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ADDRESSING THE IMPACTS OF AN INEXPERIENCED WORKFORCE TO IMPROVE PROJECT DELIVERY

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ABSTRACT: The construction industry is facing a skilled labor shortage driven by an aging workforce and increased retirement and turnover. This skilled labor shortage is impacting project delivery and performance. So, organizations are challenged to find strategies to mitigate the loss of their experienced workforce. There is a lack of understanding of how this loss of experience will impact organizations. Therefore, this study explored the impact of inexperience on project delivery and performance, specifically focusing on the impacts of project design. This study used a design thinking workshop to capture multiple stakeholder perspectives on the impact of construction inexperience on the industry. The workshop engaged stakeholders from architecture, general contractor, trade contractor, and service provider firms. The outcome of the workshop was the identification of symptoms and root causes of inexperience, and a desired future state with associated strategies to address these root causes. This study provides an industry perspective on the current state and impact of inexperience on construction projects while proposing future directions to address and mitigate these impacts by reducing the negative impacts of inexperience on project delivery and performance.

1. INTRODUCTION

Designing and constructing projects in the architectural, engineering, and construction (AEC) industry requires specialized knowledge (Joseph Garcia and Mollaoglu 2020). Without this specialized knowledge, projects face delivery and performance hurdles, such as an increased number of changes orders (Naji et al. 2022) or poor cost and scheduling outcomes, among others (Larsen et al. 2016). Specifically, within construction, these impacts are compounded by the shifting labor demographics. For example, 41% of the construction workforce is expected to retire by 2031 (McKinsey & Company 2020); and the construction labor force is aging, with the 55+ population increasing from 19% in 2015 to 22% in 2021 (Zhao 2023). These changing demographics and subsequent loss of construction experience present challenges and risks related to project delivery and performance. Past research has linked the lack of construction knowledge with poor project performance. For example, Agyekum-Mensah and Knight (2017) found that a lack of knowledge related to construction methods led to negative planning and scheduling impacts. The changing workforce and the potential loss of construction knowledge presents a need to identify and mitigate the impact of inexperience. Therefore, this study investigated the impact of inexperience on project delivery and performance. A design thinking workshop was used to capture the experiences and perspectives of industry members.

Therefore, this study investigated the impact of inexperience on project delivery and performance. A design thinking workshop was used to capture the experiences and perspectives of industry members. This paper identifies key symptoms and root causes of inexperience and proposes a desired future state supported by collaborative strategies. The contribution of this study lies in offering a structured, stakeholder-informed

perspective on mitigating the effects of workforce inexperience in the AEC industry. The remainder of the paper is organized as follows: the next section provides background and literature context, followed by the research methods, results, and discussion, and finally, the study's conclusions and implications.

2. BACKGROUND

2.1 Consequences of Inexperience

Past research has identified potential consequences of inexperience, ranging from cost overrun to poor productivity (Ganguly and Luhar 2020; Larsen et al. 2016; Matthews et al. 2024; Ouyang and Luo 2022). A number of studies have linked cost overruns to schedule overruns due to poor planning, scheduling, and management (Johnson and Babu 2020; Youssefi and Celik 2023), which has been linked to the "lack of qualified and experienced personnel" (Agyekum-Mensah and Knight 2017; Al-Kharashi and Skitmore 2009). For example, at the project's outset, general contractors develop unrealistic schedules which has downstream consequences and compounding impacts on subcontractors (Johnson and Babu 2020). Similarly, cost overruns could be linked to inconsistencies in project documents (Youssefi and Celik 2023), leading to problems that must be resolved before work can continue. Negative impacts on safety related to workers' inability to identify potential hazards (Ouyang and Luo 2022). Productivity was impacted due to both inexperience of the trade professional and the inexperience of other roles, such as engineers or office staff, who are tasked with providing information and other resources to trade professionals so that they may complete their work (Dai et al. 2009; Kim et al. 2020).

In response, many industry leaders and researchers have advocated for integrated knowledge management strategies that combine technological tools with human-centered approaches (Garcia and Mollaoglu 2020; Yap et al. 2022). Technologies such as Building Information Modeling (BIM), knowledge repositories, and mobile field applications can support the documentation and dissemination of lessons learned (Saka et al. 2022). However, these tools are most effective when complemented by a collaborative culture that encourages open communication and shared learning across generations. Embedding these practices into daily workflows can help bridge the gap between senior and junior professionals and ensure continuity in project quality, safety, and efficiency (Dossick et al. 2009).

2.2 Knowledge Sharing and Transfer

Experience in the construction industry can be seen as the cumulative knowledge that industry professionals build through working on different projects with different project stakeholders (Monson and Dossick 2014; Yap et al. 2022). Building experiences is a time-consuming process; similarly, transferring experience needs education, training, mentorship, reforming hiring and workforce development, and leveraging technology for skills development (Fu et al. 2003; Ganguly and Luhar 2020; Ouyang and Luo 2022). So, a knowledge gap is created when experienced professionals retire or leave the construction industry. This gap can impact the project performance and outcomes adversely. Sun et al. (2019) explore knowledge transfer factors and their relationships in the construction project cooperation networks; the findings showed that the relationship between knowledge suppliers and recipients plays a critical role in mediating the influence of project characteristics on knowledge transfer performance.

3. METHODS

This research used a design thinking workshop to elicit perspectives on the current state of the AEC industry as it relates to construction knowledge (or inexperience), its impact on project delivery and performance, and the desired future state of the industry. Design thinking workshops typically contain activities to empathize, define, ideate, prototype, and test (Shanks 2010). These steps allow the workshop participants to grasp the problem or challenge at hand and then to develop and test potential solutions (Shanks 2010). The participants in this design thinking workshop were recruited using purposive and convenience sampling (Campbell et al. 2020; Valerio et al. 2016), targeting industry professionals who had project experience and who would represent architects, general contractors, specialty trade contractors, and service providers. In the case of this study, these steps were iterated upon (Monson and Dossick 2014), where the design

thinking workshop team (referred to as the “team”) first identified the current state of the industry through a brainstorming activity where they drew the process map of an entire project while identifying and subsequently narrowing down the entire project lifecycle to one distinct phase to focus on. After narrowing down to one phase, the project team identified how information would flow from one activity to another and what actors were involved. They then evaluated this current state by identifying symptoms of inexperience (or lack of construction knowledge) by sharing their own project experiences to illustrate what challenges they currently phase and then determined root causes for these symptoms. The team was then challenged to identify a potential future state and a roadmap to achieve this future state—in essence a prototype of an AEC industry that could address the impacts of inexperience. This was done by brainstorming how the original process map would or should change to address the challenges identified in the previous step. The team focused on the actors and information flow throughout this process of developing their vision of a future state and the strategies required to achieve this state.

4. RESULTS AND DISCUSSION

The design thinking workshop was held in April 2024 by the Construction Progress Coalition. It engaged a group of eleven professionals representing the AEC industry and academia. The industry members represented different stakeholder groups within the AEC industry, including architects, general contractors, specialty trade contractors, and service providers.

4.1 Current State

The team first narrowed down its scope of the design thinking workshop to project design, as they identified it as a potential root cause for other challenges faced during project delivery. The team then developed their current state of project design, as seen in Figure 1.

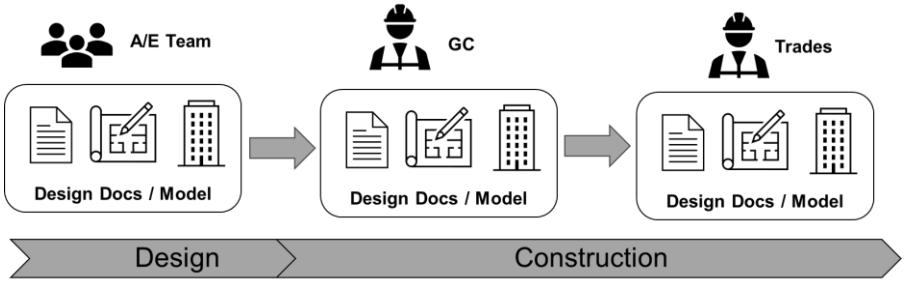

Figure 1: Current State of Project Design

This team identified a linear flow of design information from the architect/engineer (A/E) team to the general contractor (GC) to the trade contractors. This involved the A/E team developing design documents, including drawings and specifications, and models and handing these off to the general contractor, who then passed them on to the trade contractors.

4.2 Symptoms

The workshop team members generally defined the symptoms of inexperience as negative outcomes that are experienced in the project due to inexperience. The participants identified six main symptoms that can be seen due to inexperience. Table 1 summarizes the identified symptoms based on their impact on the project performance and delivery. Cost and schedule were used to specify the project's performance aspects, which reflects a connection between other identified symptoms. For instance, rework directly impacts the project cost and schedule. It is often associated with a chain of requests for information (RFIs) between project stakeholders, which leads to change orders (COs) to authorize the builder to execute the changes and potentially delay the project.

As defined by the Project Management Institute, cost, schedule, scope, and quality are the components of the management iron triangle (Caccamese and Bragantini 2012). Fayek et al. (2003) studied the rework

cost and time impacts. The study identified the reworks as the time when rework is completed, and activity has returned to the condition or state it was in initially. Further, rework is often a result of inexperience during the design or construction phase. Designers might have limited knowledge of the construction means and methods. Similarly, builders' limited experience limits their abilities to discover design flows or use inappropriate construction means and methods (Enshassi et al. 2017; Matthews et al. 2024; Oyewobi and Ogunsemi 2010).

Table 1: Symptoms of Inexperience in the Construction Projects

Symptoms (Outcomes)	Selected academic references
Cost Overrun	(Asiedu and Ameyaw 2021; Choi and Hartley 1996; Fang et al. 2020; Larsen et al. 2016; Rosenfeld 2014; Samarghandi et al. 2016)
Schedule Impact	(Assaf et al. 2018; Ganguly and Luhar 2020; Hsu et al. 2017; Larsen et al. 2016; Mukuka et al. 2015; Yap et al. 2022)
Requests for Information	(Aboseif and Hanna 2023; Assaf et al. 2018; Shoar and Payan 2022; Shrestha et al. 2023)
Rework	(Assaf et al. 2018; Gumusburun Ayalp and Erdem 2025; Matthews et al. 2024)
Delays	(Assaf et al. 2018; Chidambaram et al. 2012; Larsen et al. 2016; Sambasivan and Soon 2007; Yap et al. 2022; Zidane and Andersen 2018 p. 10)
Change Orders	(Assaf et al. 2018; Ilter and Celik 2021; Naji et al. 2022; Padala et al. 2022; Yap et al. 2022)

Requests for information (RFIs) relate to the quality of design documents and the field workforce's experience. During the design process, designers with expertise in construction tend to produce high-quality documents, which leads to fewer RFIs, COs, and rework (Enshassi et al. 2017; Padala et al. 2022; Shrestha et al. 2023). Assaf et al. (2018) investigate the design documents' deficiencies as a significant cause of plagues in the construction industry from the consultants' perspective. The study classified the found causes into four categories: causes pertaining to staff, causes pertaining to the composition of the design team, causes pertaining to design management, and factors pertaining to the client's involvement. Under all these categories, experience and knowledge were the leading cause of DDDs. Also, the findings showed that "assigning design tasks to designers who lack work experience" was the most significant cause. The study reflects the impacts of inexperience on the outcomes (symptoms) of the preconstruction phase, as low-quality outcomes impact the project performance and delivery adversely.

Time and cost overruns are metrics to assess the project performance. Projects with high levels of cost and schedule overruns reflect low performance. Oyewobi and Ogunsemi (2010) studied the rework in the construction industry and its direct connection with time and cost overruns in the projects. The study identified factors contributing to rework and categorized them under three categories: technical, quality, and human resources factors. The experience of project stakeholders highly controls the technical and human factors. Workforces with high experience reduce the chance of re-work, cost, and time overrun.

4.3 Root Causes

The task force and design thinking workshop team tried to identify the root causes behind the inexperience. Eight root causes were identified during the design thinking workshop. Table 2 lists the identified root causes.

Table 2: Symptoms of Inexperience in the Construction Projects

Symptoms (Outcomes)	Selected academic references
Retirement and Turnover	(Borg and Scott-Young 2022; Girma 2019; Hoffman and Burks 2017; Ilmi et al. 2019)
Construction Knowledge	(Ipsen et al. 2021; Monson and Dossick 2014; Sik-wah Fong and Chu 2006; Yap et al. 2022)
Technology versus Construction	(Dixit 2020; Ganguly and Luhar 2020; Monson and Dossick 2014; Yap et al. 2022)

Trust	(Cheung et al. 2013; Huang et al. 2008; Jarvenpaa and Leidner 1999; Khalfan et al. 2007)
Silos	(Abideen et al. 2023; Akintan and Morledge 2013a; Bemelmans et al. 2012; Dossick et al. 2009)
Processes	(Arditi and Gunaydin 1997; Asemi et al. 2011; Díaz et al. 2017; Frommweiler and Poirier 2023)
Time	(Çavuşoğlu 2015; Ishtiaque et al. 2024b; Song et al. 2009)
Early Engagement	(Assaf et al. 2018; Ilter and Celik 2021; Naji et al. 2022; Padala et al. 2022; Yap et al. 2022)

Retirement and turnover are significant root causes of inexperience in the construction industry. Retiring experienced professionals, such as superintendents, architects, engineers, builders, or skilled workforce, leads to a loss of expertise with a time-consuming process to replace them (Borg and Scott-Young 2022). Thus, a knowledge transfer gap is created due to insufficient planning and mentorship programs, leaving new entrants without proper guidance (Suryadi 2018).

Even though turnover was associated with retirement in the design thinking workshop, turnover can be seen due to external factors impacting the industry (Girma 2019). For example, COVID-19 increases unemployment in most sectors, but construction was one of the most impacted sectors. Additionally, job instability, seasonal work, demanding physical labor, and safety risks increase the turnover rate, which leads to losing professional expertise and trained staff in the construction industry (Borg and Scott-Young 2022; Girma 2019). The turnover happens and impacts all levels; at the managerial level, it affects the continuity of leadership, decision-making processes, and adherence to the best practices, while at the operational level, it affects the work quality (Ilmi et al. 2019).

Construction knowledge is a broad and interdisciplinary topic due to the involvement of different stakeholders (Yap et al. 2022). However, a clear distinction should be made between technology and construction knowledge, as technology knowledge refers to the ability to use technology to perform or facilitate tasks in different project lifecycle phases (Monson and Dossick 2014). In contrast, construction knowledge refers to understanding real-world methods, materials, systems, and workflows. Lack of experience in construction or technology knowledge impacts the project quality timeline, budget, and overall success (Joseph Garcia and Mollaoglu 2020). Ipsen et al. (2021) studied the barriers hindering the implementation of eco-design in the construction industry, the study's findings showed that lack of knowledge among building designers is one of the barriers that hinder implementing eco-design. Similarly, Ahmed (2018) conducted an exploratory study to identify crucial barriers to implementing BIM. Among 37 identified barriers, lack of BIM experts and knowledge were identified as the main barriers to implementing BIM. Thus, a lack of knowledge hinders the development of the industry and exposes projects to time, quality, scope, and other risks l (Agyekum-Mensah and Knight 2017; Yap et al. 2022).

Trust, silos, processes, and early engagement can be seen as related root causes. Trust among project stakeholders stems from working collaboratively during the early stages of the project phases, avoiding isolation, and aligning goals and objectives to avoid disputes (Akintan and Morledge 2013a; Dossick et al. 2009). In contrast, Silos lead to focusing solely on specific responsibilities without considering how their work impacts or is impacted by others, which limits the understanding across disciplines, creates poor communication, and over-reliance on technology without practical context (Dossick et al. 2009; Horvath 2001). Khalfan et al. (2007) studied the trust among the supply chain participants working on construction projects and found that trust, reliance, and honest professional relationships stem from clear communication between project stakeholders. Similarly, Akintan and Morledge (2013) investigate the importance of collaboration between main contractors and subcontractors. The study found that collaboration is a source of innovation and knowledge transfer among project stakeholders.

4.4 Desired Future State

The team determined a future state for project design, as seen in Figure 2, that would lessen the impacts (symptoms) by addressing the root causes. The lack of construction knowledge during the design phase is the main challenge facing projects.

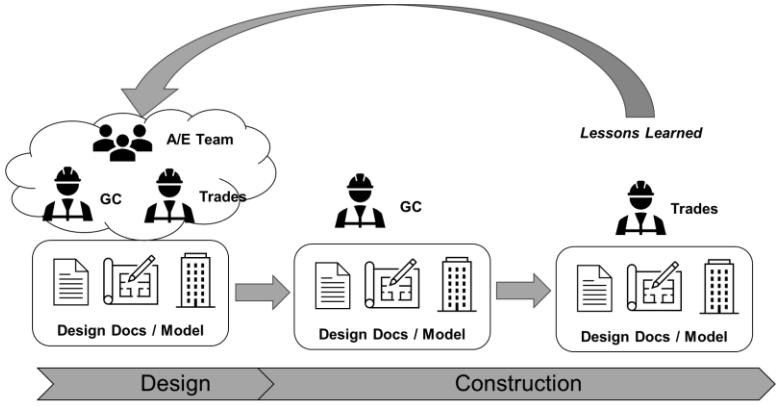

Figure 2: Desired Future State of Project Design

The desired future state is marked by early engagement and collaboration of the A/E team, GC, and trade contractors to add construction-related knowledge to the design documents and models. The desired outcome is more constructible design documents and models that would reflect the construction team's experience, which would potentially alleviate some of the project challenges that typically happen during the construction phase by allowing the construction and design team to have an open dialogue to discuss potential issues before construction has begun. One past study that focused on pipe and steel fabricators found that early involvement improved the quality of design drawings, information flow, and project schedule (Song et al. 2009). Similarly, other studies have found that early contractor involvement can improve constructability, innovation, and collaboration (Ishtiaque et al. 2024b; a). Generally, this knowledge sharing has been linked to numerous benefits, such as reducing project costs and schedule durations (Memić et al. 2024; Sik-wah Fong and Chu 2006).

Past research has identified numerous enablers and strategies related to early contractor involvement and knowledge sharing. For example, more collaborative delivery methods, such as design/build or integrated project delivery, allow project stakeholders to be brought on earlier in the project process and potentially incentivize collaboration among stakeholders (Akintan and Morledge 2013a; Horvath 2001). Similarly, past research has identified technological enablers for capturing knowledge, such as BIM or other common data environments, that promote access of information across stakeholders and provide a common repository for project teams (Ahmed 2018; Akintola et al. 2017; Bryde et al. 2013). Overall, the team has identified a desired future state of project design that is centered on collaboration with the goal of developing constructible designs to improve project delivery and performance.

5. CONCLUSIONS

This paper summarized a design thinking workshop focused on the impact of inexperience in construction projects. It identified the current state of project design and its downstream impacts on construction, including cost overrun and schedule delays, among others. It presented a desired future state of AEC projects, which relies upon early contractor involvement in design to provide construction knowledge with the goal of improving design deliverables and overall project delivery and performance. There are numerous limitations of this study, mainly that it involved one design thinking workshop with one group of participants. Future studies can engage a representative sample of the AEC industry and collect a larger volume of data to identify the various "states of the industry," providing a more complete view of the challenges and opportunities that face the industry today. Similarly, the scenario presented in this study focused solely on project design. Future research can focus on other project processes to identify symptoms, root causes, and strategies to address these impacts. This study can be used as a starting point for future research and development, including developing intra-organizational and inter-organizational knowledge capture and transfer strategies, developing project delivery methods that incentivize collaboration and knowledge

sharing among project stakeholders, and developing technology-based tools that enable knowledge sharing across organizations. In parallel, there is a need to create robust professional development programs focused on training and mentoring to enable knowledge sharing from experienced construction professionals to those who are new entrants to the industry.

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