

# *Study of Challenges in Implementing Digital Transformation in Construction Projects*

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**Abstract—** The main objective of this paper is to identify the challenges in implementing digital transformation in construction projects. Digital transformation is vital for construction projects due to its many benefits including increased productivity and an improved collaborative environment. A literature review was conducted to study the existing publications on digital transformation to identify the possible challenges and barriers that affect the construction industry transformation. Papers published from 2019 to 2021 were studied for this literature review with the objective of finding the latest knowledge on this topic. This paper identifies challenges and barriers in the construction sector as well as solutions to overcome the possible challenges. Digital transformation phases, processes and resources are discussed in this paper. This study also identified gaps and future research areas to obtain more accurate data regarding the challenges in digital transformation in construction projects.

**Keywords—** construction projects; digital transformation; digitalization; challenges; construction

## I. INTRODUCTION

The construction industry plays a vital role in the economic growth of any country around the world. As a result, it owns a major portion of the economy. However, until recent, construction projects did not utilize digital technology to the fullest other than some of the software for project management. Not every country around the world utilizes technological advancement to improve construction project performance due to different reasons and challenges. However, digitalization in the construction sector brings benefits including increased productivity, improved collaboration and efficiency. During the past few years, the construction industry experienced digital transformation and the Covid-19 pandemic accelerated it.

Digital transformation allows the construction companies to choose the right technology for their projects and highlight the areas to focus more on that brings improved productivity and efficiency. Among the technologies, building information modeling (BIM), 3D printing, laser scanning, virtual reality (AR/VR), digital twins and the internet of things (IoT) play a vital role in the digitalization of the construction sector (Olanipekun & Sutrisna, 2021). Technology can help construction sector companies to achieve their project targets by process organization, system integration, improved cost-cutting techniques and more. However, there are many factors to consider in achieving a totally transformed state. None of the companies in the construction sector achieves the total transformation without a well-planned strategy (Buisman, 2018).

The companies and countries that successfully adopt digital transformation achieve benefits while there are some challenges for most of the companies. In this digital transformation, construction companies need to adopt the right process. That will help to achieve a smooth transformation from labour-intensive project management to a more collaborative and technology-oriented process. However, the present digital transformation trends change the business operating environment. These changes can be opportunities for the company on doing things more efficiently and effectively for an affordable cost (Parviainen et al., 2017). Further, digitalization does not mean converting the current business processes into new digital processes. Instead of that, digital

transformation requires rethinking current business operations in a new way where digital technology is enabled (Parviainen et al., 2017).

This paper discusses the challenges in implementing digital transformation in construction projects. By identifying the challenges that the construction sector faces will help in identifying the most appropriate solutions to overcome the challenges and to make the digital transformation successful. As a result, a successful digital transformation will gain the benefits of the latest technology to the project implementation of the construction industry.

### II. PURPOSE

The purpose of this study was to explore possible challenges in digital transformation in the construction sector which were not identified in previous studies. By identifying the hidden challenges that are specific to the construction industry, the author expects this research will be a guideline to the construction companies to accelerate their digital transformation by focusing on these issues with possible alternatives and solutions.

### III. PROBLEM AND HYPOTHESIS

The main problem that this study focuses on is the challenges in implementing digital transformation in construction projects. This study doesn't focus on any specific country. Instead of that, it is assumed that the digital transformation process is mostly the same regardless of the geographic location.

### IV. THEORETICAL BACKGROUND

#### A. Digital Transformation

Digital transformation undergoes three different phases that are digitization, digitalization and digital transformation. Digital competition, digital technology and digital customer behavior are the external drivers of digital transformation (Verhoef et al., 2019). According to a recent study done by Verhoef et al (2019), digital resources, organizational structure, growth strategy, metrics and goals are the strategic imperatives resulting from digital transformation.

#### B. Digitization

Encoding analogue information into a new digital format is called digitization where computers can store and transmit the information (Verhoef et al., 2019). Digitization aims at integrating products, services and data to reformulate the value proposition of a company (Sebastian et al., 2017).

#### C. Digitalization

Digitalization enables rearranging the existing business processes using IT or digital technologies (Verhoef et al., 2019). For example, instead of inspecting a building itself, one might choose a digital model of it for the inspection utilizing the technologies (Greenwood et al., 2019).

#### D. Digital Transformation

Digital transformation utilizes digitized data and digitalized applications to transform business processes to create new business models and this creates a companywide change (Verhoef et al., 2019). The goal of digital transformation is to create a new business model which is more efficient, productive and profitable.

Below figure 1 (Gamage, 2021) shows the three phases of digital transformation

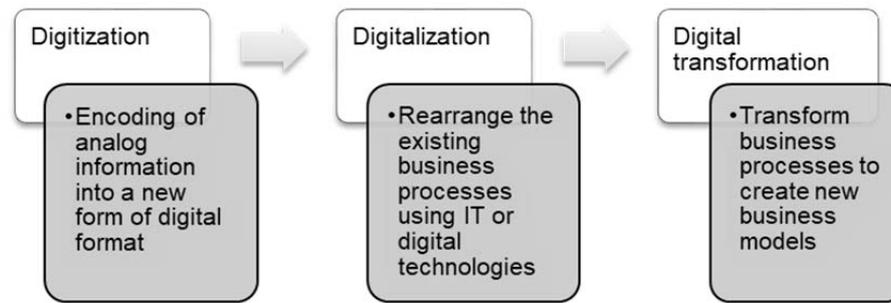


Figure 1: Phases of Digital Transformation

#### E. Digital Transformation in the Construction Sector

Construction projects involve complex processes that require better project management solutions to deliver them on time within the estimated budget by utilizing the available resources fulfilling the stipulated quality requirements. However, the construction sector was slow in adopting new technologies and, it is one of the industries among the least digitalized. Due to the lack of innovation practiced in construction projects, productivity is low that affects the outcome of successful project completion. Recent studies have shown the importance of digitalization in the construction sector and especially in construction project management practices to improve productivity (Prebanić & Vukomanović, 2021).

Therefore, productivity is one of the focus areas that construction firms look for improving due to the project delivery challenges. Poor resource utilization and unsafe working environments are some other challenges in this sector. By digitalization, business organizations aim to gain benefits such as improved productivity in the construction sector together with other benefits. According to Parusheva (2019), the benefits of digital transformation in construction include improved designs, time-saving by speeding up the construction activities, proper documentation and improved quality and safety.

According to research done by the McKinsey Global Institute, digital transformation in the construction industry can result in 14 to 15 per cent productivity gains and 4 to 6 percent cost reductions (Koeleman et al., 2019). They suggest construction companies focus on fixing the current pain points instead of just installing some IT solutions. Another suggestion in the same report highlights the importance of reskilling and restructuring the engineering teams for better digital transformation. Due to the fragmentation along the project lifecycle, it requires coordinating among the organization to manage the change during digital solutions implementation of a construction project. However, that can be hard considering the short period given for the completion of a project (Koeleman et al., 2019).

#### F. Digital Transformation and Changing Processes Requirement

When the construction industry undergoes a rapid digital transformation, then that includes a change to existing business models and processes. The overall transformation affects the construction processes and the way employees work throughout the value chain. Digital transformation in any industry includes impact on business issues rather than technical issues. Therefore, the transformation shouldn't be a tactic, but it should be strategic (Jose, 2018).

According to Jose (2018), well designed technological transformations failed during the execution stage. However, there are companies that planned for changing the culture before executing the digital transformation. Companies, that have foreseen the changing culture as a challenge applied a systematic change management methodology to execute digital transformation successfully (Jose, 2018). Therefore Jose (2018) proposes to implement emotional intelligence-based change management for successful digital transformation.

Due to the combination of disruptive technologies, digital transformation makes it hard to change the existing structure. It will need time and more effort to change the organization's structure which is challenging due to resistance to change by the employees (Abdallah et al., 2019). Considering the nature of the construction industry and its processes, the author focused on identifying the digital transformation process before conducting the research and literature review.

G.Digital Transformation Process

According to Omer (2021), digital transformation means the use of digital tools to organize better, create value and sell better. However, digital transformation doesn't mean that it is all about technology. It includes the transformation of people. During the digital transformation, a company faces three kinds of problems that are aligned with technology, money and people. Therefore, a company needs to focus on aligning these three factors to the same goal during the digital transformation process (Omer, 2021). Figure 2 (Gamage, 2021) which is adapted from the book *The Digital Transformation Handbook* (Omer, 2021) shows a company's trilemma of digital transformation.

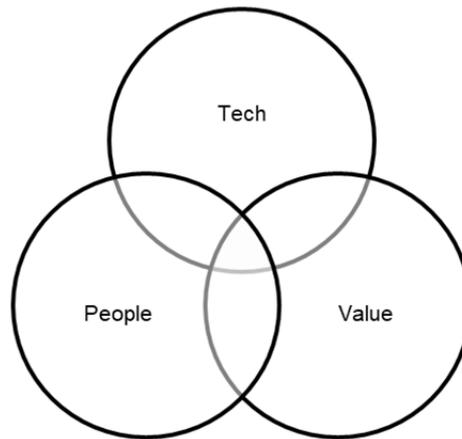


Figure 2: The Company's Trilemma of Digital Transformation

Note. Figure is adapted from *The Digital Transformation Handbook* (1st ed.). (p. 11), by A. Omer, 2021, Bookboon. Copyright 2021 Omer Atiker & Bookboon.com.

At the same time, employees faces their trilemma during the digital transformation to find the answers of why, what and how. When the people have a clear idea on why, what and how then that moves towards a successful change (Omer, 2021). Figure 3 (Gamage, 2021) shows the employee's trilemma of digital transformation and it is adapted from the book *The Digital Transformation Handbook* (Omer, 2021).

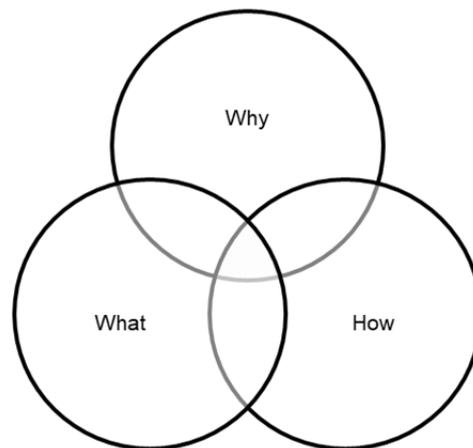


Figure 3: The Employee's Trilemma of Digital Transformation

Note. Figure is adapted from *The Digital Transformation Handbook* (1st ed.). (p. 11), by A. Omer, 2021, Bookboon. Copyright 2021 Omer Atiker & Bookboon.com.

Considering the digital transformation phase that should start from the planning stage followed by the implementation of digital technologies, the below figure 4 (Gamage, 2021) is derived from figure 1(Gamage, 2021). The author found the similarity

of project management lifecycle with the digital transformation process considering the digital transformation phase as a project itself. To show this connection, figure 4 (Gamage, 2021) is derived.

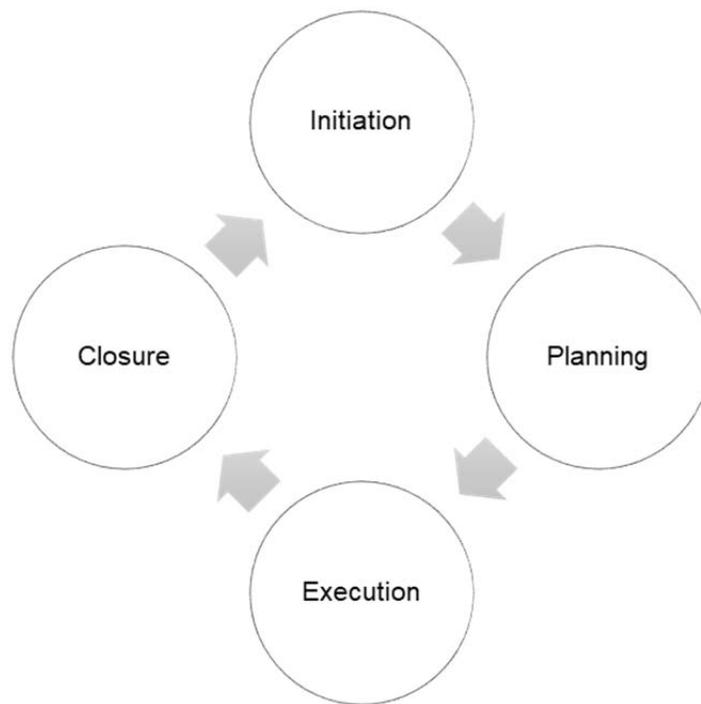


Figure 4: Digital Transformation Process Cycle

However, processes are guides that help initiate, planning and execute any project. By identifying the objectives at the initiation phase, it is easy to deliver the project within planned time, cost and quality (Newton, 2016). This concept applies to digital transformation as well where the organization needs to start from initiating its transformation and planning on how to implement it.

Veldhoven & Vanthienen (2019) identified key components of digital transformation through a recent study. These key components include the use of digital technologies, new business models, internal operations, customer experience, change process, organizational transformation, digital innovation, digital economy, organizational transformation, value creation, and products and services (Veldhoven & Vanthienen, 2019). To reconcile the digital transformation characteristics, Veldhoven & Vanthienen (2019) summarize the identified key components into three key transformations by constructing a digital transformation framework. The digital transformation framework includes business transformation, digital technologies transformation and society transformation (Veldhoven & Vanthienen, 2019). Figure 5 (Veldhoven & Vanthienen, 2019) shows the digital transformation framework introduced by Veldhoven & Vanthienen in 2019.

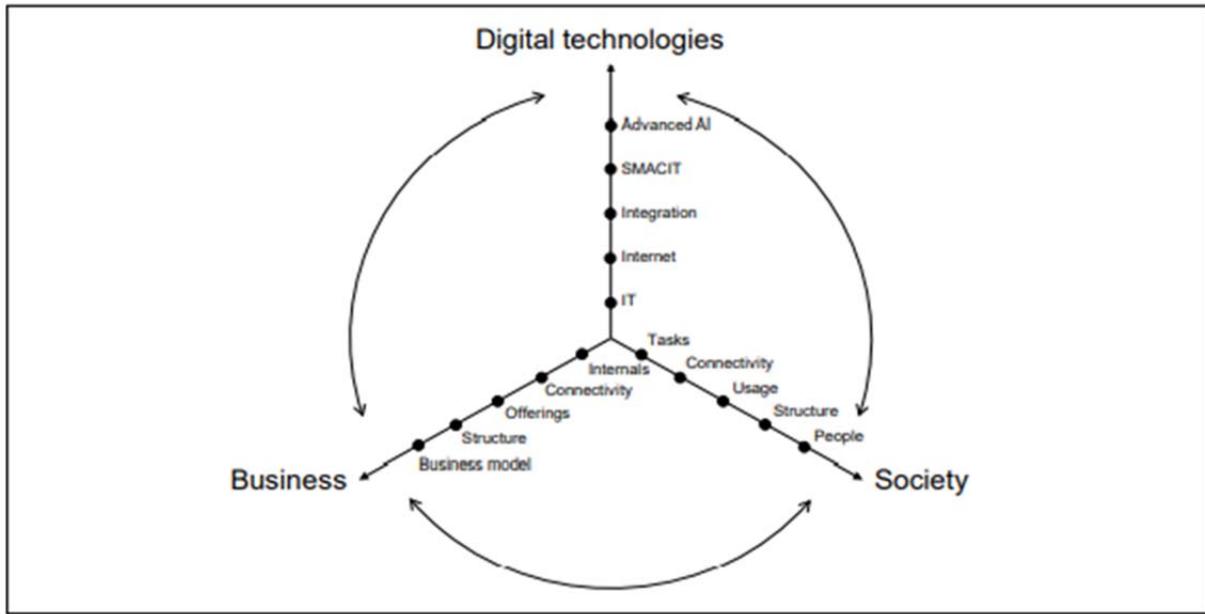


Figure 5: Digital Transformation Framework

**Note:** Digital transformation framework by Veldhoven, Z.V., vanthienen, J.(2019). Designing a Comprehensive Understanding of Digital Transformation and its Impact. 32nd Bled Econference.

**V. DIGITAL TRANSFORMATION TALENT REQUIREMENT**

Digital transformation requires talent in four different domains which are technology, data, process and organizational change capability. Therefore, an organization that focuses on having the right people who demonstrate skills in these four domains in their digital transformation team may get benefits (Davenport & Redman, 2020). Below figure 6 illustrates the digital transformation talent requirements (Gamage, 2021).

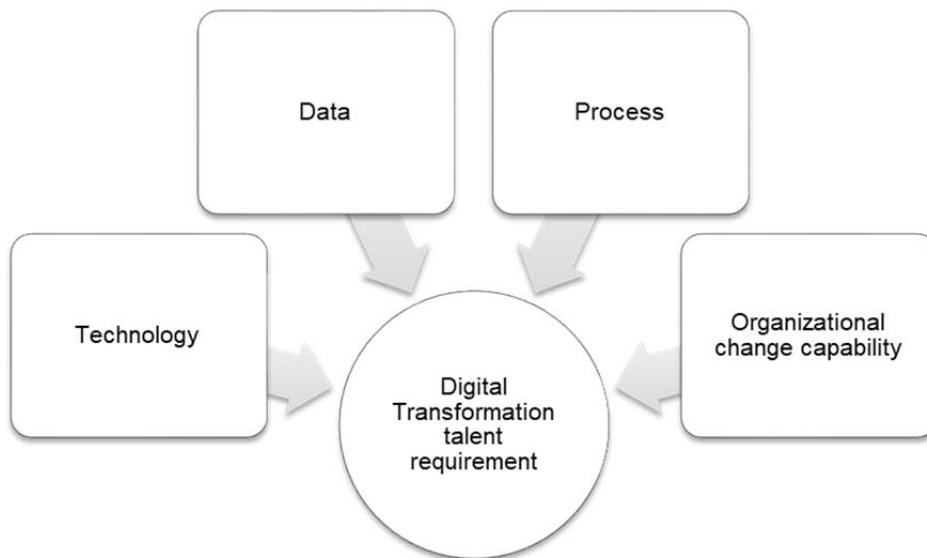


Figure 6: Digital Transformation Talent Requirement

### A. Change Management Process

As shown in figure 6 above, organizational change capability is one of the domains to focus on during the digital transformation. When an organization transits from a current state to another desired state, then an organizational change occurs. Therefore, effective management of this change is vital. Such organizational change management includes the planning and implementation of the change in a way that minimizes employee resistance and costs while maximizing the effectiveness of change management efforts (Schwertner,2017).

Nowadays, a mixed approach of bottom-up change management and top-bottom approach is widely used by organizations that need constant dialogue by both parties (Passenheim, 2014). According to Passenheim (2014), the change management process includes,

- Correct understanding of the change organization
- Correct understanding of the people in the change
- Effective realization of the change
- Understanding of the change dynamics

Therefore, organizational culture influences the change. The way people work, their attitudes and norms affect the change (Passenheim, 2014).

### B. Change Management Theories

Implementing and managing change in an organization is a difficult task. Therefore, implementing change management strategies is vital for a successful change in digital transformation. There are a number of change management theories and models available that describe handling a change. Lewin's Change theory, Adkar Change Model and Kotter's Model are some of the widely used change management theories by organizations (Nakigudde, 2019). However, this paper discusses only Lewin's Change theory as one of the suitable change management models for the construction industry digital transformation.

### C. Lewin's Change Theory

Kurt Lewin's change theory includes three steps that are unfreezing, change and refreezing (Nakigudde, 2019).

### D. Unfreeze

This stage includes the preparation of the people for the change. Things such as liaising with the upper management, conducting a survey and making aware of the people of the organization help people to get ready for the change (Nakigudde,2019).

### E. Change

This is the stage to implement the necessary change. Leadership is vital in this stage as initiating the change and transition can be difficult. Challenge, command, educate and restructuring are some of the strategies to implement during this stage to support the change and the transition (Passenheim, 2014).

### F. Refreeze

At the end of the change process, the next step is to refreeze. The goal of refreezing stage is to establish the change. At this stage, people are in a "change shock" state. Therefore, people will work at a low level of efficiency and effectiveness as they expect a subsequent change (Passenheim, 2014). An organization should consider frequent training for their employees at this stage (Nakigudde, 2019). Below figure 7 (Gamage, 2021) shows the three steps of Lewin's change theory.

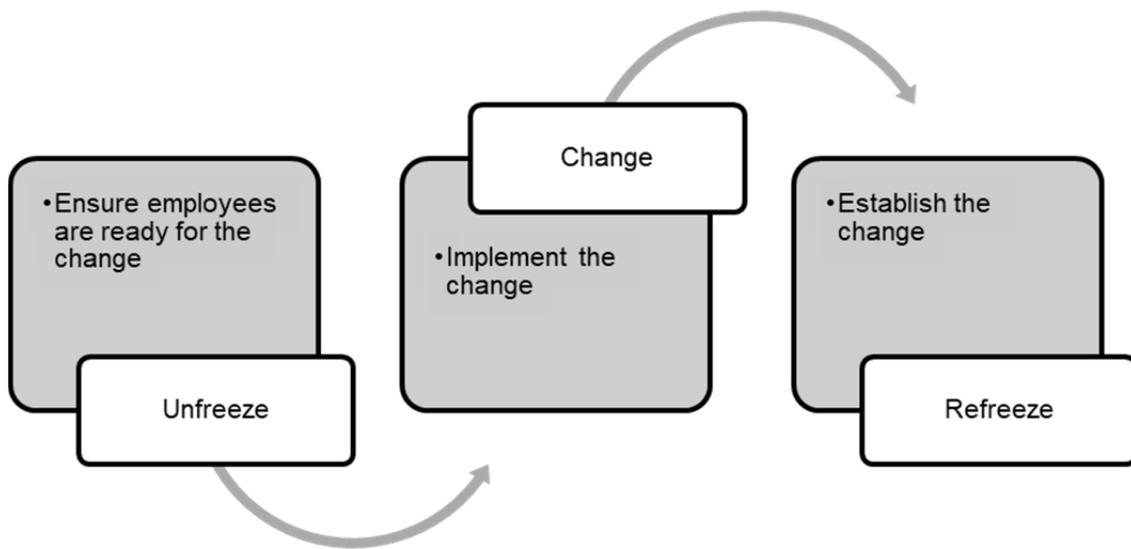


Figure 7: Lewin's Change Theory

While successful digital transformation in the construction sector requires strategically planned change management, there are pitfalls that exist. According to (Passenheim, 2014), typical pitfalls during the change management process include lack of problem awareness, lack of communication, lack of analysis in operative and strategic challenges, unprofessional use of the change management process methods and lack of control. Therefore, even in the construction industry, these pitfalls can occur during the digital transformation process. It is the responsibility of the managers who handle change management to avoid these pitfalls.

#### G. Resources to Support the Digital Transformation

Relevant technological resources are vital for digital transformation in the construction sector. A study conducted by Mahraz et al (2019) suggests big data, cloud computing, the Internet of things, and blockchain as trends that support the digital transformation in any industry as technological tools. Other new technologies include Artificial Intelligence and Augmented & Virtual reality that supports digital transformation. For some of the office tasks, organizations can utilize Robot Process Automation and free up some of their workforces to focus on more specific tasks that add value (Telegescu, 2018).

Koscheyev et al (2019) suggest the use of digital tools such as Materials procurement digital platforms, Industrial robots and drones, Digital marketing and sales channels, Service digital tools and Infrastructure of BIM- technologies during the digital transformation process. Further, organizations can obtain full advantage of digital transformation when they combine a variety of digital tools (Koscheyev et al, 2019). Schwertner (2017) suggests cloud computing, the Internet of things (IoT), mobile technology, big data and data analysis as technical aspects of digital transformation.

Further, Prebanić & Vukomanović (2021) highlight the importance of digital transformation to enable digitalized construction stakeholder management. For this transformation, they suggest the use of different ICT concepts to Digitalize Communication and Management of Stakeholders. This study further highlights the Utilization of BIM Collaboration to enhance the Engagement and Integration of Internal Project Stakeholders while using Virtual and Augmented Reality (VR/AR) to Enhance Design Phase Collaboration. By utilizing VR/AR, the End-Users will involve in Early Project Phases (Prebanić & Vukomanović, 2021).

Considering the available tools and resources to support the digital transformation, it is important to choose the most suitable tools and technologies to implement the digital transformation for construction projects.

## VI. LITERATURE REVIEW

### A. Methodology

The research methodology used for this study is a literature review process that includes an analysis of several previous studies. Typically, a literature review is based on existing published work on research that has been conducted on a particular topic. A literature review on existing research publications also provides a better discussion on existing literature, any inconsistencies and controversies that also help for identifying future research needs (Graulich et al., 2021). Below figure 8 (Gamage, 2021) shows the steps followed to collect and evaluate existing literature for writing this paper.

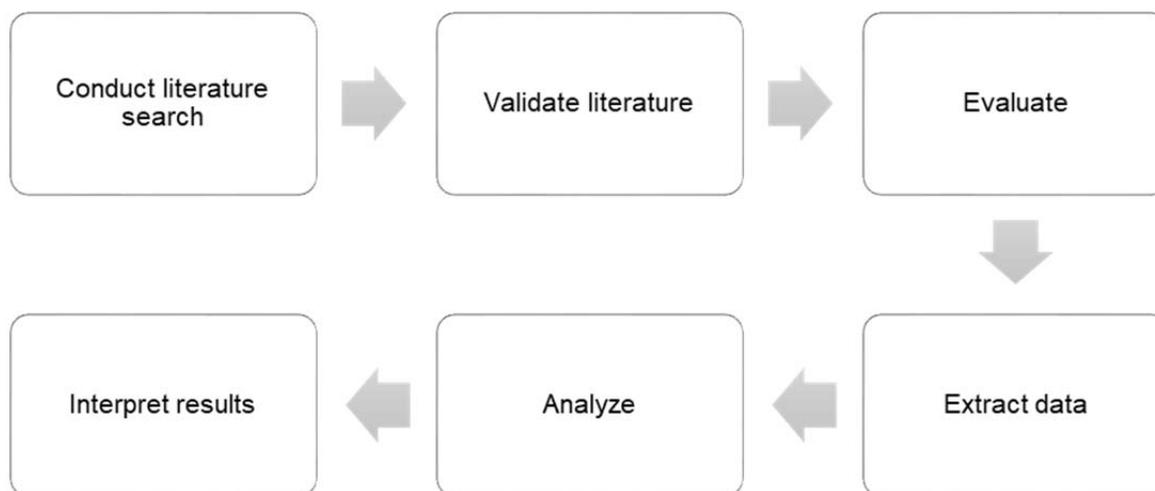


Figure 8: Literature Review Steps

For this seminar paper, the referred literature was on the topics related to digital transformation in the construction industry. Some of the publications were on topics that focus on challenges in digital transformation in construction. However, in collecting data, the author also focused on reading publications on topics related to digital transformation in the construction industry although some of the researches were not specifically focused on challenges. Other than that, the author included several publications on topics that discuss the challenges in digital transformation in general due to the fact that these challenges can affect the construction industry transformation as well.

Google Scholar was the main search engine used for collecting existing literature. To find search results through Google Scholar, the used keywords were “digital transformation”, “digital transformation in construction”, “challenges in digital transformation” and “challenges in digital transformation in construction” or a mix of these keywords.

Below is the selection criteria utilized for this study to choose the most relevant existing literature. Paper should have published in the period of 2019-2021 to include the latest research data for this paper

- Paper needs to be in English
- Paper needs to discuss a topic related to challenges in digital transformation
- Paper needs to be published in a scientific journal
- Paper needs to be available with free access

During the literature validation step, the author excluded the publications that were not within the literature selection criteria. There were some publications that discussed challenges in digital transformation in general. The author included such papers for

this review due to the lack of recent papers that discusses challenges in digital transformation specifically in the construction sector.

The initial search for keywords returned 51,600 papers as Google Scholar search results. However, further checking indicated that most publications don't relate to digital transformation in the construction industry. A further search with specific keywords resulted in a total of 44 papers related to digital transformation that was published from 2019 to 2021. Manual reading of each publication resulted in relevant 11 publications that specifically discuss the challenges of digital transformation in the construction industry which is the research objective of this paper.

### B. Results and Findings

Below are the findings from the analyzed literature. Although some of the publications discussed digital transformation in general, the author could identify challenges that are also relevant to the construction sector.

A study conducted in 2019 shows that most construction companies utilize digital technologies fragmentarily and therefore they fail in utilizing the full benefits. The authors of that study further indicate that even some companies that employed extensive and innovative tools failed in integrating the new technological tools with everyday tasks of the company. As a result, these companies could not achieve improvements in organizational key financial and economic aspects (Koscheyev et al, 2019).

Another study that focused on identifying the challenges and enablers of BIM-enabled digital transformation in mega projects revealed that lack of experienced BIM professionals, lack of awareness of digital transformation tools, the complexity of the project and unsupportive organizational culture are the main challenges. This study which was based on the Istanbul new airport project experienced such digital transformation challenges at technical levels and also at executive levels. Other than the above-mentioned challenges, the team also encountered conflicts between project personal due to the strict requirements of BIM deliverables. Therefore, the project management team had to manage these issues as well during the BIM-enabled digital transformation (Koseoglu et al, 2019).

Based on their studies on digital transformation in SMEs, Pelletier & Cloutier (2019), mention that one of the challenges of digital transformation includes the struggle to assess IT needs for SMEs. Due to different IT value creation and digital strategies, SMEs achieve mixed results in their digital transformation efforts.

Lack of training and lack of digital culture are other major challenges in digitalization in the construction sector and this is especially common among SMEs. SMEs with limited resources in investing in new technologies require adequate government support to overcome the challenges in their digital transformation (Hossain & Nadeem, 2019).

Further, Vial (2019) mentions that inertia where the available capabilities and resources can be a barrier for disruption is one of the major challenges in digital transformation. His studies are not only focused on the construction industry but, all industries in general. He mentions the impact of organizational culture, legitimacy and identity on creating strong barriers that result in obstructing the smart services development (Vial, 2019). Other than inertia, the resistance of employees plays a significant role as a barrier to digital transformation. He further mentions that resistance from the employees can be due to the lack of understanding of the potential advantages of digital technologies (Vial, 2019).

Technical challenges that are specific to the construction industry make another barrier to digital transformation which creates a lag in the construction industry digitalization (Parusheva, 2019). Although construction companies understand the emerging technologies in the industry such as Building Information Modeling (BIM), robots and wireless sensing, they do not have a full understanding of choosing the right resources for their digitalization efforts. This also includes lack of management for their digital transformation teams (Parusheva, 2019).

Atanasova (2019) further indicates technical challenges that affect negatively the construction sector digital transformation. This study further highlights the importance of having internet access for SME construction companies to make it easy to access digital technologies. This Bulgaria focused research also indicates the importance of human resources in successful digital transformation in the construction industry (Atanasova, 2019).

Other than the challenges some studies highlight possible issues due to digital transformation. IT security issues such as data misuse and information leakage are some of the issues that arise during the digitalization process in the construction sector (Alaloul et al, 2019). Another study shows the potential challenges due to different understanding levels when utilizing cloud-

based tools. These issues include time-consuming meetings and misinterpretation of information exchanged digitally (Kifokeris et al, 2020).

Further, a study done by McKinsey & Company indicates some of the characteristics of the construction sector as challenges for digital transformation. Fragmentation is one of the challenges in the industry where there are different layers of contractors and subcontractors involved in a construction project (Koeleman et al, 2019). According to the studies done by Verhoef et al (2019), the organisational structure of digital transformation plays a major role other than the digital assets. Decentralization of organizations with different business units and divisions is another challenge that creates a barrier in digital transformation (Koeleman et al, 2019).

According to a study done in Cambodia, the digital divide is one of the major challenges for digital transformation. The same study shows how the availability of digital skills create specific gaps that affect successful digital transformation (Banga et al, 2020). Olanipekun & Sutrisna (2021) identifies major three barriers in digital transformation in their study. Those are data access and ownership, low standardization and lack of system integration (Olanipekun & Sutrisna, 2021).

Due to large amounts of data-generating over a short period, another issue arises during the digital transformation which is Data security issues (Hao & Zhang, 2021). Due to data security issues, many other potential issues arise including risks related to corporate internal confidentiality, legitimacy issues and risks due to leakage of public personal information. Other than these risks arising due to handling data, the shortage of experienced employees and digital talents are barriers to digital transformation (Hao & Zhang, 2021).

However, SMEs achieve lower results over their digital investments than initially planned. This can also lead to demotivation due to budget constraints among small scale companies (Koscheyev et al, 2019). Further, construction sector employees misinterpret digital tools as additional complications for the work process which creates another barrier (Koscheyev et al, 2019).

Although there are different challenges and barriers that exist in the digital transformation process, some of the studies suggest possible solutions to overcome these challenges. Vishnivetskaya & Ablyazov (2019) highlights the importance of government support in enhancing the digital transformation including the improvements in regulations. A study published by McKinsey & Company suggests reskilling and restructuring the engineering teams for successful digital transformation. They suggest organizations focus on the pain points and fix those instead of focusing on simply the installation of IT solutions (Koeleman et al, 2019).

During the digital transformation process, it is important to create suitably skilled change teams to lead this process and to introduce adaptability. It is also important to consider the new business models and the changes to different job roles due to digitalization (Larsson & Wallin, 2020). Another study mentions two enablers of digital transformation in the construction industry. Those are digital culture and new organization forms which connects to organizational internal processes and objectives (Olanipekun & Sutrisna, 2021).

According to the literature reviewed, below are the identified major challenges in the construction sector digital transformation.

- Lack of experienced professionals and lack of training creates a major barrier in digital transformation. This also includes lack of awareness of digital transformation tools to utilize.
- Unsupportive organizational culture together with resistance of employees is another challenge that exists in construction sector.
- Technical challenges including struggle to assess IT needs, lack of full understanding on choosing the right resources for their digitalization efforts create a barrier.
- Lack of management of digital transformation teams
- IT security issues such as data misuse and information leakage including impacts on corporate internal confidentiality, legitimacy issues and risks due to leakage of public personal information creates another barrier to digital transformation.

- Lower results compared to the digital investments lead to demotivation due to budget constraints and it creates a barrier to digital transformation.
- Digital divide is a major challenge for some companies in different countries.
- Another challenge arises due to limited resources in investing in new technologies.

The identified challenges were then categorized as internal challenges and external challenges as shown in table 1 (Gamage, 2021). When analyzing these barriers to digital transformation; it is obvious that most of the challenges are internal factors. Therefore, if an organization strategically identifies the best solutions to overcome the internal challenges, then it can successfully implement the digital transformation.

Table 1: Internal and External Challenges of Digital Transformation

Internal challenges	External challenges
Lack of experienced professionals	IT security issues
Lack of training	Lower returns for higher digital investments
Unsupportive organizational culture	Digital divide
Technical challenges	
Lack of management of digital transformation teams	
Limited resources	

## VII. CONCLUSION

By analyzing the existing literature, this study identified possible challenges and barriers to the construction industry digital transformation. According to the available literature, lack of knowledge, lack of training and lack of resources create a barrier in digital transformation. Other than that, organizational structure and organizational culture have an impact on successful digital transformation. By focusing on these identified challenges, a construction company may be able to digitally transfer its project processes to achieve more benefits including increased productivity and collaboration. However, there are some gaps identified in this research.

The purpose of this study was to identify the potential challenges in digital transformation in the construction sector. One of the major challenges for this study was the lack of recent research done with a focus on digital transformation in the construction sector. Although there were some studies done focusing on the construction industry digital transformation, only a few studies discuss the possible challenges and barriers. Therefore, future studies based on primary data on challenges that are specific to the construction industry digital transformation will provide much-needed knowledge to strategically digitalize the construction sector and to achieve its benefits. Further, such a study will help to verify these identified challenges using primary data.

Although some studies mention challenges due to organizational culture and behaviour, there were no specific studies that suggest the importance of successful change management during digital transformation. Therefore, further studies on the change management process during the construction project digital transformation is needed. Further, most of the literature used for this study was not focused on specific geographical locations. As such, future studies are needed to find out geographically based challenges.

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