing CM Ph.D. students for multiple career paths is beneficial? (Please select all that apply)

    ☐ Yes, beneficial for students

    ☐ Yes, beneficial for academia

    ☐ Yes, beneficial for industry

    ☐ No

☐ Not sure

20. In which of the following ways do you think preparing CM Ph.D. students for multiple career paths will be beneficial?
    ☐ Provides more career options for CM Ph.D. students

    ☐ Enhances University-Industry Research Collaborations

    ☐ Provides experts into managerial roles in industry

    ☐ Ability to incorporate industry experience and examples into the curriculum

    ☐ Advance construction industry by developing future fool proof solutions

    ☐ Improve construction industry's ability to constantly innovate and implement new changes

    ☐ Other (Please specify): _________________

21. Does your current Ph.D. program provide you an opportunity to collaborate with the construction industry?
    ☐ Yes. Please describe:_______

    ☐ No

    ☐ Not sure

    ☐ Other. Please describe:_____

22. What resources and opportunities should be provided to CM Ph.D. students for industry career path preparation?
    ☐ Internships

    ☐ Part time positions in industry

    ☐ Research partnerships with construction firms

    ☐ experience of teaching undergraduate classes

    ☐ experience of writing grant proposals

☐ Service learning

☐ Professional development

☐ Industry networking events

☐ Academic networking events

☐ Industry mentorship programs

☐ Industry funded research opportunities

☐ Other (Please specify): ______________________

23. What resources and opportunities should be provided to CM Ph.D. students for academic career path preparation?

☐ Internships

☐ Part time positions in industry

☐ Research partnerships with construction firms

☐ experience of teaching undergraduate classes

☐ experience of writing grant proposals

☐ Service learning

☐ Professional development

☐ Industry networking events

☐ Academic networking events

☐ Industry mentorship programs

☐ Industry funded research opportunities

☐ Other (Please specify): ______________________

D. CORE COMPETENCIES REQUIRED FOR MULTIPLE CAREERS AFTER CM Ph.D.

24. In your opinion, how important are the following "Workplace Competencies" for construction management PhD graduates to possess to be employable in academia ?

Workplace Competencies	1 Not	2 Slightly	3 Moderately	4 Very	5 Extremely
Effective Written Communication					
Effective Oral Communication					
Critical, Independent Thinking					
Networking Skills					
People management skills, Teamwork and Teambuilding					
Interdisciplinary knowledge and interest					
Latest Technology Adaptability					
Leadership skills					
Interpersonal skills					
Multi-tasking					
Dispute Avoidance ability					
Risk Assessment ability					
Innovation and Problem-Solving Skills					
Other, please specify: __________________					
Other, please specify: __________________					

25. In your opinion, how important are the following "Technical and Managerial Competencies" for construction management PhD graduates to possess to be employable in academia ?

Technical and Managerial Competencies	1 Not	2 Slightly	3 Moderately	4 Very	5 Extremely
Proficiency in latest construction advances and technology.					
Ability to make informed decisions					
Understanding big picture of the problems					
Ability to communicate and convince various stakeholders					
Value engineering/Constructability analysis/ Design Review					
Financial analysis of projects					
Understanding impacts of global, regional and local economics on the construction business					
Estimating					
Scheduling					
Contracts Management					
Knowledge of construction materials, methods and equipment					
Managing labor issues					
Safety/Quality Management					
Building Information Modelling (3D to 5D) knowledge					
Project Management					

Other, please specify: _________________					

26. In your opinion, , how important are the following "Workplace Competencies" for construction management PhD graduates to possess to be employable in industry?

Workplace Competencies	1	2	3	4	5
	Not	Slightly	Moderately	Very	Extremely
Effective Written Communication					
Effective Oral Communication					
Critical, Independent Thinking					
Networking Skills					
People management skills, Teamwork and Teambuilding					
Interdisciplinary knowledge and interest					
Latest Technology Adaptability					
Leadership skills					
Interpersonal skills					
Multi-tasking					
Dispute Avoidance ability					
Risk Assessment ability					
Innovation and Problem-Solving Skills					
Other, please specify: _________________					
Other, please specify: _________________					

27. In your opinion, how important are the following "Technical and Managerial Competencies" for construction management PhD graduates to possess to be employable in industry?

Technical and Managerial Competencies	1	2	3	4	5
	Not	Slightly	Moderately	Very	Extremely
Proficiency in latest construction advances and technology.					
Ability to make informed decisions					
Understanding big picture of the problems					
Ability to communicate and convince various stakeholders					
Value engineering/Constructability analysis/ Design Review					
Financial analysis of projects					
Understanding impacts of global, regional and local economics on the construction business					
Estimating					
Scheduling					
Contracts Management					
Knowledge of construction materials, methods and equipment					
Managing labor issues					
Safety/Quality Management					
Building Information Modelling (3D to 5D) knowledge					

Project Management					
Other, please specify: ________________					

E. MULTIPLE CAREER PREPARATORY CM Ph.D. PROGRAM STRUCTURE

28. In your opinion, how important are the following coursework for construction PhD students to be employable in academia?

Ph.D. Coursework	1	2	3	4	5
	Not	Slightly	Moderately	Very	Extremely
Advanced Construction Research					
Supervised Teaching					
Professional Internship					
Advanced Construction Planning and Control					
Advanced Construction Safety and Health					
Construction Law / Legal Aspects of Construction					
Construction Value Engineering, Cost Analysis & Project Controls					
Construction Business Management					
Advanced Construction Project Management					
Sustainable Construction & Green Buildings					
Advanced Estimation and Bidding Strategy					
Advanced Construction Planning and Scheduling					
Construction Financial Management					
Construction Business Management					
Advanced BIM Concepts / Virtual Design Construction / BIM for Multi-disciplinary Integration					
Construction Risk Management and Decision Analysis					
Advanced Construction Contracts					
Simulation and Visualization of Construction Operations					
Advanced Productivity and Lean Construction					
Information Technology in Construction					
Alternative Project Delivery Methods					
Construction Personnel Management and Negotiations					
Emerging Technologies in the Construction Industry					
Mechanical and Electrical Construction					
Data Analytics for Construction					
Artificial Intelligence and Machine Learning for Construction					
Organizational theory and change management					
Other, please specify: ________________					
Other, please specify: ________________					

29. In your opinion, how important are the following coursework for construction PhD students to be employable in industry?

Ph.D. Coursework	1	2	3	4	5

	Not	Slightly	Moderately	Very	Extremely
Advanced Construction Research					
Supervised Teaching					
Professional Internship					
Advanced Construction Planning and Control					
Advanced Construction Safety and Health					
Construction Law / Legal Aspects of Construction					
Construction Value Engineering, Cost Analysis & Project Controls					
Construction Business Management					
Advanced Construction Project Management					
Sustainable Construction & Green Buildings					
Advanced Estimation and Bidding Strategy					
Advanced Construction Planning and Scheduling					
Construction Financial Management					
Construction Business Management					
Advanced BIM Concepts / Virtual Design Construction / BIM for Multi-disciplinary Integration					
Construction Risk Management and Decision Analysis					
Advanced Construction Contracts					
Simulation and Visualization of Construction Operations					
Advanced Productivity and Lean Construction					
Information Technology in Construction					
Alternative Project Delivery Methods					
Construction Personnel Management and Negotiations					
Emerging Technologies in the Construction Industry					
Mechanical and Electrical Construction					
Data Analytics for Construction					
Artificial Intelligence and Machine Learning for Construction					
Organizational theory and change management					
Other, please specify: __________________					
Other, please specify: __________________					

30. In your opinion, how important are the following in preparing CM Ph.D. students for career paths in both academia and industry?

CM Ph.D. multiple career path preparation	1 Not	2 Slightly	3 Moderately	4 Very	5 Extremely
The construction management Ph.D. programs should prepare Ph.D. students for careers in both academia and industry					
Collaboration between universities and construction industry is important in order to prepare construction management Ph.D. students for multiple career paths					
Performing applied research that is practically applicable and relevant to construction industry					

prepares CM Ph.D. students better for industry career path					
Performing theoretical research that advances the field and widens the research horizon prepares CM Ph.D. students better for academic career path					
Performing a research that balances both theoretical and applied research orientations is crucial in preparing CM Ph.D. students for career paths in both academia and industry					
Having in-field experience is crucial for CM Ph.D. graduate's success in academic employment					
Having in-field experience is crucial for CM Ph.D. graduate's success in industry employment					
CM Ph.D. students should have mentors from both construction industry and academia for multiple career path preparation					
Awareness to construction employers regarding advantages of employing CM Ph.D. graduates in the industry should be provided					
The CM Ph.D. students should be provided with academia and industry networking opportunities for multiple career path preparation					
Student engagement with construction industry throughout the duration of Ph.D. is critical for multiple career path preparation					
The student's Ph.D. dissertation committee should have a co-advisor from construction industry for multiple career path preparation					
The students must be provided with opportunities to experience both industry and teaching in their Ph.D. program for multiple career path preparation					
Other, please specify: ___________________					

31. Please provide any final thoughts / suggestions / comments regarding opportunities and resources to be provided for preparing Construction Management Ph.D. students for multiple career paths in academia and industry.

Ph.D. GRADUATES

A. GENERAL INFORMATION

2. Title of your Ph.D. Degree:

3. Year of Ph.D. graduation

4. Your Ph.D. dissertation topic

5. Did you possess construction industry experience prior to starting your Ph.D. studies?
   ☐ Yes. Please briefly describe your experience: _____________

   ☐ No

6. What was your student status?
   ☐ Domestic Student

   ☐ International Student

7. If you are working in the construction industry, what is your title?

8. What are your responsibilities in your construction industry position?

9. What was your primary motivation for pursuing a Ph.D. in construction management?
   ☐ Develop expertise in construction to pursue a high-level construction industry position

   ☐ Develop a career in academia as a faculty member

   ☐ Other (Please mention): ______________________

10. What was your employment prior to starting your Ph.D. in construction management?

11. Why did you prefer employment in construction industry over construction academia?

B. PREPARATION FOR CAREERS BEYOND ACADEMIA

12. During your Ph.D., how prepared (by university) were you for an employment in construction academia?

    ☐ Well prepared

    ☐ Largely prepared

    ☐ Somewhat prepared

    ☐ Not prepared

13. During your Ph.D., how prepared (by university) were you for an employment in construction industry?

    ☐ Well prepared

    ☐ Largely prepared

    ☐ Somewhat prepared

    ☐ Not prepared

14. During your Ph.D., did you have a good understanding of the non-academic career paths available for you and your areas of expertise within Construction Management?

    ☐ Yes

    ☐ No

    ☐ Not sure

15. During your Ph.D., were your provided with adequate resources, opportunities and preparation to get an employment in the construction industry post completion of your Ph.D. ?

    ☐ Yes

    ☐ No

    ☐ Not sure

16. During your Ph.D., were your provided with adequate resources, opportunities and preparation to get an employment in the construction academia post completion of your Ph.D. ?

    ☐ Yes

☐ No

☐ Not sure

17. Do you think it is important to train Construction Management Ph.D. student for both academic and industry employment opportunities?

    ☐ Yes

    ☐ No

    ☐ Not sure

    ☐ Other (Please specify):

18. What is your current area of employment within construction industry?

    ☐ Technology and Innovation (Building Information Modelling, etc.)

    ☐ Business Processes and Business Development

    ☐ Project Management

    ☐ Other (Please specify):

19. What are some roles/areas of employment within construction industry you think are apt for CM Ph.D. graduates?

    ☐ Technology and Innovation (Building Information Modelling, etc.)

    ☐ Business Processes and Business Development

    ☐ Project Management

    ☐ No one area, many areas based on student's dissertation

    ☐ Other (Please specify):

20. What are the challenges that construction management Ph.D. students face to obtain employment in construction industry?

    ☐ lack of prior construction industry experience

    ☐ lack of training and resources provided by the university

☐ lack of support from the advisor

☐ lack of interest from construction companies

☐ lack of industry's awareness regarding how PhD graduates can advance the companies

☐ industry's negative perception that there is no need for PhD graduates in the industry

☐ immigration challenges

☐ Not sure

☐ Other (Please specify):

C. INDUSTRY – UNIVERSITY COLLABORATIVE CM Ph.D.

21. Do you believe preparing CM Ph.D. students for multiple career paths is beneficial? (Please select all that apply)

    ☐ Yes, beneficial for students

    ☐ Yes, beneficial for academia

    ☐ Yes, beneficial for industry

    ☐ No

    ☐ Not sure

22. In which of the following ways do you think preparing CM Ph.D. students for multiple career paths will be beneficial?

    ☐ Provides more career options for CM Ph.D. students

    ☐ Enhances University-Industry Research Collaborations

    ☐ Provides experts into managerial roles in industry

    ☐ Ability to incorporate industry experience and examples into the curriculum

    ☐ Advance construction industry by developing future fool proof solutions

    ☐ Improve construction industry's ability to constantly innovate and implement new changes

☐ Other (Please specify): _________________

23. During your Ph.D., did your Ph.D. program provide you an opportunity to collaborate with the construction industry?
   ☐ Yes. Please describe how:_______

   ☐ No

   ☐ Not sure

   ☐ Other. Please describe:_____

24. During the course of your Ph.D. program, in which of the following ways did you engage with construction industry?
   ☐ Internship

   ☐ Part time position

   ☐ Full time position

   ☐ Data Collection for Research

   ☐ Research Collaboration

   ☐ Other (please specify): _______________________

25. What type of activities were you involved with or are you involved to prepare yourself for multiple career opportunities within construction?
   ☐ Internships

   ☐ Part time position

   ☐ Full time position

   ☐ Research Partnerships

   ☐ Service Learning

   ☐ Professional Development

☐ Industry Networking Events

☐ Industry Mentorship Programs

☐ Other (Please specify): ______________________

26. What resources and opportunities should be provided to CM Ph.D. students for industry career path preparation?

☐ Internships

☐ Part time positions in industry

☐ Research partnerships with construction firms

☐ experience of teaching undergraduate classes

☐ experience of writing grant proposals

☐ Service learning

☐ Professional development

☐ Industry networking events

☐ Academic networking events

☐ Industry mentorship programs

☐ Industry funded research opportunities

☐ Teaching opportunities

☐ Other (Please specify): ____________________

27. What resources and opportunities should be provided to CM Ph.D. students for academic career path preparation?

☐ Internships

☐ Part time positions in industry

☐ Research partnerships with construction firms

☐ experience of teaching undergraduate classes

☐ experience of writing grant proposals

☐ Service learning

☐ Professional development

☐ Industry networking events

☐ Academic networking events

☐ Industry mentorship programs

☐ Industry funded research opportunities

☐ Teaching opportunities

☐ Other (Please specify): ______________________

D. CORE COMPETENCIES REQUIRED FOR MULTIPLE CAREERS AFTER CM Ph.D.

28. In your opinion, how important are the following "Workplace Competencies" for construction management PhD graduates to possess to be employable in academia ?

Workplace Competencies	1	2	3	4	5
	Not	Slightly	Moderately	Very	Extremely
Effective Written Communication					
Effective Oral Communication					
Critical, Independent Thinking					
Networking Skills					
People management skills, Teamwork and Teambuilding					
Interdisciplinary knowledge and interest					
Latest Technology Adaptability					
Leadership skills					
Interpersonal skills					
Multi-tasking					
Dispute Avoidance ability					
Risk Assessment ability					
Innovation and Problem-Solving Skills					
Other, please specify: __________________					

Other, please specify: _________________					

29. In your opinion, how important are the following “Technical and Managerial Competencies” for construction management PhD graduates to possess to be employable in academia ?

Technical and Managerial Competencies	1 Not	2 Slightly	3 Moderately	4 Very	5 Extremely
Proficiency in latest construction advances and technology.					
Ability to make informed decisions					
Understanding big picture of the problems					
Ability to communicate and convince various stakeholders					
Value engineering/Constructability analysis/ Design Review					
Financial analysis of projects					
Understanding impacts of global, regional and local economics on the construction business					
Estimating					
Scheduling					
Contracts Management					
Knowledge of construction materials, methods and equipment					
Managing labor issues					
Safety/Quality Management					
Building Information Modelling (3D to 5D) knowledge					
Project Management					
Other, please specify: _________________					

30. In your opinion, how important are the following “Workplace Competencies” for construction management PhD graduates to possess to be employable in industry?

Workplace Competencies	1 Not	2 Slightly	3 Moderately	4 Very	5 Extremely
Effective Written Communication					
Effective Oral Communication					
Critical, Independent Thinking					
Networking Skills					
People management skills, Teamwork and Teambuilding					
Interdisciplinary knowledge and interest					
Latest Technology Adaptability					
Leadership skills					
Interpersonal skills					
Multi-tasking					
Dispute Avoidance ability					

Risk Assessment ability					
Innovation and Problem-Solving Skills					
Other, please specify: __________________					
Other, please specify: __________________					

31. In your opinion, how important are the following "Technical and Managerial Competencies" for construction management PhD graduates to possess to be employable in industry?

Technical and Managerial Competencies	1	2	3	4	5
	Not	Slightly	Moderately	Very	Extremely
Proficiency in latest construction advances and technology.					
Ability to make informed decisions					
Understanding big picture of the problems					
Ability to communicate and convince various stakeholders					
Value engineering/Constructability analysis/ Design Review					
Financial analysis of projects					
Understanding impacts of global, regional and local economics on the construction business					
Estimating					
Scheduling					
Contracts Management					
Knowledge of construction materials, methods and equipment					
Managing labor issues					
Safety/Quality Management					
Building Information Modelling (3D to 5D) knowledge					
Project Management					
Other, please specify: __________________					

E. MULTIPLE CAREER PREPARATORY CM Ph.D. PROGRAM STRUCTURE

32. In your opinion, how important are the following coursework for construction PhD students to be employable in academia?

Ph.D. Coursework	1	2	3	4	5
	Not	Slightly	Moderately	Very	Extremely
Advanced Construction Research					
Supervised Teaching					
Professional Internship					
Advanced Construction Planning and Control					
Advanced Construction Safety and Health					
Construction Law / Legal Aspects of Construction					
Construction Value Engineering, Cost Analysis & Project Controls					
Construction Business Management					

Advanced Construction Project Management					
Sustainable Construction & Green Buildings					
Advanced Estimation and Bidding Strategy					
Advanced Construction Planning and Scheduling					
Construction Financial Management					
Construction Business Management					
Advanced BIM Concepts / Virtual Design Construction / BIM for Multi-disciplinary Integration					
Construction Risk Management and Decision Analysis					
Advanced Construction Contracts					
Simulation and Visualization of Construction Operations					
Advanced Productivity and Lean Construction					
Information Technology in Construction					
Alternative Project Delivery Methods					
Construction Personnel Management and Negotiations					
Emerging Technologies in the Construction Industry					
Mechanical and Electrical Construction					
Data Analytics for Construction					
Artificial Intelligence and Machine Learning for Construction					
Organizational theory and change management					
Other, please specify: __________________					
Other, please specify: __________________					

33. In your opinion, how important are the following coursework for construction PhD students to be employable in industry?

Ph.D. Coursework	1 Not	2 Slightly	3 Moderately	4 Very	5 Extremely
Advanced Construction Research					
Supervised Teaching					
Professional Internship					
Advanced Construction Planning and Control					
Advanced Construction Safety and Health					
Construction Law / Legal Aspects of Construction					
Construction Value Engineering, Cost Analysis & Project Controls					
Construction Business Management					
Advanced Construction Project Management					
Sustainable Construction & Green Buildings					
Advanced Estimation and Bidding Strategy					
Advanced Construction Planning and Scheduling					
Construction Financial Management					
Construction Business Management					
Advanced BIM Concepts / Virtual Design Construction / BIM for Multi-disciplinary Integration					

Construction Risk Management and Decision Analysis					
Advanced Construction Contracts					
Simulation and Visualization of Construction Operations					
Advanced Productivity and Lean Construction					
Information Technology in Construction					
Alternative Project Delivery Methods					
Construction Personnel Management and Negotiations					
Emerging Technologies in the Construction Industry					
Mechanical and Electrical Construction					
Data Analytics for Construction					
Artificial Intelligence and Machine Learning for Construction					
Organizational theory and change management					
Other, please specify: __________________					
Other, please specify: __________________					

34. In your opinion, how important are the following in preparing CM Ph.D. students for career paths in both academia and industry?

CM Ph.D. multiple career path preparation	1 Not	2 Slightly	3 Moderately	4 Very	5 Extremely
The construction management Ph.D. programs should prepare Ph.D. students for careers in both academia and industry					
Collaboration between universities and construction industry is important in order to prepare construction management Ph.D. students for multiple career paths					
Performing applied research that is practically applicable and relevant to construction industry prepares CM Ph.D. students better for industry career path					
Performing theoretical research that advances the field and widens the research horizon prepares CM Ph.D. students better for academic career path					
Performing a research that balances both theoretical and applied research orientations is crucial in preparing CM Ph.D. students for career paths in both academia and industry					
Having in-field experience is crucial for CM Ph.D. graduate's success in academic employment					
Having in-field experience is crucial for CM Ph.D. graduate's success in industry employment					
CM Ph.D. students should have mentors from both construction industry and academia for multiple career path preparation					
Awareness to construction employers regarding advantages of employing CM Ph.D. graduates in the industry should be provided					

The CM Ph.D. students should be provided with academia and industry networking opportunities for multiple career path preparation					
Student engagement with construction industry throughout the duration of Ph.D. is critical for multiple career path preparation					
The student's Ph.D. dissertation committee should have a co-advisor from construction industry for multiple career path preparation					
The students must be provided with opportunities to experience both industry and teaching in their Ph.D. program for multiple career path preparation					
Other, please specify: __________________					

35. Please provide any final thoughts / suggestions / comments regarding opportunities and resources to be provided for preparing Construction Management Ph.D. students for multiple career paths in academia and industry.

FACULTY

A. GENERAL INFORMATION

1. Name of the University you work for
2. Name of your Department:
3. Topic of your Ph.D. dissertation:
4. Does your department offer Ph.D. degrees in Construction Management?

   ☐ Yes, my department offers Ph.D. degrees in construction

   ☐ Yes, my department offers Ph.D. degrees focusing in construction in collaboration with other departments

   ☐ No, we do not offer Ph.D. degrees in construction

   ☐ Other (Please specify):

5. What is your current position? (Please select all that apply)

   ☐ Assistant Professor

   ☐ Associate Professor

   ☐ Professor

   ☐ Department Head

   ☐ Grad Program Coordinator

   ☐ Other (Please specify):

6. Do you possess construction industry experience? (Please select all that apply)

   ☐ Yes, I have work experience in construction before pursuing Ph.D. Please state how many years:

☐ Yes, I have work experience in construction while pursuing Ph.D. Please state how many years:

☐ Yes, I have work experience in construction after completing Ph.D. Please state how many years:

☐ I have internship work experience in construction industry

☐ No, I do not have work experience in construction industry

☐ Other (please specify):

7. Overall, what is the amount of Industry experience you have?

   ☐ No Industry Experience

   ☐ 1-3 years

   ☐ 4-6 years

   ☐ 7-10 years

   ☐ > 10 years

8. In the last five years, approximately how many Ph.D. CM students have graduated from your department?

9. Within one year of graduation, approximately what percentage of your employed Ph.D. CM graduates work for?

   ☐ Academia %

   ☐ Industry %

   ☐ Government %

   ☐ Entrepreneurship %

   ☐ Others (please mention) %

10. In last five years, have you noticed any difference in job obtainment patterns in terms of academic versus non-academic for CM Ph.D. graduates?

    ☐ Yes, please explain:___________________

    ☐ No

    ☐ Not sure

B. CAREERS BEYOND ACADEMIA

11. Do you think it is important to train Construction Management Ph.D. student for both academic and industry employment opportunities?

    ☐ Yes

    ☐ No

    ☐ Not sure

    ☐ Other (Please specify):

12. What are some roles/areas of employment within construction industry you think are apt for CM Ph.D. graduates?

    ☐ Technology and Innovation (Building Information Modelling, etc.)

    ☐ Business Processes and Business Development

    ☐ Project Management

    ☐ No one area, many areas based on student's dissertation

    ☐ Other (Please specify):

13. From your experience, what are the challenges that construction management Ph.D. students face to obtain employment in construction industry ?

    ☐ lack of prior construction industry experience

    ☐ lack of training and resources available

    ☐ lack of support from the advisor

    ☐ lack of interest from construction companies

☐ lack of industry's awareness regarding how PhD graduates can advance the companies

☐ industry's negative perception that there is no need for PhD graduates in the industry

☐ immigration challenges

☐ Not sure

☐ Other (Please specify):

14. Do you believe preparing CM Ph.D. students for multiple career paths is beneficial? (Please select all that apply)

    ☐ Yes, beneficial for students

    ☐ Yes, beneficial for academia

    ☐ Yes, beneficial for industry

    ☐ No

    ☐ Not sure

15. In which of the following ways do you think preparing CM Ph.D. students for multiple career paths will be beneficial? (Please select all that apply)

    ☐ Provides more career options for CM Ph.D. students

    ☐ Enhances University-Industry Research Collaborations

    ☐ Provides experts into managerial roles in industry

    ☐ Ability to incorporate industry experience and examples into the curriculum

    ☐ Advance construction industry by developing future fool proof solutions

    ☐ Improve construction industry's ability to constantly innovate and implement new changes

    ☐ Other (Please specify): ___________________

16. What resources and opportunities should be provided to CM Ph.D. students for industry career path preparation?

☐ Internships

☐ Part time positions in industry

☐ Research partnerships with construction firms

☐ experience of teaching undergraduate classes

☐ experience of writing grant proposals

☐ Service learning

☐ Professional development

☐ Industry networking events

☐ Academic networking events

☐ Industry mentorship programs

☐ Industry funded research opportunities

☐ Other (Please specify): ______________________

17. What resources and opportunities should be provided to CM Ph.D. students for academic career path preparation?

☐ Internships

☐ Part time positions in industry

☐ Research partnerships with construction firms

☐ experience of teaching undergraduate classes

☐ experience of writing grant proposals

☐ Service learning

☐ Professional development

☐ Industry networking events

☐ Academic networking events

☐ Industry mentorship programs

☐ Industry funded research opportunities

☐ Other (Please specify): ______________________

C. CORE COMPETENCIES REQUIRED FOR MULTIPLE CAREERS AFTER CM Ph.D.

18. In your opinion, how important are the following “Workplace Competencies” for construction management PhD graduates to possess to be employable in academia ?

Workplace Competencies	1	2	3	4	5
	Not	Slightly	Moderately	Very	Extremely
Effective Written Communication					
Effective Oral Communication					
Critical, Independent Thinking					
Networking Skills					
People management skills, Teamwork and Teambuilding					
Interdisciplinary knowledge and interest					
Latest Technology Adaptability					
Leadership skills					
Interpersonal skills					
Multi-tasking					
Dispute Avoidance ability					
Risk Assessment ability					
Innovation and Problem-Solving Skills					
Other, please specify: __________________					
Other, please specify: __________________					

19. In your opinion, how important are the following “Technical and Managerial Competencies” for construction management PhD graduates to possess to be employable in academia ?

Technical and Managerial Competencies	1	2	3	4	5
	Not	Slightly	Moderately	Very	Extremely
Proficiency in latest construction advances and technology.					
Ability to make informed decisions					
Understanding big picture of the problems					
Ability to communicate and convince various stakeholders					
Value engineering/Constructability analysis/ Design Review					

Financial analysis of projects					
Understanding impacts of global, regional and local economics on the construction business					
Estimating					
Scheduling					
Contracts Management					
Knowledge of construction materials, methods and equipment					
Managing labor issues					
Safety/Quality Management					
Building Information Modelling (3D to 5D) knowledge					
Project Management					
Other, please specify: ___________________					

20. In your opinion, how important are the following "Workplace Competencies" for construction management PhD graduates to possess to be employable in industry?

Workplace Competencies	1 Not	2 Slightly	3 Moderately	4 Very	5 Extremely
Effective Written Communication					
Effective Oral Communication					
Critical, Independent Thinking					
Networking Skills					
People management skills, Teamwork and Teambuilding					
Interdisciplinary knowledge and interest					
Latest Technology Adaptability					
Leadership skills					
Interpersonal skills					
Multi-tasking					
Dispute Avoidance ability					
Risk Assessment ability					
Innovation and Problem-Solving Skills					
Other, please specify: ___________________					
Other, please specify: ___________________					

21. In your opinion, how important are the following "Technical and Managerial Competencies" for construction management PhD graduates to possess to be employable in industry?

Technical and Managerial Competencies	1 Not	2 Slightly	3 Moderately	4 Very	5 Extremely
Proficiency in latest construction advances and technology.					
Ability to make informed decisions					
Understanding big picture of the problems					
Ability to communicate and convince various stakeholders					

Value engineering/Constructability analysis/ Design Review					
Financial analysis of projects					
Understanding impacts of global, regional and local economics on the construction business					
Estimating					
Scheduling					
Contracts Management					
Knowledge of construction materials, methods and equipment					
Managing labor issues					
Safety/Quality Management					
Building Information Modelling (3D to 5D) knowledge					
Project Management					
Other, please specify: __________________					

D. MULTIPLE CAREER PREPARATORY CM PH.D. PROGRAM STRUCTURE

22. In your opinion, how important are the following coursework for construction PhD students to be employable in academia?

Ph.D. Coursework	1 Not	2 Slightly	3 Moderately	4 Very	5 Extremely
Advanced Construction Research					
Supervised Teaching					
Professional Internship					
Advanced Construction Planning and Control					
Advanced Construction Safety and Health					
Construction Law / Legal Aspects of Construction					
Construction Value Engineering, Cost Analysis & Project Controls					
Construction Business Management					
Advanced Construction Project Management					
Sustainable Construction & Green Buildings					
Advanced Estimation and Bidding Strategy					
Advanced Construction Planning and Scheduling					
Construction Financial Management					
Construction Business Management					
Advanced BIM Concepts / Virtual Design Construction / BIM for Multi-disciplinary Integration					
Construction Risk Management and Decision Analysis					
Advanced Construction Contracts					
Simulation and Visualization of Construction Operations					
Advanced Productivity and Lean Construction					
Information Technology in Construction					
Alternative Project Delivery Methods					
Construction Personnel Management and Negotiations					

Emerging Technologies in the Construction Industry					
Mechanical and Electrical Construction					
Data Analytics for Construction					
Artificial Intelligence and Machine Learning for Construction					
Organizational theory and change management					
Other, please specify: __________________					
Other, please specify: __________________					

23. In your opinion, how important are the following coursework for construction PhD students to be employable in industry?

Ph.D. Coursework	1 Not	2 Slightly	3 Moderately	4 Very	5 Extremely
Advanced Construction Research					
Supervised Teaching					
Professional Internship					
Advanced Construction Planning and Control					
Advanced Construction Safety and Health					
Construction Law / Legal Aspects of Construction					
Construction Value Engineering, Cost Analysis & Project Controls					
Construction Business Management					
Advanced Construction Project Management					
Sustainable Construction & Green Buildings					
Advanced Estimation and Bidding Strategy					
Advanced Construction Planning and Scheduling					
Construction Financial Management					
Construction Business Management					
Advanced BIM Concepts / Virtual Design Construction / BIM for Multi-disciplinary Integration					
Construction Risk Management and Decision Analysis					
Advanced Construction Contracts					
Simulation and Visualization of Construction Operations					
Advanced Productivity and Lean Construction					
Information Technology in Construction					
Alternative Project Delivery Methods					
Construction Personnel Management and Negotiations					
Emerging Technologies in the Construction Industry					
Mechanical and Electrical Construction					
Data Analytics for Construction					
Artificial Intelligence and Machine Learning for Construction					
Organizational theory and change management					
Other, please specify: __________________					
Other, please specify: __________________					

24. In your opinion, how important are the following in preparing CM Ph.D. students for career paths in both academia and industry?

CM Ph.D. multiple career path preparation	1 Not	2 Slightly	3 Moderately	4 Very	5 Extremely
The construction management Ph.D. programs should prepare Ph.D. students for careers in both academia and industry					
Collaboration between universities and construction industry is important in order to prepare construction management Ph.D. students for multiple career paths					
Performing applied research that is practically applicable and relevant to construction industry prepares CM Ph.D. students better for industry career path					
Performing theoretical research that advances the field and widens the research horizon prepares CM Ph.D. students better for academic career path					
Performing a research that balances both theoretical and applied research orientations is crucial in preparing CM Ph.D. students for career paths in both academia and industry					
Having in-field experience is crucial for CM Ph.D. graduate's success in academic employment					
Having in-field experience is crucial for CM Ph.D. graduate's success in industry employment					
CM Ph.D. students should have mentors from both construction industry and academia for multiple career path preparation					
Awareness to construction employers regarding advantages of employing CM Ph.D. graduates in the industry should be provided					
The CM Ph.D. students should be provided with academia and industry networking opportunities for multiple career path preparation					
Student engagement with construction industry throughout the duration of Ph.D. is critical for multiple career path preparation					
The student's Ph.D. dissertation committee should have a co-advisor from construction industry for multiple career path preparation					
The students must be provided with opportunities to experience both industry and teaching in their Ph.D. program for multiple career path preparation					
Other, please specify: __________________					

25. Please provide any final thoughts / suggestions / comments regarding opportunities and resources to be provided for preparing Construction Management Ph.D. students for multiple career paths in academia and industry.

INDUSTRY

A. GENERAL INFORMATION

1. What type of construction firm do you work for? (Select all that apply)

   ☐ General Contractor

   ☐ Sub-Contractor

   ☐ Construction technology firm (e.g. Autodesk, Trimble)

   ☐ Construction Consultant Firm

   ☐ Construction Allied firm (e.g. Surety)

   ☐ Other (please specify):

2. Which sector of construction industry does your firm represent? (Select all that apply)

   ☐ Heavy Civil / Highway / Infrastructure

   ☐ Residential

   ☐ Industrial

   ☐ Commercial

   ☐ Electrical

   ☐ Mechanical

   ☐ Other (please specify):

3. What is the current size of your firm?

   ☐ Small (less than 36.5 million USD average annual revenue)

   ☐ Small to Medium (36.5 million USD to 200 million USD)

   ☐ Medium (200 million USD to 600 million USD)

☐ Medium to Large (600 million USD to 1 billion USD)

☐ Large (more than 1 billion USD)

4. What is your years of experience in construction industry?

☐ 0-5 years

☐ 6-10 years

☐ 11-15 years

☐ 16-20 years

☐ More than 20 years

5. What is your highest level of education?

☐ High school

☐ Associate degree

☐ Bachelor’s degree

☐ Master’s degree

☐ Ph.D. degree

☐ Other (please specify): ___________________

6. What is your current role?

☐ Executive Role (e.g., CEO, CFO, CIO, CTO)

☐ Leadership Role (e.g., Director, Vice President, Head)

☐ Managerial Role (e.g., Project Manager)

☐ Other (Please specify): ___________________

7. Do you currently hire construction Ph.D. graduates within your organization ?

☐ Yes

☐ No

☐ Other (Please specify): ___________________

8. Do you think there is place for Ph.D. graduates within the construction industry?

☐ Yes

☐ No

☐ Other (Please specify): ___________________

9. (Answered Yes for Q8) What are some roles/areas of employment within construction industry you think are apt for CM Ph.D. graduates?

☐ Technology and Innovation (Building Information Modelling, etc.)

☐ Business Processes and Business Development

☐ Project Management

☐ No one area, many areas based on student's dissertation

☐ Other (Please specify):

10. What are the challenges for construction management Ph.D. graduates to get hired in construction industry ?

☐ lack of prior construction industry experience

☐ lack of training and resources provided by the university

☐ lack of support from the advisor

☐ lack of interest from construction companies

☐ lack of industry’s awareness regarding how PhD graduates can advance the companies

☐ industry’s negative perception that there is no need for PhD graduates in the industry

☐ immigration challenges

☐ Not sure

☐ Other (Please specify):

B. INDUSTRY – UNIVERSITY COLLABORATIVE CM PH.D.

11. How important you think is hiring construction Ph.D. graduates within industry roles to advance construction industry ?

    ☐ Extremely Important

    ☐ Very Important

    ☐ Moderately Important

    ☐ Slightly Important

    ☐ Not Important

12. Do you think there is a need for industry collaboration in CM Ph.D. education?

    ☐ Yes

    ☐ No

    ☐ Not sure

13. Do you believe preparing CM Ph.D. students for multiple career paths (both academia and industry) is beneficial? (Please select all that apply)

    ☐ Yes, beneficial for students

☐ Yes, beneficial for academia

☐ Yes, beneficial for industry

☐ No

☐ Not sure

14. In which of the following ways do you think an industry-university collaborative CM Ph.D. will be beneficial?

☐ Provides more career options for CM Ph.D. students

☐ Enhances University-Industry Research Collaborations

☐ Provides experts into managerial roles in industry

☐ Ability to incorporate industry experience and examples into the curriculum

☐ Advance construction industry by developing future fool proof solutions

☐ Improve construction industry's ability to constantly innovate and implement new changes

☐ Other (Please specify): __________________

15. What resources and opportunities should be provided to CM Ph.D. students for industry career path preparation?

☐ Internships

☐ Part time positions in industry

☐ Research partnerships with construction firms

☐ experience of teaching undergraduate classes

☐ experience of writing grant proposals

☐ Service learning

☐ Professional development

☐ Industry networking events

☐ Academic networking events

☐ Industry mentorship programs

☐ Industry funded research opportunities

☐ Other (Please specify): ______________________

C. CORE COMPETENCIES REQUIRED FOR MULTIPLE CAREERS AFTER CM PH.D.

16. In your opinion, how important are the following "Workplace Competencies" for construction management PhD graduates to possess to be employable in industry?

Workplace Competencies	1	2	3	4	5
	Not	Slightly	Moderately	Very	Extremely
Effective Written Communication					
Effective Oral Communication					
Critical, Independent Thinking					
Networking Skills					
People management skills, Teamwork and Teambuilding					
Interdisciplinary knowledge and interest					
Latest Technology Adaptability					
Leadership skills					
Interpersonal skills					
Multi-tasking					
Dispute Avoidance ability					
Risk Assessment ability					
Innovation and Problem-Solving Skills					
Other, please specify: __________________					
Other, please specify: __________________					

17. In your opinion, how important are the following "Technical and Managerial Competencies" for construction management PhD graduates to possess to be employable in industry?

Technical and Managerial Competencies	1	2	3	4	5
	Not	Slightly	Moderately	Very	Extremely
Proficiency in latest construction advances and technology.					

Ability to make informed decisions					
Understanding big picture of the problems					
Ability to communicate and convince various stakeholders					
Value engineering/Constructability analysis/ Design Review					
Financial analysis of projects					
Understanding impacts of global, regional and local economics on the construction business					
Estimating					
Scheduling					
Contracts Management					
Knowledge of construction materials, methods and equipment					
Managing labor issues					
Safety/Quality Management					
Building Information Modelling (3D to 5D) knowledge					
Project Management					
Other, please specify: __________________					

D. MULTIPLE CAREER PREPARATORY CM PH.D. PROGRAM STRUCTURE

18. In your opinion, how important are the following coursework for construction PhD students to be employable in industry?

Ph.D. Coursework	1	2	3	4	5
	Not	Slightly	Moderately	Very	Extremely
Advanced Construction Research					
Supervised Teaching					
Professional Internship					
Advanced Construction Planning and Control					
Advanced Construction Safety and Health					
Construction Law / Legal Aspects of Construction					
Construction Value Engineering, Cost Analysis & Project Controls					
Construction Business Management					
Advanced Construction Project Management					
Sustainable Construction & Green Buildings					
Advanced Estimation and Bidding Strategy					
Advanced Construction Planning and Scheduling					
Construction Financial Management					
Construction Business Management					
Advanced BIM Concepts / Virtual Design Construction / BIM for Multi-disciplinary Integration					
Construction Risk Management and Decision Analysis					
Advanced Construction Contracts					
Simulation and Visualization of Construction Operations					

Advanced Productivity and Lean Construction					
Information Technology in Construction					
Alternative Project Delivery Methods					
Construction Personnel Management and Negotiations					
Emerging Technologies in the Construction Industry					
Mechanical and Electrical Construction					
Data Analytics for Construction					
Artificial Intelligence and Machine Learning for Construction					
Organizational theory and change management					
Other, please specify: __________________					
Other, please specify: __________________					

19. In your opinion, how important are the following components to prepare CM Ph.D. students for careers in industry?

CM Ph.D. multiple career path preparation	1 Not	2 Slightly	3 Moderately	4 Very	5 Extremely
The construction management Ph.D. programs should prepare Ph.D. students for careers in both academia and industry					
Collaboration between universities and construction industry is important in order to prepare construction management Ph.D. students for multiple career paths					
Performing applied research that is practically applicable and relevant to construction industry prepares CM Ph.D. students better for industry career path					
Performing theoretical research that advances the field and widens the research horizon prepares CM Ph.D. students better for academic career path					
Performing a research that balances both theoretical and applied research orientations is crucial in preparing CM Ph.D. students for career paths in both academia and industry					
Having in-field experience is crucial for CM Ph.D. graduate's success in academic employment					
Having in-field experience is crucial for CM Ph.D. graduate's success in industry employment					
CM Ph.D. students should have mentors from both construction industry and academia for multiple career path preparation					
Awareness to construction employers regarding advantages of employing CM Ph.D. graduates in the industry should be provided					
The CM Ph.D. students should be provided with academia and industry networking opportunities for multiple career path preparation					
Student engagement with construction industry throughout the duration of Ph.D. is critical for multiple career path preparation					

The student's Ph.D. dissertation committee should have a co-advisor from construction industry for multiple career path preparation					
The students must be provided with opportunities to experience both industry and teaching in their Ph.D. program for multiple career path preparation					
Other, please specify: ___________________					

20. Please provide any final thoughts / suggestions / comments regarding opportunities and resources to be provided for preparing Construction Management Ph.D. students for multiple career paths in academia and industry.

APPENDIX I – SAMPLE CODING SCHEME