

Using Proper Techniques to Manage Construction Documents and Work Processes: Core Competencies Required

Fatemeh Pariafsai
Dept. of Construction Management
Bowling Green State University
Bowling Green, USA
fpariaf@bgsu.edu

Manish Kumar Dixit
Dept. of Construction Science
Texas A&M University
College Station, USA
mdixit@tamu.edu

Shirley Nelly Tandoh
Dept. of Construction Management
Bowling Green State University
Bowling Green, USA
tandohs@bgsu.edu

Sadjad Pariafsai
Dept. of Aerospace Engineering and
Mechanics
The University of Alabama
Tuscaloosa, USA
spariafsai@crimson.ua.edu

Stephen Mark Caffey
Dept. of Architecture
Texas A&M University
College Station, USA
stephencaffey@tamu.edu

Abstract— This research full paper describes competencies required for the ability to use proper techniques and tools to manage and analyze construction documents and work processes. The construction industry stands as a cornerstone of global economies, employing seven percent of the world's workforce and contributing thirteen percent to the global Gross Domestic Product (GDP). Its significance extends to the United States, where it notably impacts a substantial portion of the population. However, despite its pivotal role, the construction industry grapples with challenges such as diminishing productivity, workplace safety concerns, and work disputes, underscoring the pivotal role of construction project managers. The efficacy of construction project managers in addressing the construction industry challenges hinges upon their competencies, necessitating a comprehensive understanding of their essential skills. In a previous study, twenty-one critical competencies essential for construction project managers were identified, encompassing their associated universal and domain-specific knowledge areas and personality characteristics. To assess the significance of these competencies, a survey comprising six hundred seventy-two ranking questions was devised, utilizing an innovative design framework. Each participant received a randomized set of twenty-one ranking questions to ensure fairness in evaluation. Data from two thousand sixteen academics worldwide was collected. This paper delves into the importance of these competencies, i.e. universal and domain-specific knowledge areas and personality characteristics, concerning the ability to use proper techniques and tools to manage and analyze construction documents and work processes. By emphasizing the significance of these competencies, this study aims to provide guidance to construction academia in prioritizing competency development areas, crafting relevant courses, and designing curricula tailored to meet the evolving needs of the global construction workforce effectively. By elucidating the critical role of competencies in addressing industry challenges and enhancing managerial effectiveness, this research contributes to the ongoing discourse on optimizing construction management practices. Furthermore, the findings serve as a valuable resource for educators, policymakers, and industry stakeholders striving to fortify the construction workforce with the requisite skills to navigate the complexities of the contemporary construction industry.

Keywords—*construction project management, knowledge area, personality characteristic, skill, technique*

I. INTRODUCTION

The construction sector is a pivotal component of the world's economy, employing about 7% of the global workforce and accounting for around 13% of the global Gross Domestic Product [1]. In the United States, this industry not only significantly influences the economy but also affects a large segment of the population. In 2019 alone, it contributed \$884 billion to the U.S. GDP [2] and provided jobs for more than 7.5 million people [3]. However, the U.S. construction industry is currently facing numerous challenges, including competition from international markets, the impact of new technologies, environmental regulations, an aging workforce, and changing regulations. These issues, along with the industry's broad reach and inherent complexities, present persistent obstacles [4, 5]. Additionally, the sector is undergoing transformations due to developments in automation, robotics, big data and predictive analysis, modular construction, the Internet of Things, digital innovations, new methods of project delivery, and 3D printing [1, 6, 7]. According to a 2013 survey by the Associated General Contractors of America, 74% of construction companies reported difficulties in securing enough skilled workers [8].

Debra and Anil suggest that the evolving landscape of the construction industry presents both challenges and opportunities that necessitate a collaborative approach between industry professionals and academic institutions [6]. This partnership is crucial for training and equipping the future workforce to meet the changing demands of the construction sector. It is imperative for academia to evaluate whether the skills they impart are in sync with what will be required in the future construction environment. A key focus should be on adapting educational outcomes to meet the challenges of modern construction practices such as industrialized construction [9-13]. The success of construction projects heavily depends on the workforce, especially the role of construction project managers. These managers are vital for enhancing project performance and achieving successful outcomes, thus requiring them to have a diverse set of skills to lead their teams effectively [4].

This research aims to evaluate the significance of ten universal knowledge areas, ten domain-specific knowledge

areas, and twelve personality characteristics to the ability to use proper techniques and tools to manage and analyze construction documents and work processes. By identifying the key components of construction project management (CPM) competencies, this study offers insights into training strategies for the future CPM workforce. Furthermore, the findings will help in formulating management development policies that construction firms can implement to enhance their organizational effectiveness.

II. LITERATURE REVIEW

A. Conceptual Model for CPM Competencies

McClelland likens competencies to an iceberg [14], where the visible part above the water represents knowledge and skills, while the more substantial, hidden part below the surface encompasses enduring personal traits [14-16]. These foundational characteristics form the bulk of competencies that are not immediately apparent. Additionally, the methods for developing these two aspects of competencies differ significantly. Knowledge and skills can be rapidly enhanced through training and skill-building exercises. In contrast, behavioral competencies, which lie beneath the surface, are more challenging to measure and improve [15, 16].

Competency models encompass a range of frameworks that detail both innate and acquired aspects of professional capabilities [16]. These models are integral to enhancing the quality of human capital by categorizing competencies into personal and professional types [17]. In the educational and training sectors, competencies are often seen as an amalgamation of trainable skills, knowledge, and attitudes [18].

One model posits that effective management hinges on three levels of qualities: foundational knowledge, practical skills and attributes, and higher-level meta-qualities that adapt to specific situations [19]. Additionally, competencies are sometimes divided into input competencies, which include the knowledge and skills a person brings to a position, and personal competencies, which define an individual's capacity to perform their role [20].

Further classifications include essential professional and personal skills or talents, along with behavioral patterns [21]. Another approach groups competencies into interrelated sets of knowledge, skills, and personal attributes, further subdividing knowledge and skills into soft and hard categories [22]. Soft skills define personal traits, whereas hard skills reflect specific knowledge [23]. While soft skills and knowledge are more difficult to cultivate, hard skills and knowledge are more straightforward to develop [24].

Other models differentiate competencies into behavioral and technical levels, where behavioral includes abilities and soft skills, and technical covers knowledge and hard skills [25]. In crisis management, competencies are clustered into functional, focusing on task-specific abilities, and personal, which relate to maintaining professional readiness [26].

The International Project Management Association (IPMA) Competence Baseline 3.0 categorizes competency elements into three types: technical competencies essential for project deliverables, behavioral competencies crucial for interpersonal relations, and contextual competencies that integrate the project team within the project environment [27, 28].

Fig.1 in the study outlines a competency model for CPM, categorizing required competencies into personal and input types. Personal competencies consist of fundamental personality traits, which are inherently challenging to measure and improve. Conversely, input competencies involve the skills necessary for effective CPM, further divided into hard and soft skills. According to the model, hard skills derive from knowledge, while soft skills are influenced by both core personality traits and knowledge. Additionally, the model differentiates knowledge into two types: universal and domain-specific. Universal knowledge refers to the expertise all project managers must have, whereas domain-specific knowledge pertains specifically to those managing construction projects. This framework emphasizes that skills are influenced by both knowledge and personality characteristics.

B. Identification of Skills, Knowledge Areas, and Personality Characteristics

The literature uses different terms to refer to a specific skill. The skills identified from the literature could be grouped into 21 categories based on their nature. This study focuses on the skill defined as the ability to create and implement a construction project health and safety plan.

Moreover, the Project Management Institute (PMI) has developed a list of ten knowledge areas as the body of knowledge required in project management [29]. This study used these ten elements as the universal knowledge areas (UKAs) required in CPM. They are as follows: project communications management (UKA₁), project cost management (UKA₂), project integration management (UKA₃), project procurement management (UKA₄), project quality management (UKA₅), project resource management (UKA₆), project risk management (UKA₇), project schedule management (UKA₈), project scope management (UKA₉), and project stakeholder management (UKA₁₀) [29].

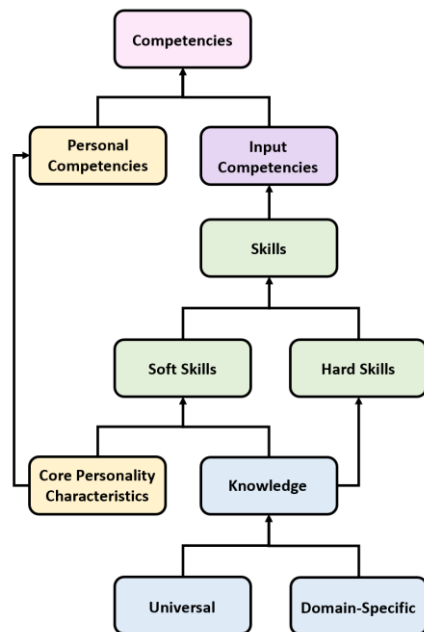


Fig. 1. Conceptual competency model for CPM education and training

To provide the list of knowledge areas required for CPM, PMI has added the following elements to the previous list: (a) Project health, safety, security, and environmental management and (b) Project financial management [30]. The

literature utilizes various phrases to mention a specific knowledge area needed in CPM. The identified domain-specific knowledge areas (DKAs) were grouped into ten categories based on their similarities: construction operation (DKA₁), culture and ethics management (DKA₂), legal and contractual management (project claims, conflicts, and dispute management) (DKA₃), project change management (DKA₄), project environmental management (DKA₅), project financial management (DKA₆), project health and safety management (DKA₇), project leadership management (DKA₈), project security management (DKA₉), and project value management (DKA₁₀).

The literature uses different terms to refer to a specific personality characteristic. The personality characteristic identified from the literature were grouped into 12 categories based on their nature to avoid redundancy: ambition, charisma, creativity, curiosity, determination, leadership, maturity, organization, patience, reasoning, team player, and trustworthiness.

III. METHODOLOGY

A. Survey Design

A design framework was used to divide the lengthy questionnaire investigating the importance of the knowledge areas and personality characteristics to the skills. The survey includes 672 ranking questions:

- 210 ranking questions regarding the importance of 10 universal knowledge areas to 21 skills
- 210 ranking questions regarding the importance of 10 domain-specific knowledge areas to the 21 skills
- 252 ranking questions regarding the importance of 12 personality characteristics to the 21 skills

The aim was to randomly and evenly present 21 ranking questions to each participant. Each participant should have ranked the importance of two universal knowledge areas, two domain-specific knowledge areas, and three personality characteristics to three skills. Qualtrics, a popular web-based survey tool, was used to design the survey.

B. Data Collection

The website <https://www.topuniversities.com/universities> was used to find top Civil and Structural Engineering departments in different countries worldwide. Next, 35,928 professors, post-docs, and students from 86 countries whose email were available on their department's website were invited to participate. Among the invited people, 2,016 individuals tried the survey.

IV. ANALYSIS

A. Statistical Test

The one-sample sign test compares values to a given default value for ordinal data. The null hypothesis is that the population median from which the sample was drawn equals the default value. In addition to descriptive analysis, the one-sample sign test was used to investigate whether the corresponding five-point Likert scores were statistically significantly different from the default score of 3, representing the important option.

B. Required Sample Size

G * Power has been used to compute the required sample size based on the given α , power, and effect size. For the sign test, G * Power uses the following effect size conventions defined by Cohen in 1969: small $g = 0.05$, medium $g = 0.15$, and large $g = 0.25$ [31]. In addition, it is generally accepted that power should be 0.8 or greater [32]. For $\alpha = 0.05$, power = 0.8, and effect size = 0.25, G * Power computed 30 for the sample size of each ranking question.

V. RESULTS

Using the split questionnaire design, at least 37 participants identified the importance of each universal knowledge area, domain-specific knowledge area, and personality characteristic to the ability to use proper techniques and tools to manage and analyze construction documents and work processes. The one-sample sign test results revealed that the participants perceived project communications management, project resource management, and project schedule management as the universal knowledge areas more than important for this skill. Most participants ranked the remaining universal knowledge areas as important (Table I).

TABLE I. ONE-SAMPLE SIGN TEST RESULTS FOR UKAS

Competency	p	Median – Score			Total
		Negative	Positive	Ties	
UKA ₁	.015	19	6	12	37
UKA ₂	.063	20	9	11	40
UKA ₃	.824	11	9	18	38
UKA ₄	.832	12	10	18	40
UKA ₅	.064	17	7	13	37
UKA ₆	.004	18	4	17	39
UKA ₇	.230	16	9	14	39
UKA ₈	.000	19	2	18	39
UKA ₉	.405	14	9	16	39
UKA ₁₀	.424	10	15	14	39

The one-sample sign test results revealed that the participants perceived project change management as the only domain-specific knowledge area more than important for this skill. The one-sample sign test results also indicate that the participants ranked the rest of the domain-specific knowledge as important for this skill (Table II).

TABLE II. ONE-SAMPLE SIGN TEST RESULTS FOR DKAS

Competency	p	Median – Score			Total
		Negative	Positive	Ties	
DKA ₁	.078	15	6	18	39
DKA ₂	.383	13	8	18	39
DKA ₃	1.000	12	11	14	37
DKA ₄	.031	19	7	12	38
DKA ₅	.648	8	11	20	39

DKA ₆	.556	11	15	12	38
DKA ₇	.286	14	8	16	38
DKA ₈	.503	12	8	18	38
DKA ₉	.238	6	12	21	39
DKA ₁₀	1.000	11	10	16	37

The one-sample sign test results revealed that reasoning was the only personality characteristic perceived as more than important for the skill. The results also indicate that the participants perceived ambition, determination, charisma, and curiosity as less than important for the skill. The participants perceived the rest of the personality characteristics as important for the skill (Table III).

TABLE III. ONE-SAMPLE SIGN TEST FOR PERSONALITY CHARACTERISTICS

Competency Component	p	Median – Score			Total
		Negative	Positive	Ties	
Ambition	.003	7	25	14	46
Creativity	.742	17	20	11	48
Determination	.026	8	21	17	46
Organization	.078	18	8	19	45
Charisma	.000	4	33	10	47
Team player	.265	18	11	18	47
Leadership	.186	18	10	19	47
Reasoning	.006	23	7	18	48
Patience	.855	14	16	17	47
Maturity	1.000	15	14	17	46
Curiosity	.026	8	21	19	48
Trustworthiness	.307	15	9	23	47

I. CONCLUSION

The study's outcomes indicate that the academic community places a high value on certain universal knowledge areas such as project communications management, project resource management, and project schedule management, considering them more than just important for the ability to use proper techniques and tools to manage and analyze construction documents and work processes. Conversely, other universal knowledge areas are deemed important but not critical. Notably, project change management stands out as the only domain-specific knowledge area regarded as more than important for the skill, while other domain-specific areas are viewed as simply important. Furthermore, among personality characteristics, reasoning is uniquely perceived by academia as more than important for this skill set. In contrast, traits like ambition, determination, charisma, and curiosity are seen as less critical for success in these tasks.

The necessity for both existing and newly recruited construction project managers to develop crucial competencies promptly is fundamental, given the escalating complexity of the construction industry. A strategic plan is

crucial to maintain the relevance and update the competencies of construction project managers, enabling them to handle the growing challenges effectively. The initial phase in reassessing the education and training of construction project managers involves identifying the most essential competencies required to bridge current competency gaps. This study contributes to this objective by pinpointing key knowledge areas and personality traits essential for the ability to use proper techniques and tools to manage and analyze construction documents and work processes.

The insights from this study are instrumental in enhancing training programs and assessment criteria for CPM. These results are also valuable for refining recruitment processes and promoting long-term employability within CPM roles. Overall, this research offers recommendations that help pave the way forward by guiding the construction industry to focus on key areas of competency development. This approach ensures that training and professional development initiatives are aligned with the actual needs of the future workforce, thereby supporting industry advancements and sustainability [33-38].

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