EXAMINE DIGITAL MATURITY IN CONSTRUCTION SUPPLY CHAIN

GORDON TAY ZHI WEI

UNIVERSITI TUNKU ABDUL RAHMAN

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GORDON TAY ZHI WEI

A project report submitted in partial fulfilment of the requirements for the award of Bachelor of Science (Honours) Quantity Surveying

Lee Kong Chian Faculty of Engineering and Science Universiti Tunku Abdul Rahman

September 2023

DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.
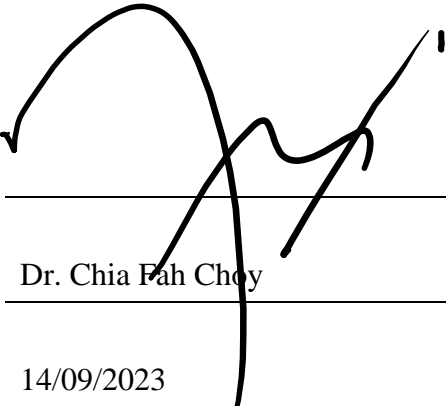
Signature :

Name : Gordon Tay Zhi Wei

ID No. : 1906660

Date : 14/09/2023

APPROVAL FOR SUBMISSION

I certify that this project report entitled **"EXAMINE DIGITAL MATURITY IN CONSTRUCTION SUPPLY CHAIN"** was prepared by **GORDON TAY ZH WEI** has met the required standard for submission in partial fulfilment of the requirements for the award of Bachelor of Science (Honours) Quantity Surveying at Universiti Tunku Abdul Rahman.

Approved by,

Signature   :

Supervisor   :   Dr. Chia Fah Choy

Date   :   14/09/2023

Signature   :

Co-Supervisor   :

Date   :

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ABSTRACT

The construction supply chain is a network of organizations that work together to procure and deliver a built asset. The application of digital technologies to this supply chain is advancing rapidly, and maturity models can be used to assess an organization's level of capability in this regard. This research examines the digital maturity level of the construction supply chain in Malaysia. Seven digitalization dimensions synthesize from the reviewed literature are: digital strategy, digital organization, digital training, digital metrics, digital technology, digital culture, and utilization of BIM. A questionnaire consists of 21 closed ended questions covering these dimensions and another three open ended questions was used to collect the primary data from 163 respondents. The results analyzed with correlation, independent samples, and related samples tests concluded that the construction supply chain maturity in Malaysia is significantly higher than average (3.4 on a 5.0 scale). Digital technology leads the four pillars of digital maturity, the other three pillars are digital strategy, digital organization, and digital training. The research also found that experience and company size are two significant demographic attributes affecting the digital maturity of the company. The relationship between company size and digital maturity is not linear. However more experienced respondents were more likely to be digitally mature in most of the case. The findings of this research can help industry leaders understand the factors that contribute to digital maturity, the governing bodies to develop policies and regulations that support digital transformation and researchers and academics to develop new theories and models of digital maturity.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1   Background

Construction industry is an important sector that greatly contributes to the economic growth of a nation such as by improving infrastructure, creating jobs, and simulating innovation (Alaloul et al., 2021). The industry is interconnected with hierarchy of supply contracts to procure a built asset. Construction players have been focusing on improving the efficiency and productivity of the construction industry throughout the supply chain, from inception to completion, from the production of raw materials to the transportation of goods and services to constructing the building with manpower and machinery (Olawumi et al., 2018). Managing the supply chain involves understanding the breakdown and of products, services, organizations, logistics, people, activities, information, and resources. It also involves understanding the traceability of these elements as they transform raw materials into a finished product. The finished product must be fit for its purpose. The construction industry has the particular difficulty that every building as a prototype. This means that a team of consultants, contractors, and other suppliers who may never have worked together before and may never work together again. To add to the complexity, different procurement systems assign elements of the supply chain to different organizations.

In order to improve project efficiency and overcome the difficulties faced by the construction industry, digitalization of the construction supply chain has become a buzzword lately. The main focuses of digitalization of the construction supply chain are integrating the Internet of Things (IoT), Building Information Modeling (BIM), and automated parametric design and object libraries (Stimmel, 2015).

With the widespread use of the Internet, data and information can be shared online through a cloud database, and there is open communication for better productivity, as work can be done anytime, anywhere with any parties involved. Better planning, delivery, operation, and maintenance of assets can result from simulating their digital twins, and more data exchange can produce

considerable economic benefits and improve credibility across the construction supply chain (Olawumi et al., 2018). Digitalisation enables the industry to have faster innovation, more flexible utilising resources and higher economic scale compared to the traditional methods (Ranger, 2022).

1.2 Problem Statement

However, the digitalization of the construction industry has always been low, due to the unique nature of the construction industry (Liu et al., 2023).

It is difficult to standardize the level of digitalization in the construction industry, as the different scale between projects requires different levels of machines and technology, capital and resources, and the proficiency in using technology by the professional teams involved.

It is crucial for the industry to understand its level of digital maturity. This will help to evaluate the current situation, analyse the barriers to digitalization, and develop methods or solutions for better efficiency in future construction projects. Although industry and organizational leaders have been helped by digital maturity frameworks and indexes to understand the historical context and antecedents of the digital transformation, and to help them make decisions about when and how to intervene (Zulu et al., 2021), there is a lack of published research in studying the maturity level of digitalization in the construction supply chain. There is an urgent need to assess and benchmark the maturity of digitalization in the construction supply chain.

1.3 Research Aim

This research seeks to address the gap identified in the previous section by examining the digital maturity in the construction supply chain.

1.4 Research Objectives

To achieve the above-mentioned research aim, the following research objectives have been established:

i. To assess the current digital maturity level in construction supply chain.

ii. To evaluate the impact of demographic background on the digital maturity.

    iii.   To identify areas of improvement for the future of construction digitalisation.

1.5   Research Methodology

Seven digitalisation dimensions were synthesized to evaluate the digital maturity of a company through literature review. Subsequently, a questionnaire is developed to study the practices of the current digital maturity level of the construction company which covers the seven digitalisation dimensions. A total of 21 investigation questions were included in the questionnaire with three questions cover each dimension of the seven digitalisation dimensions. The data collected are analyzed descriptively and inferentially through Cronbach's alpha reliability test, Correlation test, and Kruskal-Wallis H test.

1.6   Research Scope

The proposed research scope covers targeted respondents consisting of professionals within the construction industry and mainly around Kuala Lumpur, the capital of Malaysia. There are no limitations or restrictions to the qualifications of respondents as long as there are currently in the construction workforce.

1.7   Report Structure

The layout of this research project report is divided into five chapters: Introduction, Literature Review, Research Methodology, Result and Discussion, and Conclusion and Recommendations

Chapter One: Introduction

This chapter generally describes the background and the problem statement of the research work which is the current digital maturity in construction supply chain and the available assessments. It also outlines the research aim, objectives, research methodology, research scope and the report structure.

Chapter Two: Literature Review

This chapter is focused on summarizing and reviewing the existing scholarly research on the digital maturity in construction supply chain. The existing digital

maturity assessments are reviewed, and the seven digitalisation dimensions are formulated.

Chapter Three: Research Methodology

The chapter basically explains the questionnaire design which includes the details of open ended and close ended questions, and the respondents' attributes intended to collect through the questionnaire survey. The sampling is collected through random sampling. Sample size is determined according to central limit theorem. The data are analysed through descriptive and inferential test such as Cronbach's Alpha Reliability test, Correlation Test, and Kruskal Wallis H test. The chapter concludes with consideration of the research ethics.

Chapter Four: Result and Discussion

The results from the survey are presented in tables and charts. The correlations of the 21 investigations and seven digitalisation dimensions are analysed. The attributes of the respondents are used to identify the significant incidences among the 21 investigation questions and seven digital dimensions.

Chapter Five: Conclusion and Recommendations

The conclusions of the research are justified with achievements of research aim and objectives. The implications of this research to the industry, regulatory institutions and academics or researchers are elucidated. Lastly, the last section of this report reflects limitations and provide recommendations for future research.

CHAPTER 2

LITERATURE REVIEW

2.1   Introduction

Digital maturity is the measure of an organization's ability to create value through digital. It is also a key predictor of success for companies launching a digital transformation (Boston, n.d.). The application of digital technologies to this supply chain is rapidly advancing, and maturity models can be used to assess an organization's level of capability in this area. The following Section 2.2 describes the definition of digital maturity as well as reviewing of existing digital maturity assessments. Section 2.3 examines the construction supply chain along with the stakeholders and processes throughout construction. Finally, section 2.4 summarised the literature reviewed and used an affinity diagram to synthesize the conceptual framework of digitalisation dimensions for this research to be used in questionnaire preparations. The following Table 2.1 listed the definitions of the terms adopted in this research.

Table 2.1: Specific Terms

Terms	Definition	Sources
Digitalisation	The most fundamental ongoing change in modern civilization, which affects many aspects of business and daily life and involves both a move from "analogue" to "digital" (for example, from cash to electronic payments) and the facilitation of new kinds of value creation (e.g. Accessibility, availability, and transparency)	Hagberg et al., 2016
Digital Maturity	The capability of an organisation to react rapidly to emerging and changing technological trends	Dieffenbacher S., 2022
Construction Industry	Infrastructure development, upkeep, and repair are within the commercial manufacturing and trade categories. It influences the nation's technological and technical development, frequently regulating the growth of the nation's infrastructure, which frequently promotes	Hussain et al., 2022

	the advancement of the sustainability assurance of the country.	
Supply Chain	A well-organized manufacturing process that involves turning raw resources into completed products and delivering them to consumers	Beamon B., 1998

2.2   Digital Maturity

Digital maturity refers to an organization's ability to effectively leverage digital technologies to achieve its goals and objectives. As Dave Rutkowski, CEO of Performance Improvement Partners states, "Digital maturity is the ability to quickly respond to or take advantage of opportunities in the market based on current tech stacks, staffing resources, and digital technology. It's an organization's ability to take on digital transformation not only from the standpoint of digital technology, but organization-wide, including people, culture, and processes, to achieve business outcomes." (Performance Improvement Brothers, 2022).

2.2.1   Why Digitalisation?

Digitalisation is key in the Fourth Industrial Revolution to improve efficiency and productivity. A study by McKinsey & Company found that digitalization could improve productivity by up to 20% in some industries (McKinsey & Company, 2016).

According to MIT Sloan Management Review, digitalisation could enable businesses to respond quickly to changes in the market or customer demands and thus, that business is more adaptive to change and competitive (MIT Sloan Management Review, 2015). Moreover, businesses would have better decision making and data analysis to identify new business opportunities.

2.2.2   Concerns of Digital Maturity

As businesses concern more on the expected returns, digital maturity may not necessarily be deemed useful but as a bonus to the upgrowing state of the business.

Digital maturity does not identify what or where to invest and is only useful when the business strategies are complete (Dieffenbacher, 2022). There is limited access to technology due to the hardware that most companies have

and the level of technologies in Malaysia (Gartner, 2020). There is also resistance to change and the fear of weak cybersecurity.

2.2.3 Digital Maturity Assessment

Digital Maturity is not a destination. It is a multidimensional construct that can be measured using various frameworks and models. The key digital maturity assessments found are summarised as follows:

1. According to Gartner, digital maturity is a five-stage process that starts with a "foundation" stage and progresses to a "transformation" stage, where the organization is fully digitalized and able to drive innovation and growth (Gartner, 2021).

2. Digital maturity requires a strategic approach with a clear vision of their digital goals and objectives and align their digital strategy with their business strategy. A study by MIT Sloan Management Review found that organizations that had a clear digital strategy have higher digital maturity (MIT Sloan Management Review, 2019).

3. Digital maturity involves a cultural shift. A study by Deloitte found that organizations that had a culture of innovation and experimentation had better success in implementing digitalisation into their company (Deloitte, 2018).

4. Digital maturity requires the right skills and talent. Organizations need to have a workforce that is skilled in digital technologies and able to adapt to new technologies as they emerge. A study by Capgemini investigated the relations between organizations that invested in digital skills and talent with their digital maturity status (Capgemini, 2020).

5. Digital maturity involves a focus on customer experience.to create new business models that are customer centric. A study by Forrester Research found that organizations should focus on customer experience to achieve digital maturity (Forrester Research, 2021).

6. BCG's Digital Acceleration Index (DAI) includes assessing the company profile, doing survey, pre-results and benchmarking with more than 10,000 records in database to benchmark new digital growth, go-to-market capabilities and future-ready technology functions.

2.3   Construction Supply Chain

Eccles (1981) defined construction as "the erection, maintenance, and repair of immobile structures, the demolition of existing structures, and land development". Vrijhoef and Koskela (2000) characterized the supply chain in construction as:

- assembling the thing from incoming materials at the construction site.
- by frequently reconfiguring project organisations apart from the design, temporarily produce one-off building projects.
- typical make-to-order supply chain, with every project creating a new product or prototype.

The construction supply chain refers to the network of organizations, individuals, and activities involved in the creation of a construction project from start to finish. The supply chain includes a variety of processes and stakeholders. The current construction supply chain results in large quantities of waste and problems caused by obsolete and myopic control (Vrijhoef and Koskela, 2000).

2.3.1   Stakeholders

The stakeholder in construction refers to the parties involved in any stage of construction from inception to completion, from the client proposing a building to suit the market demand of the end-users, design teams coming up with a feasible design, contractors and engineers building and constructing the building to the post completion and handover of the building.

As an illustration, the main construction company in charge of a construction project typically only completes a tiny portion of the "product" using its own workforce and manufacturing equipment. Around 75% or more of the value of the product is created with the assistance of suppliers and subcontractors (Dubois and Gadde, 2000).

Stakeholders are normally diversified into two group: direct and internal stakeholders, and indirect and external stakeholders. As a result, a proper stakeholder engagement is crucial no matter how small or big to ensure the success of the project by compiling a stakeholder engagement plan with the respective needs, requirements and risk (Wijntjes, 2023). Consequently, all stakeholders are aware of their responsibilities, motives, direction, risk and

return, and involvement in a construction project for it to run smoothly like a well-oiled engine.

Table 2.2: Stakeholders and Responsibilities

Processes	Stakeholders	Outcomes
Procurement	Project Owner, Contractor, Suppliers	Generate a workable plan for the project
Planning & Scheduling	Project Owner, Contractor, Project Manager	Work out the details and schedules
Manufacturing & Fabrication	Manufacturers, Fabricators, Suppliers	Produce raw materials and goods to site
Transportation & Logistic	Contractor, Transportation companies, Suppliers	Delivery of goods on time
Construction on site	Contractor, Subcontractors, Construction Workers	Construction of building
Quality Control & Inspection	Project Owner, Contractor, Inspectors	Ensure building is up to standard
Commissioning & Handover	Project Owner, Contractor, Commissioning Agents	Handover property to buyer after completion

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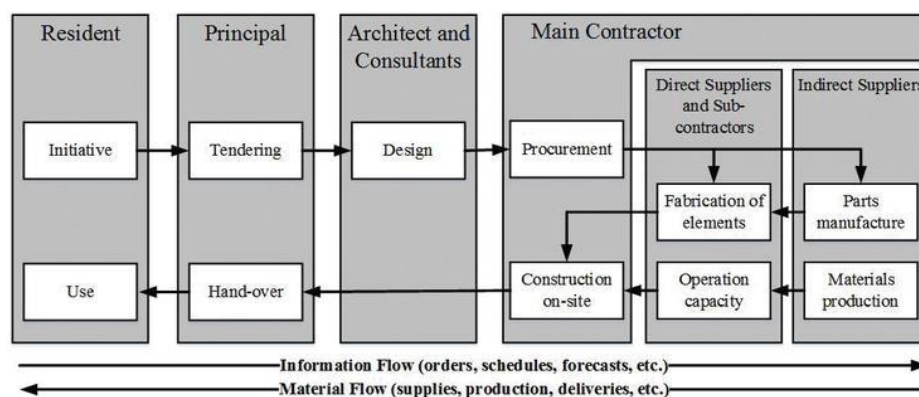
Figure 2.1: Brief insight on the respective stakeholders' roles in the different construction stages.

The table and figure above show the stakeholders roles and involvement in each stage of the construction process. Only by knowing their positions, we can identify the risk that come along and schedule the task

required from them for a more efficient project which requires frequent meetings and an experienced project manager to organise all the parties appropriately.

2.3.2 Processes

The construction supply chain involves several processes from procurement, planning and scheduling, construction and quality control to handover and commissioning. These processes could be undergone one by one following the conventional method or simultaneously in a parallel workflow which hastens the project.

Table 2.3: Processes and Functions

Processes	Functions
Procurement	Acquiring goods, services and works from suppliers to fulfil requirements of the construction project
Planning & Scheduling	Determining the scope of work, defining the project timeline, and creating a detailed schedule of activities.
Manufacturing & Fabrication	Creating components, materials, and systems that are used in construction.
Transportation & Logistic	Moving materials, equipment, and personnel to and from the construction site.
Construction on site	Carrying out the physical work of the project, including the installation of materials, systems, and equipment.
Quality Control & Inspection	Ensuring that the work performed meets the required standards and specifications.
Commissioning & Handover	Testing and verifying that the project is complete and meets the requirements of the project owner.

Construction processes are not only about the task on site but everything that is required to make sure that the project is successful. The actual scope of processes greatly depends on the procurement method which varies by the line of responsibilities. There are mainly two types of procurement methods which results in different work schedule within the project including traditional

procurement method or known as "design-bid-build" or "linear procurement" while the modern procurement methods involve design and build which promotes greater collaboration and integration.

A very clear example of modernized construction would be the blockchain-enabled construction supply chain. Unlike a linear supply chain, these supply chains are diversified into mainly three categories: material supply chain, labour supply chain and equipment supply chain with each having its respective companies. The client could choose the companies based on his preferences or budget and have them supply their products while still working together within a project. Therefore, the respective supply chains could focus on their field like manufacturing, buying equipment to rent or providing training semi-skilled or high skilled labour.
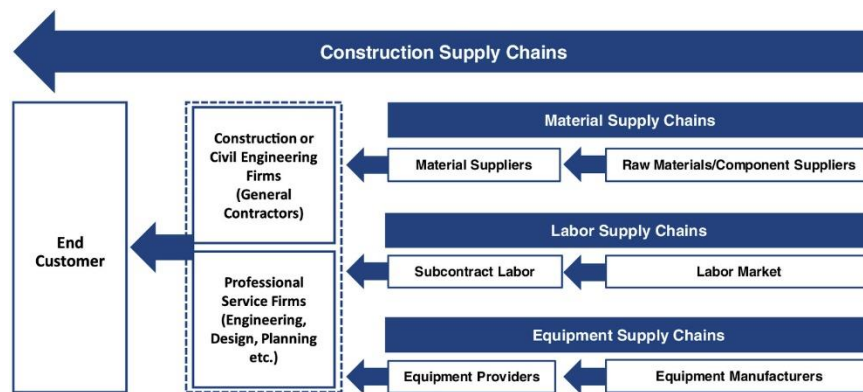
Figure 2.2: Blockchain-enabled Construction Supply Chain

According to Masca ID (2022), Blockchain-enabled supply chain instills reduction in development costs, higher efficiency in logistic, automation of task, time saving due to reduction in transit and shipping, and higher planning of production processes. However, these supply chains greatly rely on technology such as Artificial Intelligence and automation to make sure that everything goes according to plan as one manufacturing company could be involved in several projects and situations might get complicated easily.

2.4   Proposed Conceptual Framework

Through the analysis from existing digital maturity level assessments and other research papers, the affinity diagram of conceptual framework of digitalisation dimensions are synthesised (Figure 2.3. The affinity diagram consists of seven dimensions, namely digital strategy, digital organisation, digital training, digital

metrics, digital technology, digital culture, and utilisation of BIM. These will be used to generate investigation questions in the questionnaire survey explained in the following Chapter 3.

H1 Digital Strategy:

- Development and definition of a digital strategy (Lipsmeier et al., 2020)
- Aligning the organisation for the digital future (Kiron et al., 2016)
- Prespective leadership thinking to drive digital transformation (Perez et al., 2021)

H2 Digital Organisation:

- Change management activities to support organisation (Bellantuono et al., 2021)
- Collaborative platform for supply chain integration (Mattos and Laurindo, 2015)
- Team integration via delivery processes, open communication, and cloud documention (Aapaoja et al., 2013)

H3 Digital Training:

- Empower employees to use new digital technologies (Foroughi, 2021)
- Conventional training and case study assignments to suit the requirements (Stone, 2014)
- Digital transformation to conceptualize digital roadmap for company (Kirsti, 2011)

H4 Digital Metrics:

- Big data analytics capability for decision making (Awan et al., 2021)
- Data reinforcement for monitoring and controlling (Mehbodniya et al., 2022)
- Key principles to govern digital iniatives (Obwegeser, 2020)

H5 Digital Technology:

- Promote employees towards technology adoption (Taofeeq et al., 2020)
- Cloud computing for data sharing and cost efficiency (Carroll et al., 2011)
- Framework of design and construction operations within a company (Perera et al., 2023)

H6 Digital Culture:

- Digital mindset including digital habits, attitudes, and customer centricity (Bhatia, 2022)
- Employee's digital competence on digital autonomy and innovative work behaviour (Huu, 2023)
- Culture having most significant influence on knowledge-sharing (Siakas et al., 2010)

H7 Utilisation of BIM:

- Mult-dimensional (nD) technology to visualize working units (Ding et al., 2012)
- BIM usage in design of construction projects (Herrera et al., 2021)
- Automatic clash detection and capturing field-detected issues (Alsuhaibai et al., 2022)

Figure 2.3: Affinity Diagram of Seven Digitalisation Dimensions of Digital Maturity Level

CHAPTER 3

METHODOLOGY AND WORK PLAN

3.1 Introduction

This Chapter explains the methods of primary data collection for this research. The research approach adopted in this research is explained in Section 3.2, which include outline of questionnaire design, and rubric of rating scale. Section 3.3 presents the hypothesis testing included in this research. Section 3.4 justifies the sample size determination and targeted respondents. Section 3.5 describes the preliminary testing. Section 3.6 highlight the data analysis methods adopted which include Cronbach's alpha reliability test, correlation test and Kruskal Wallis test. Lastly, section 3.7 declares the protocols for research ethics.

3.2 Research Approach

This research used a mixed method approach with data collection via questionnaire. Figure 3.1 illustrated different types of variables required in the research, where the independent variable, digitalisation dimension, is an aggregated value of the seven dimensions. The Dependent variable is the digital maturity level, and the attributes of respondents serves as the moderating variables. The questionnaire consists of both close ended questions (quantitative) and open-ended questions (qualitative) as explain in the following section. The sample of questionnaire is available as Appendix A to this report.
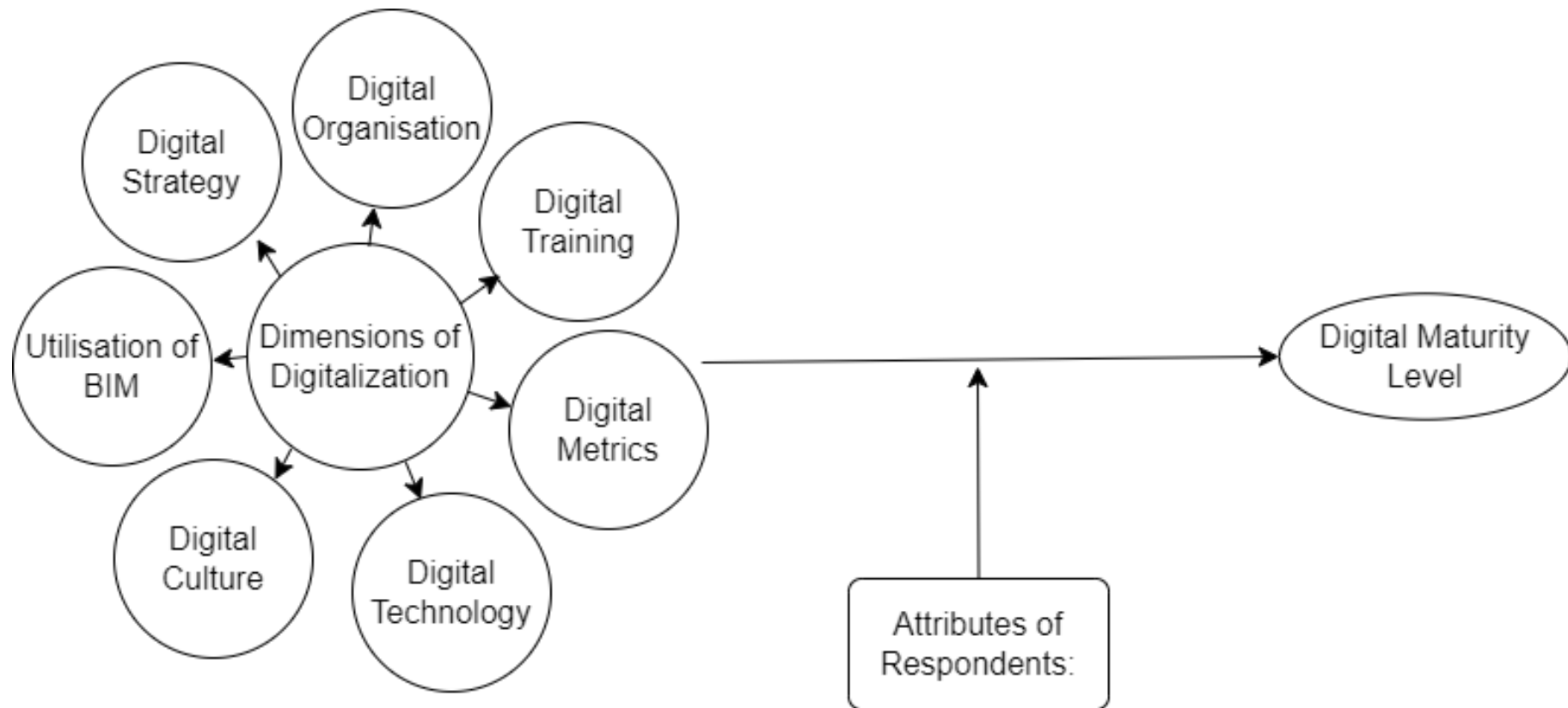
Figure 3.1: Conceptual Framework for Digital Maturity Level Assessment in Construction Supply Chain

3.2.1 Questionnaire Design

The context and purpose of the questionnaire for the research undertaken, and the expected objectives are described in the first part of the questionnaire. The main questionnaire is divided into three sections Section A includes 21 close ended questions with a rating scale from one to five covering the Seven Digitalisation Dimensions of Digital Maturity Level in Figure 2.1 to measure digital maturity level in a company. The related questions numbers to each of the digitalization dimensions are summarised in Table 3.1.

Table 3.1: Questionnaire Summary for Section A

Digitalisation Dimensions	Questions No.
Strategy	A1 – A3
Organisation	A4 – A6
Training	A7 – A9
Metrics	A10 – A12
Technology	A13 – A15
Culture	A16 – A18
Utilisation of BIM	A19 – A21

The details of the 21 investigation questions asked in the questionnaire are tabulated in the following Table 3.2.

Table 3.2: Section A – Close Ended Questions

Items (η)	Questions
	Digital Strategy
A1	How well-defined is your organization's digital strategy?
A2	How effectively does your organization communicate and align digital objectives with overall business goals?
A3	To what extent does your senior leadership team champion digital transformation initiatives?

Digital Organisation

A4 How effectively do you manage organizational change during digital transformation initiatives?

A5 To what extend does your organization use collaborative platforms and tools?

A6 How effectively do you share information and documents across teams and stakeholders?

Digital Training

A7 To what extent does your organization provide training and development opportunities for digital skills?

A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?

A9 How effectively does the training support the overall digital maturity roadmap of the company?

Digital Metrics

A10 To what extent do you use data analytics to gain insights and inform decision-making?

A11 To what extent do you use data analytics for monitoring and controlling purposes?

A12 How effectively do you measure the impact of digital initiatives on project performance?

Digital Technology

A13 To what extent does your organization promote user adoption and acceptance of new digital tools?

A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?

A15 What percentage of construction processes and activities are digitized?

Digital Culture

A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?

A17 How effectively does your organization prioritize digital skills development and provide training opportunities?

A18	How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?
	Utilisation of BIM
A19	To what extent do you integrate 3D modelling tools for visualizing project progress?
A20	How extensively does your organization utilize BIM in design and construction projects?
A21	How well do you leverage BIM and 3D modelling for clash detection and coordination?

Each question has its own rating scale or rubric designed specifically for the question to obtain the most accurate indication from the respondents as summarised in the following Table 3.3. The details definitions of the rating scales are made known to the respondents in the questionnaire (Appendix B). The respondents' choices will be coded using a 1-5 scale in the subsequent analysis, where 1 is the least mature response and 5 is the most mature response.

Table 3.3: Response Categories of Questionnaire

Type of Rating	Rating Scale (1-5)	Question
Agreement	Undefined / Vague / Partially Defined / Well-Defined / Highly Defined and Documented	A1
	Ineffectively / Partially Effectively / Moderate Effectively / Highly Effectively / Excellently Effectively	A4, A9, A12, A17, A18
	Ineffective / Partially Effective / Adequate / Effective / Highly Effective	A6
	Inadequately / Partially / Moderately / Effectively / Excellently	A8
	Poorly / Partially / Adequately / Effectively / Excellently	A21

Amount	0% Digitized / Minimal Digitization / Partial Digitization / Substantial Digitization / Extensive Digitization	A15
Frequency	No Communication or Alignment / Limited Communication and Alignment / Partial Communication and Alignment / Adequate Communication and Alignment / Strong Communication and Alignment	A2
	No Championing / Limited Championing / Moderate Championing / Strong Championing / Highly Effective Championing	A3
	No Utilization / Limited Utilization / Moderate Utilization / Substantial Utilization / Comprehensive Utilization	A5, A10, A11, A14, A20
	No Opportunities / Limited Opportunities / Moderate Opportunities / Substantial Opportunities / Comprehensive Opportunities	A7
	No Promotion / Limited Promotion / Moderate Promotion / Substantial Promotion / Comprehensive Promotion	A13
	Not at all / Minimally / Moderately / Significantly / Fully	A16
	No Integration / Limited Integration / Moderate Integration / Substantial Integration / Comprehensive Integration	A19

Section B consists of three open ended questions for the respondents to provide deeper insights and share their past experiences and knowledge on an optional basis.

Table 3.4: Section B – Open Ended Questions

Ref. Code	Questions
B1	Do you believe your company has adequately embraced digitalization in its daily operations? Please provide details on areas where further enhancements can be made to improve digitalization efforts.
B2	What are the primary challenges encountered when striving to enhance the digital maturity of your company further?
B3	Do you believe there is a need for further improvement in digital maturity within the construction supply chain? Please provide an elaboration on why it is necessary and how it can be achieved.

Section C consists of five demographic details which includes business activities of the company, Working Profession, years of working experience, numbers of employees within the company, and yearly sales turnover in the company.

Table 3.5: Section C – Respondents' Attributes

Ref. Code	Respondents' Demographic Information
C1	Business Activities of the Company
C2	Working Profession
C3	Years of Working Experience
C4	Number of Employees within the Company
C5	Yearly Sales Turnover in the Company

C4 and C5 is used to classify the size of company according to the definition of SME Corporation Malaysia (SME Corp. Malaysia), the central coordinating agency (CCA) under the Ministry of Entrepreneur & Cooperatives Development (MECD).

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Table 3.6: Classification of Size of Company

Size of Company	Manufacturing		Services and Others Sectors	
	No. of Employees	Sales Turnover (RM)	No. of Employees	Sales Turnover (RM)
Large	More than 200	More than 50 mil	More than 75	More than 20 mil
Medium	75 to less than or equal to 200	15 mil to less than or equal to 50 mil	30 to less than or equal to 75	3 mil to less than or equal to 20 mil
Small	5 to less than 75	300,000 to less than 15 mil	5 to less than 30	300,000 to less than 3 mil
Micro	Less than 5	Less than 300,000	Less than 5	Less than 300,000

Source: SME Corp. Malaysia

3.3   Research Hypothesis

Table 3.7 tabulated 21 pairs of hypothesis statements constructed for hypothesis testing on the seven digitalisation dimensions. Each pair of the hypothesis are tested on the three questions asked in the relevant dimension once at a time.

Table 3.7: Hypothesis Statements

Item	Hypothesis (H) and Null Hypothesis (H_0) Statements
$H1_\eta$	The organisation's digital strategy is different with respect to the respondents' attribute of the organisation in the construction supply chain.
H_01_η	The organisation's digital strategy is indifferent with respect to the respondents' attribute of the organisation in the construction supply chain
$H2_\eta$	The organisation's digital organisation is different with respect to the respondents' attribute of the organisation in the construction supply chain.
H_02_η	The organisation's digital organisation is indifferent with respect to the respondents' attribute of the organisation in the construction supply chain
$H3_\eta$	The organisation's digital training is different with respect to the respondents' attribute of the organisation in the construction supply chain.
H_03_η	The organisation's digital training is indifferent with respect to the respondents' attribute of the organisation in the construction supply chain
$H4_\eta$	The organisation's digital metrics is different with respect to the respondents' attribute of the organisation in the construction supply chain.
H_04_η	The organisation's digital metrics is indifferent with respect to the respondents' attribute of the organisation in the construction supply chain

$H5_\eta$ The organisation's digital technology is different with respect to the respondents' attribute of the organisation in the construction supply chain.

H_05_η The organisation's digital technology is indifferent with respect to the respondents' attribute of the organisation in the construction supply chain

$H6_\eta$ The organisation's digital culture is different with respect to the respondents' attribute of the organisation in the construction supply chain.

H_06_η The organisation's digital culture is indifferent with respect to the respondents' attribute of the organisation in the construction supply chain

$H7_\eta$ The organisation's utilisation of BIM is different with respect to the respondents' attribute of the organisation in the construction supply chain.

H_07_η The organisation's utilisation of BIM is indifferent with respect to the respondents' attribute of the organisation in the construction supply chain

η = Question Number (1-3)

In addition, the analysis also determined the differences of responds according to the four attributes illustrated in Figure 3.1. Therefore, a further 84 (21 questions multiply with 4 attributes) hypothesis testing were needed to determine the following pair of hypotheses:

H_0:   There is no significant differences across the respondents' attributes on the digitalisation dimensions of digital maturity level.

H_1:   There is significant difference across the respondents' attribute on the digitalisation dimensions of digital maturity level.
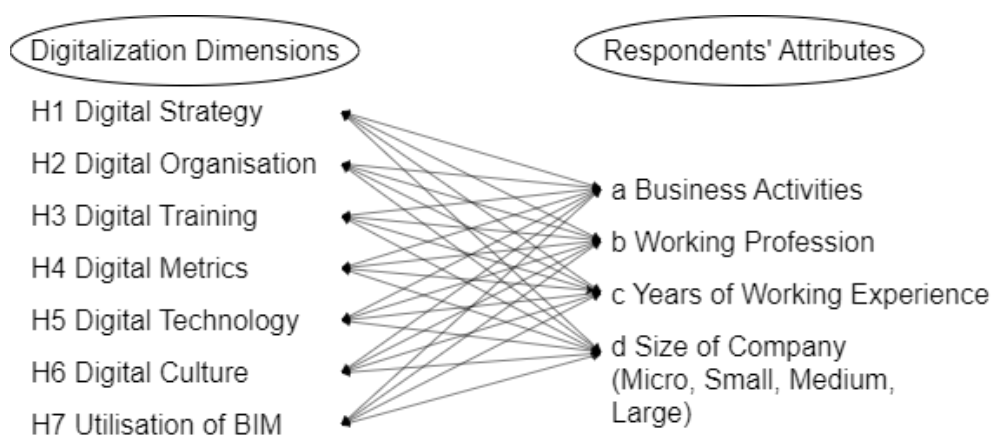
Figure 3.1: Hypothesis Testing

3.4 Sample Size

The sampling determination, the participants of questionnaire survey and the distribution of questionnaire are explained as follows:

3.4.1 Sampling Determination

Sampling is used to ensure that the characteristics of the sample are the same as its population and act as representative of the population. The members of the sample are chosen based on their knowledge, relationships, and experience in the study's topic which is the lecturers, working professionals and other member who have the knowledge about digital construction.

According to sample size computation, the sampling size for this research should be 384 respondents.

Formula for calculating sample size,

$$n = \frac{(Z^2)(p)(1-p)}{\sigma^2}$$

Where Z = Z value based on confidence level

     P = Percentage of Population

     σ = Standard Deviation

$$n = \frac{(1.96^2)(0.95)(0.05)}{0.0218^2}$$

$$= 384$$

However, the Central Limit Theorem (CLT), first proved by Pierre-Simon Laplace in 1810, states that the distribution of sample means approximates a normal distribution as the sample size gets larger, regardless of the population size and the CLT is valid for sample sizes equal or greater than 30. As there are around five subgroups of every demographic question asked, the minimum expected sample size is 150 respondents if each subgroup answered by 30 respondents.

3.4.2   Targeted Respondents

The targeted respondents are construction practitioners working in Malaysia either directly or indirectly related to work on site. They can be with any background related to their business affiliations, professions, age, education backgrounds, and years of working experience.

3.4.3   Questionnaire Distribution

The questionnaire was prepared by using "Google Forms" and distributed online to the respondents. the Google Form were attached with hyperlink sent to the targeted participants via Linkedin, Facebook pages, Whatsapp groups, and other platforms. The duration of data collection is three weeks from 7th August 2023 to 27th August 2023.

3.5   Preliminary Testing

A preliminary testing was done with eight respondents with aim to pilot the test in order to refine and improvise the questionnaire. Respondents who took part in the pilot test are one architect, one project manager, and six quantity surveyors. There was no further suggestions or issues with the questions. As a result, the questionnaire was unchanged and distributed to the public.

3.6   Data Analysis
3.6.1   Cronbach's Alpha Reliability Test

The consistency of all the questions asked in Section A are tested with Cronbach's Alpha Reliability Test. The coefficient of Cronbach's alpha varies between zero to one with a greater value meaning greater reliability and

consistency. Generally, having a coefficient of 0.70 to 0.80 is fair, and a coefficient greater than 0.90 is deemed excellent.

3.6.2   Descriptive Statistics

Statistics including frequency, percentage, mean rank, mode are used to provide the basic information about the variables in the dataset, and seek relationships with the statements in Section A and the respondents' demographic background in Section C. Furthermore, the answers from the open-ended questions are presented graphically.

3.6.3   Inferential Statistics

The responses to the questionnaire are gathered and analysed using the Statistical Package for Social Science (SPSS) software. Three data analysis methods, Chi-Square Test, Correlation Test and Kruskal Wallis Test were adopted in this study to infer generalisable results.

3.6.3.1   Chi-square Test

Chi-square test is to test the randomness of the results to make sure that the data from the questionnaire is random and repeatable by comparing the observed and expected frequencies. The results would be significant as long as less than 0.05. The test was used in Section 4.4.

3.6.3.2   Correlation Test

Correlation test is a non-parametric test commonly utilised by researchers to establish the course and magnitude of the variables. Generally, the corelation coefficient falls between -1 to 1 where negative means opposite correlation with one going positive and the other going negative, and vice versa. The degree of correlations follows the coefficient with less than 0.60 as moderate correlation and 0.80 to 1.00 as very strong correlation.

Table 3.8: Cohen Table

General Interpretation of Strength of Relationship	Coefficient (r)
Very Large	≥ 0.70
Large	> 0.50

Medium	> 0.30
Small	> 0.10

3.6.4   Kruskal-Wallis Test

Kruskal-Wallis Test or H test is a non-parametric substitute to evaluate the presence of significant differences between one or more independent samples. This is to analyse the preferences or choices of the respondents based on their demographic background and find significant differences to evaluate as shown in section 3.3.

3.7   Research Ethics

The respondents' participation is fully voluntary and are requested to answer truthfully. The results from the questionnaire would be strictly private and confidential and would not be publicized without their consent. The personal information obtained would only be of use for this research. The respondents are advised to go through and agree with the consent of participation before answering the questionnaire.

3.8   Summary

The research approach and inferential statistics adopted in this research have been explained in this Chapter. The outcome and analysis of the questionnaire survey will be reported in the next Chapter 4.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

The data collection was undergone for 3 weeks from 7th August 2023 to 27th August 2023 and a total of 163 respondents were obtained. The respondents' backgrounds are tabulated in Section 4.2. Section 4.3 depicts the reliability testing for Section A of the questionnaire. Section 4.4 is the descriptive statistics of the maturity level of the seven digitalisation dimensions as well as the detailed statistics of the 21 investigation questions. Section 4.5 depicts the inferential statistic of the seven digitalisation dimensions including correlation testing between the seven dimensions and 21 investigations questions. Section 4.6 tabulates the difference between mean ranks between the seven dimensions with the attributes of respondents. Meanwhile, Section 4.7 includes tabulation of the three open ended questions. Section 4.8 summarises the results of Section 4.4 to Section 4.7 with discussions.

4.2 Respondents' Background

Table 4.1 depicts the detailed attributes of respondents for all 163 people who participated in the questionnaire. Most of the respondents are in contractor firms (38.7%) with profession as Chartered Builders (22.1%). Besides, majority of the respondents are experienced with six to ten years (45.4%) in the construction industry and worked in medium sized companies. (54%).

Table 4.1: Attributes of Respondents (N=163)

Demographic Background	Frequency (n)	Percentage (%)
Business Activities of Company		
Property Development	26	16.0
Business Consultancy	40	24.5
Business Contracting	63	38.7
Building Material Manufacturing	21	12.9

Equipment Supply/Rent Business	10	6.1
Others	3	1.8
Profession		
Architect	25	15.3
Chartered Builder	36	22.1
Civil & Structural Engineer	32	19.6
Mechanical & Electrical Engineer	27	16.6
Quantity Surveyor	34	20.1
Others	9	5.5
Years of Working Experience		
Less than 2 years	30	18.4
2 – 5 years	34	20.9
6 – 10 years	74	45.4
11 – 20 years	20	12.3
More than 20 years	5	3.1
Size of Company		
Micro	1	0.6
Small	34	20.9
Medium	88	54.0
Large	40	24.5

4.3   Reliability Analysis

The reliability coefficient of the internal consistency test is 0.97 for the 21 items (Table 4.2). It means the survey construct is reliable for further analysis.

Table 4.2: Reliability Coefficient of Internal Consistency Test for Questionnaire

Section of Questionnaire	**Number of Items**	**Cronbach's Alpha**
Section A: Digital Infrastructure within the Company	21	0.970

**4.4	Descriptive Statistics**

This section shows the descriptive statistics including the mean, standard deviation according to the seven digitalisation dimensions and 21 questions within the questionnaire.

**4.4.1	Maturity Level of the Seven Digitalisation Dimensions**

Table 4.3 summarised the aggregated maturity level of seven digitalisation dimensions. The maturity level of the seven digitalisation dimension maturity in descending order are: H5 digital technology ($\mu = 3.49$, $\sigma = 0.74$), H2 digital organisation ($\mu = 3.47$, $\sigma = 0.71$), H3 digital training ($\mu = 3.46$, $\sigma = 0.75$), H1 digital strategy ($\mu = 3.46$, $\sigma = 0.77$), H4 digital metrics ($\mu = 3.42$, $\sigma = 0.73$), H6 digital culture ($\mu = 3.39$, $\sigma = 0.72$), and H7 utilisation of BIM ($\mu = 3.33$, $\sigma = 0.68$).

Table 4.3: Mean and Standard Deviation of Maturity Level of Seven Digitalisation Dimensions

Dimensions	Mean (μ)	Standard Deviation (σ)
H5 Digital Technology	3.4908	0.73732
H2 Digital Organisation	3.4663	0.70811
H3 Digital Training	3.4642	0.75034
H1 Digital Strategy	3.4601	0.76910
H4 Digital Metrics	3.4213	0.73033
H6 Digital Culture	3.3926	0.72476
H7 Utilisation of BIM	3.3333	0.68092

The details of the means, standard deviations and Chi-Square Test of all the 21 investigation questions are tabulated in Table 4.4. The p-value of results are less than 0.05 indicated they are significant results. The top five most mature domains are related to "H1 Strategy" (2nd and 4th), "H2 Organisation" (3rd), and "H3 Training" (1st and 5th). The investigation question related "H5 Technology" in the aggregated maturity level appears in the Sixth position.

Table 4.4: Mean, Standard Deviation and Chi Square of Maturity Level of 21 Investigation Questions

Questions	Mean (μ)	Standard Deviation (σ)	Chi Square (χ)	Digital Dimension (Question No.)
To what extent does your organization promote user adoption and acceptance of new digital tools?	3.56	0.862	124.70	Training (A13)
How well-defined is your organization's digital strategy?	3.55	0.856	138.69	Strategy (A1)
How effectively do you share information and documents across teams and stakeholders?	3.55	0.925	146.42	Organisation (A6)
How effectively does your organization communicate and align digital objectives with overall business goals?	3.53	0.801	130.41	Strategy (A2)
To what extent does your organization provide training and development opportunities for digital skills?	3.52	0.834	147.09	Training (A7)
To what extent does your organization utilises cloud computing, data storage, and network capabilities?	3.49	0.848	160.22	Technology (A14)
To what extend does your organization use collaborative platforms and tools?	3.48	0.834	142.00	Organisation (A5)
To what extent do you use data analytics to gain insights and inform decision-making?	3.47	0.838	132.61	Metrics (A10)
How effectively does the training support the overall digital maturity roadmap of the company?	3.46	0.891	123.35	Training (A9)

				Utilisation of BIM
To what extent do you integrate 3D modelling tools for visualizing project progress?	3.45	0.855	164.88	(A19)
How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	3.44	0.875	113.66	Culture (A18)
To what extent do you use data analytics for monitoring and controlling purposes?	3.43	0.831	110.53	Metrics (A11)
How well does the training curriculum address the specific digital skills required for the company's digital maturity?	3.42	0.875	137.28	Training (A8)
What percentage of construction processes and activities are digitized?	3.42	0.827	152.31	Technology (A15)
How effectively do you manage organizational change during digital transformation initiatives?	3.37	0.752	137.15	Organisation (A4)
How effectively do you measure the impact of digital initiatives on project performance?	3.37	0.794	128.99	Metrics (A12)
To what extent does your organization foster a digital-first mindset and embrace technological advancements?	3.37	0.839	125.93	Culture (A16)
How effectively does your organization prioritize digital skills development and provide training opportunities?	3.37	0.846	119.79	Culture (A17)
How extensively does your organization utilize BIM in design and construction projects?	3.34	0.771	131.08	Utilisation of BIM (A20)

To what extent does your senior leadership team champion digital transformation initiatives?	3.31	0.804	92.12	Strategy (A3)
How well do you leverage BIM and 3D modelling for clash detection and coordination?	3.20	0.802	123.84	Utilisation of BIM (A21)

Note: All p-value is <.05, indicates significant at 95% confidence level.

4.5   Inferential Statistics

**4.5.1   Correlation of the Maturity Levels among the Seven Digitalisation
            Dimensions**

Table 4.5 listed the correlations of the seven digitalisation dimensions. All
the intra correlation of the seven digitalisation dimensions shown 'very large'
relationships (>0.7) as categorised in the Cohen Table (Table 3.8) except H2-
H7 is in 'large' relationship. Figure 4.1 illustrated the strengths of pair
comparison of correlation between the digital dimensions with the thickness of
the line to differential the strength of the relationships. The strengths of H2-H5,
H1-H2, H3-H6 and H2-H3 are visualised as the most significant.

Table 4.5: Intra Correlation of the Seven Digitalisation Dimensions

Rank	Digital Dimension 1	Digital Dimension 2	Spearman Correlation
1	H2 Organisation	H5 Technology	0.8398
2	H1 Strategy	H2 Organisation	0.8391
3	H3 Training	H6 Culture	0.8294
4	H2 Organisation	H3 Training	0.8255
5	H3 Training	H5 Technology	0.8229
6	H1 Strategy	H5 Technology	0.8221
7	H5 Technology	H6 Culture	0.8218
8	H4 Metrics	H5 Technology	0.8199
9	H4 Metrics	H6 Culture	0.8181
10	H1 Strategy	H4 Metrics	0.8140
11	H1 Strategy	H3 Training	0.8090
12	H2 Organisation	H4 Metrics	0.8062
13	H3 Training	H4 Metrics	0.8049
14	H2 Organisation	H6 Culture	0.7771
15	H1 Strategy	H6 Culture	0.7764
16	H6 Culture	H7 Utilisation of BIM	0.7686
17	H4 Metrics	H7 Utilisation of BIM	0.7406

18	H5 Technology	H7 Utilisation of BIM	0.7336
19	H1 Strategy	H7 Utilisation of BIM	0.7308
20	H3 Training	H7 Utilisation of BIM	0.7289
21	H2 Organisation	H7 Utilisation of BIM	0.6472
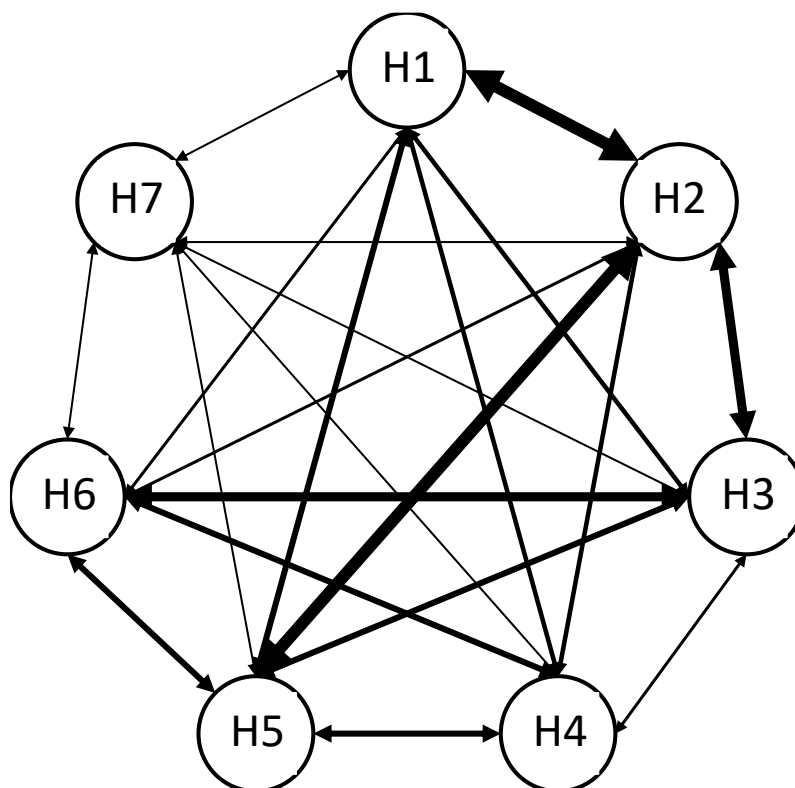
Figure 4.1: Strength of Correlation of the Seven Digitalisation Dimensions

4.5.2 Correlations of the Maturity Level of 21 Investigation Questions

All the significance value (ρ) are 0.000 meaning that all the correlations are significantly correlated. The top five rankings of the intra correlation between investigation questions are arranged from descending order are A9 – A13 (coefficient = 0.74), A14 – A15 (coefficient = 0.73), A3 – A9 (coefficient = 0.72), A13 – A15 (coefficient = 0.72), and A11 -A18 (coefficient = 0.71). The remainders of the correlations are appended as Appendix C in this report.

Table 4.6: Top 5 Correlations of 21 Investigation Questions

Rank	Question 1	Question 2	Spearman Correlation

1	A9 How effectively does the training support the overall digital maturity roadmap of the company?	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	0.7419
2	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	A15 What percentage of construction processes and activities are digitized?	0.7309
3	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A9 How effectively does the training support the overall digital maturity roadmap of the company?	0.7192
4	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	A15 What percentage of construction processes and activities are digitized?	0.7186
5	A11 To what extent do you use data analytics for monitoring and controlling purposes?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.7129

However, for the intra correlation between 21 investigation questions, in accordance with the rankings, it is between H3 Training and H5 Technologies (1st), within H5 Technologies (2nd and 4th), H1 Strategy and H3 Training (3rd), and H3 Training and H6 Culture (5th) which differ with the results from Section 4.5.1.

4.6 Differences of Mean Rank According to the Respondents' Attributes

4.6.1 Business Activities

The 21 pairs of two pairs hypotheses shown in table 3.7 are tested with six different types of business activities. Among the 126 pairs of hypotheses tested with Kruskal Wallis test, the null hypothesis of "To what extent does your organization foster a digital-first mindset and embrace technological advancements?" (A16) between (i) business contracting and property and (ii) equipment supply/rent and property development) are rejected. Hence, "organization foster a digital-first mindset and embrace technological advancements are statistically significantly higher in (i) Property Development ($\bar{x}$ = 99.75) than Business Contracting ($\bar{x}$ = 76.95) and (ii) Property Development ($\bar{x}$ = 99.75) than Equipment Supply/Rent ($\bar{x}$ = 66.05). The significantly tested results are shown in table 4.7.

Table 4.7: Differences of Mean Rank on A16 according to Business Activities

No	Business Activities	Mean Rank ($\bar{x}$)	Business Activities	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Business Contracting	76.95	Property Development	99.75	0.026
ii	Equipment Supply/Rent	66.05	Property Development	99.75	0.039

4.6.2 Profession

The 21 pairs of two pairs hypotheses shown in table 3.7 are tested with six different types of professions. Among the 126 pairs of hypotheses tested with Kruskal Wallis test, the null hypothesis of "To what extent do you integrate 3D modelling tools for visualizing project progress?" (A19) between (i) Quantity Surveyor and Mechanical & Electrical Engineer, (ii) Quantity Surveyor and Builder, (iii) Quantity Surveyor and Civil & Structural Engineer and (iv) Quantity surveyor and Architect are rejected. Hence, integrate 3D modelling tools for visualizing project progress are statistically significantly higher in (i) Quantity Surveyor ($\bar{x}$ = 61.35) than Mechanical & Electrical Engineer ($\bar{x}$ = 96.65); (ii) Quantity Surveyor ($\bar{x}$ = 61.35) than Builder ($\bar{x}$ = 87.39); (iii) Quantity

Surveyor ($\bar{x}$ = 61.35) than Civil & Structural Engineer ($\bar{x}$ = 84.34) and (iv) Quantity Surveyor ($\bar{x}$ = 61.35) than Architect ($\bar{x}$ = 84.26). The significantly tested results are shown in table 4.8.

Table 4.8: Differences of Mean Rank on A19 according to Professions

No	Working Profession	Mean Rank ($\bar{x}$)	Working Profession	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Quantity Surveyor	61.35	Mechanical & Electrical Engineer	96.65	0.001
ii	Quantity Surveyor	61.35	Builder	87.39	0.010
iii	Quantity Surveyor	61.35	Civil & Structural Engineer	84.34	0.028
iv	Quantity Surveyor	61.35	Architect	84.26	0.041

4.6.3 Years of Working Experience

The 21 pairs of two pairs hypotheses shown in table 3.7 are tested with five different groups of years of experience. Among the 105 pairs of hypotheses tested with Kruskal Wallis test, 64 null hypotheses are rejected and shown significantly different between pairwise comparisons of the relevant pairs of years of experience group as highlight below:

a) The perception of organisation's digital strategies is higher in respondents with (i) more than 20 years' experience ($\bar{x}$ = 117.00) than less than 2 years' experience ($\bar{x}$ = 66.77) (ii) 11 to 20 years' experience ($\bar{x}$ = 93.65) than less than 2 years' experience ($\bar{x}$ = 66.77) (iii) 6 to 10 years' experience ($\bar{x}$ = 93.47) than less than 2 years' experience ($\bar{x}$ = 66.77) (iv) more than 20 years' experience ($\bar{x}$ = 117.00) than 2 to 5 years' experience ($\bar{x}$ = 58.49) (v) 11 to 20 years' experience ($\bar{x}$ = 93.65) than 2 to 5 years' experience ($\bar{x}$ = 58.49) (vi) 6 to 10 years' experience ($\bar{x}$ = 93.47) than 2 to 5 years' experience ($\bar{x}$ = 58.49). The significantly tested results are shown in Table 4.9.

Table 4.9: Differences of Mean Rank on Definition of Organization's Digital
Strategy (A1) according to Years of Working Experience

No	Years of Working Experience	Mean Rank ($\bar{x}$)	Years of Working Experience	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Less than 2 years	66.77	More than 20 years	117.00	0.016
ii	Less than 2 years	66.77	11 to 20 years	93.65	0.030
iii	Less than 2 years	66.77	6 to 10 years	93.47	0.004
iv	2 to 5 years	58.49	More than 20 years	117.00	0.004
v	2 to 5 years	58.49	11 to 20 years	93.65	0.004
vi	2 to 5 years	58.49	6 to 10 years	93.47	0.000

b) The perception of senior leadership team championing is higher in
respondents with (i) 11 to 20 years' experience ($\bar{x} = 95.65$) than less than
2 years' experience ($\bar{x} = 66.27$) (ii) 6 to 10 years' experience ($\bar{x} = 93.61$)
than less than 2 years' experience ($\bar{x} = 66.27$) (iii) 11 to 20 years'
experience ($\bar{x} = 95.65$) than 2 to 5 years' experience ($\bar{x} = 62.41$) (iv) 6
to 10 years' experience ($\bar{x} = 93.61$) than 2 to 5 years' experience ($\bar{x} = 62.41$). The significantly tested results are shown in Table 4.10.

Table 4.10: Differences of Mean Rank on Senior Leadership Team
Championing Digital Transformation Initiatives (A3) according to
Years of Working Experience

No	Years of Working Experience	Mean Rank ($\bar{x}$)	Years of Working Experience	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Less than 2 years	66.27	11 to 20 years	95.65	0.022
ii	Less than 2 years	66.27	6 to 10 years	93.61	0.004
iii	2 to 5 years	62.41	11 to 20 years	95.65	0.008
iv	2 to 5 years	62.41	6 to 10 years	93.61	0.001

c) The perception of managing organisational change is higher in
respondents with (i) 6 to 10 years' experience ($\bar{x} = 88.57$) than less than

2 years' experience ($\bar{x}$ = 69.80) (ii) 6 to 10 years' experience ($\bar{x}$ = 88.57) than 2 to 5 years' experience ($\bar{x}$ = 68.99). The significantly tested results are shown in Table 4.11.

Table 4.11: Differences of Mean Rank on Managing Organizational Change during Digital Transformation Initiatives (A4) according to Years of Working Experience

No	Years of Working Experience	Mean Rank ($\bar{x}$)	Years of Working Experience	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Less than 2 years	69.80	6 to 10 years	88.57	0.046
ii	2 to 5 years	68.99	6 to 10 years	88.57	0.030

d) The perception of using collaborative platforms and tools is higher in respondents with (i) more than 20 years' experience ($\bar{x}$ = 130.80) than 6 to 10 years' experience ($\bar{x}$ = 87.72) (ii) more than 20 years' experience ($\bar{x}$ = 130.80) than less than 2 years' experience ($\bar{x}$ = 71.15) (iii) 11 to 20 years' experience ($\bar{x}$ = 96.75) than less than 2 years' experience ($\bar{x}$ = 71.15) (iv) more than 20 years' experience ($\bar{x}$ = 130.80) than 2 to 5 years' experience ($\bar{x}$ = 63.26) (v) 11 to 20 years' experience ($\bar{x}$ = 96.75) than 2 to 5 years' experience ($\bar{x}$ = 63.26) (vi) 6 to 10 years' experience ($\bar{x}$ = 87.72) than 2 to 5 years' experience ($\bar{x}$ = 63.26). The significantly tested results are shown in Table 4.12.

Table 4.12: Differences of Mean Rank on Using Collaborative Platforms and Tools (A5) according to Years of Working Experience

No	Years of Working Experience	Mean Rank ($\bar{x}$)	Years of Working Experience	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	6 to 10 years	87.72	More than 20 years	130.80	0.030
ii	Less than 2 years	71.15	More than 20 years	130.80	0.004
iii	Less than 2 years	71.15	11 to 20 years	96.75	0.039
iv	2 to 5 years	63.26	More than 20 years	130.80	0.001

| v | 2 to 5 years | 63.26 | 11 to 20 years | 96.75 | 0.006 |
| vi | 2 to 5 years | 63.26 | 6 to 10 years | 87.72 | 0.006 |

e) The perception of effective information and documents sharing is higher in respondents with (i) 6 to 10 years' experience ($\bar{x}$ = 90.47) than 2 to 5 years' experience ($\bar{x}$ = 70.76) (ii) 11 to 20 years' experience ($\bar{x}$ = 91.30) than less than 2 years' experience ($\bar{x}$ = 66.10) (iii) 6 to 10 years' experience ($\bar{x}$ = 90.47) than less than 2 years' experience ($\bar{x}$ = 66.10). The significantly tested results are shown in Table 4.13.

Table 4.13: Differences of Mean Rank on Effectiveness on Sharing Information and Documents across Teams and Stakeholders (A6) according to Years of Working Experience

No	Years of Working Experience	Mean Rank ($\bar{x}$)	Years of Working Experience	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	2 to 5 years	70.76	6 to 10 years	90.47	0.027
ii	Less than 2 years	66.10	11 to 20 years	91.30	0.042
iii	Less than 2 years	66.10	6 to 10 years	90.47	0.009

f) The perception of providing training and development opportunities is higher in respondents with (i) more than 20 years' experience ($\bar{x}$ = 106.60) than 2 to 5 years' experience ($\bar{x}$ = 64.53) (ii) 11 to 20 years' experience ($\bar{x}$ = 96.03) than 2 to 5 years' experience ($\bar{x}$ = 64.53) (iii) 6 to 10 years' experience ($\bar{x}$ = 86.89) than 2 to 5 years' experience ($\bar{x}$ = 64.53). The significantly tested results are shown in Table 4.14.

Table 4.14: Differences of Mean Rank on Providing Training and Development Opportunities for Digital Skills (A7) according to Years of Working Experience

No	Years of Working Experience	Mean Rank ($\bar{x}$)	Years of Working Experience	Mean Rank ($\bar{x}$)	Sig. (ρ)

i	2 to 5 years	64.53	More than 20 years	106.60	0.040
ii	2 to 5 years	64.53	11 to 20 years	96.03	0.009
iii	2 to 5 years	64.53	6 to 10 years	86.89	0.012

g) The perception of addressing specific digital skills required is higher in respondents with (i) more than 20 years' experience ($\bar{x} = 112.00$) than 2 to 5 years' experience ($\bar{x} = 65.71$) (ii) 11 to 20 years' experience ($\bar{x} = 95.35$) than 2 to 5 years' experience ($\bar{x} = 65.71$) (iii) 6 to 10 years' experience ($\bar{x} = 86.77$) than 2 to 5 years' experience ($\bar{x} = 65.71$). The significantly tested results are shown in Table 4.15.

Table 4.15: Differences of Mean Rank on Addressing Specific Digital Skills Required for the Company's Digital Maturity with Training Curriculum (A8) according to Years of Working Experience

No	Years of Working Experience	Mean Rank ($\bar{x}$)	Years of Working Experience	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	2 to 5 years	65.71	More than 20 years	112.00	0.026
ii	2 to 5 years	65.71	11 to 20 years	95.35	0.015
iii	2 to 5 years	65.71	6 to 10 years	86.77	0.019

h) The perception of effectiveness of training to support digital maturity roadmap is higher in respondents with (i) 11 to 20 years' experience ($\bar{x} = 95.40$) than less than 2 years' experience ($\bar{x} = 67.42$) (ii) 6 to 10 years' experience ($\bar{x} = 92.95$) than less than 2 years' experience ($\bar{x} = 67.42$) (iii) 11 to 20 years' experience ($\bar{x} = 95.40$) than 2 to 5 years' experience ($\bar{x} = 64.44$) (iv) 6 to 10 years' experience ($\bar{x} = 92.95$) than 2 to 5 years' experience ($\bar{x} = 64.44$). The significantly tested results are shown in Table 4.16.

Table 4.16: Differences of Mean Rank on Effectiveness of Training to Support the Overall Digital Maturity Roadmap of the Company (A9) according to Years of Working Experience

No	Years of Working Experience	Mean Rank ($\bar{x}$)	Years of Working Experience	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Less than 2 years	67.42	11 to 20 years	95.40	0.026
ii	Less than 2 years	67.42	6 to 10 years	92.95	0.007
iii	2 to 5 years	64.44	11 to 20 years	95.40	0.012
iv	2 to 5 years	64.44	6 to 10 years	92.95	0.002

i) The perception of using data analytics for decision making is higher in respondents with (i) 11 to 20 years' experience ($\bar{x}$ = 102.40) than less than 2 years' experience ($\bar{x}$ = 69.15) (ii) 11 to 20 years' experience ($\bar{x}$ = 102.40) than 2 to 5 years' experience ($\bar{x}$ = 66.68) (iii) 6 to 10 years' experience ($\bar{x}$ = 87.27) than 2 to 5 years' experience ($\bar{x}$ = 66.68). The significantly tested results are shown in Table 4.17.

Table 4.17: Differences of Mean Rank on Using Data Analytics to Gain Insights and Inform Decision-Making (A10) according to Years of Working Experience

No	Years of Working Experience	Mean Rank ($\bar{x}$)	Years of Working Experience	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Less than 2 years	69.15	11 to 20 years	102.40	0.008
ii	2 to 5 years	66.68	11 to 20 years	102.40	0.004
iii	2 to 5 years	66.68	6 to 10 years	87.27	0.023

j) The perception of using data analytics for monitoring and control is higher in respondents with (i) 11 to 20 years' experience ($\bar{x}$ = 95.03) than less than 2 years' experience ($\bar{x}$ = 67.60) (ii) 6 to 10 years' experience ($\bar{x}$ = 90.53) than less than 2 years' experience ($\bar{x}$ = 67.60) (iii) 11 to 20 years' experience ($\bar{x}$ = 95.03) than 2 to 5 years' experience ($\bar{x}$ = 68.01) (iv) 6 to 10 years' experience ($\bar{x}$ = 90.53) than 2 to 5 years' experience ($\bar{x}$ = 68.01). The significantly tested results are shown in Table 4.18.

Table 4.18: Differences of Mean Rank on Using Data Analytics for
Monitoring and Controlling Purposes (A11) according to Years of
Working Experience

No	Years of Working Experience	Mean Rank ($\bar{x}$)	Years of Working Experience	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Less than 2 years	67.60	11 to 20 years	95.03	0.031
ii	Less than 2 years	67.60	6 to 10 years	90.53	0.016
iii	2 to 5 years	68.01	11 to 20 years	95.03	0.029
iv	2 to 5 years	68.01	6 to 10 years	90.53	0.014

k) The perception of user adoption and acceptance promotion is higher in respondents with (i) 11 to 20 years' experience ($\bar{x} = 97.55$) than less than 2 years' experience ($\bar{x} = 70.73$) (ii) 11 to 20 years' experience ($\bar{x} = 97.55$) than 2 to 5 years' experience ($\bar{x} = 66.85$) (iii) 6 to 10 years' experience ($\bar{x} = 88.75$) than 2 to 5 years' experience ($\bar{x} = 66.85$). The significantly tested results are shown in Table 4.19.

Table 4.19: Differences of Mean Rank on Organization Promoting User
Adoption and Acceptance of New Digital Tools (A13) according
to Years of Working Experience

No	Years of Working Experience	Mean Rank ($\bar{x}$)	Years of Working Experience	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Less than 2 years	70.73	11 to 20 years	97.55	0.032
ii	2 to 5 years	66.85	11 to 20 years	97.55	0.012
iii	2 to 5 years	66.85	6 to 10 years	88.75	0.015

l) The perception of percentage of digitized construction is higher in respondents with (i) more than 20 years' experience ($\bar{x} = 105.90$) than less than 2 years' experience ($\bar{x} = 62.47$) (ii) 11 to 20 years' experience ($\bar{x} = 106.48$) than less than 2 years' experience ($\bar{x} = 62.47$) (iii) 6 to 10 years' experience ($\bar{x} = 87.55$) than less than 2 years' experience ($\bar{x} = $

62.47) (iv) 11 to 20 years' experience ($\bar{x} = 106.48$) than 2 to 5 years' experience ($\bar{x} = 69.24$) (v) 6 to 10 years' experience ($\bar{x} = 87.55$) than 2 to 5 years' experience ($\bar{x} = 69.24$). The significantly tested results are shown in Table 4.20.

Table 4.20: Differences of Mean Rank on Percentage of Construction Processes and Activities Digitized (A15) according to Years of Working Experience

No	Years of Working Experience	Mean Rank ($\bar{x}$)	Years of Working Experience	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Less than 2 years	62.47	More than 20 years	105.90	0.037
ii	Less than 2 years	62.47	11 to 20 years	106.48	0.000
iii	Less than 2 years	62.47	6 to 10 years	87.55	0.007
iv	2 to 5 years	69.24	11 to 20 years	106.48	0.002
v	2 to 5 years	69.24	6 to 10 years	87.55	0.040

m) The perception of fostering digital-first mindset is higher in respondents with (i) 11 to 20 years' experience ($\bar{x} = 93.03$) than less than 2 years' experience ($\bar{x} = 63.45$) (ii) 6 to 10 years' experience ($\bar{x} = 91.32$) than less than 2 years' experience ($\bar{x} = 63.45$). The significantly tested results are shown in Table 4.21.

Table 4.21: Differences of Mean Rank on Organization Fostering a Digital-First Mindset and Embrace Technological Advancements (A16) according to Years of Working Experience

No	Years of Working Experience	Mean Rank ($\bar{x}$)	Years of Working Experience	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Less than 2 years	63.45	11 to 20 years	93.03	0.019
ii	Less than 2 years	63.45	6 to 10 years	91.32	0.003

n) The perception of prioritizing digital skills development is higher in respondents with (i) 11 to 20 years' experience ($\bar{x} = 97.30$) than less than 2 years' experience ($\bar{x} = 66.43$) (ii) 6 to 10 years' experience ($\bar{x} = 92.32$) than less than 2 years' experience ($\bar{x} = 66.43$) (iii) 11 to 20 years' experience ($\bar{x} = 97.30$) than 2 to 5 years' experience ($\bar{x} = 64.51$) (iv) 6 to 10 years' experience ($\bar{x} = 92.32$) than 2 to 5 years' experience ($\bar{x} = 64.51$). The significantly tested results are shown in Table 4.22.

Table 4.22: Differences of Mean Rank on Effectiveness of Organization Prioritizing Digital Skills Development and Provide Training Opportunities (A17) according to Years of Working Experience

No	Years of Working Experience	Mean Rank ($\bar{x}$)	Years of Working Experience	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Less than 2 years	66.43	11 to 20 years	97.30	0.015
ii	Less than 2 years	66.43	6 to 10 years	92.32	0.006
iii	2 to 5 years	64.51	11 to 20 years	97.30	0.008
iv	2 to 5 years	64.51	6 to 10 years	92.32	0.002

o) The perception of promoting collaboration and knowledge sharing is higher in respondents with (i) 11 to 20 years' experience ($\bar{x} = 106.63$) than less than 2 years' experience ($\bar{x} = 61.67$) (ii) 6 to 10 years' experience ($\bar{x} = 94.53$) than less than 2 years' experience ($\bar{x} = 61.67$) (iii) 11 to 20 years' experience ($\bar{x} = 106.63$) than 2 to 5 years' experience ($\bar{x} = 58.82$) (iv) 6 to 10 years' experience ($\bar{x} = 94.53$) than 2 to 5 years' experience ($\bar{x} = 58.82$). The significantly tested results are shown in Table 4.23.

Table 4.23: Differences of Mean Rank on Effectiveness on Organization Promoting Collaboration and Knowledge Sharing through Digital Platforms and Tools (A18) according to Years of Working Experience

No	Years of Working Experience	Mean Rank ($\bar{x}$)	Years of Working Experience	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Less than 2 years	61.67	11 to 20 years	106.63	0.000
ii	Less than 2 years	61.67	6 to 10 years	94.53	0.001
iii	2 to 5 years	58.82	11 to 20 years	106.63	0.000
iv	2 to 5 years	58.82	6 to 10 years	94.53	0.000

p) The perception of 3D modelling tools integration for project visualisation is higher in respondents with (i) more than 20 years' experience ($\bar{x}$ = 115.50) than less than 2 years' experience ($\bar{x}$ = 67.78) (ii) 6 to 10 years' experience ($\bar{x}$ = 91.72) than less than 2 years' experience ($\bar{x}$ = 67.78) (iii) more than 20 years' experience ($\bar{x}$ = 115.50) than 2 to 5 years' experience ($\bar{x}$ = 63.76) (iv) 11 to 20 years' experience ($\bar{x}$ = 90.00) than 2 to 5 years' experience ($\bar{x}$ = 63.76) (v) 6 to 10 years' experience ($\bar{x}$ = 91.72) than 2 to 5 years' experience ($\bar{x}$ = 63.76). The significantly tested results are shown in Table 4.24.

Table 4.24: Differences of Mean Rank on Integrating 3D Modelling Tools for Visualizing Project Progress (A19) according to Years of Working Experience

No	Years of Working Experience	Mean Rank ($\bar{x}$)	Years of Working Experience	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Less than 2 years	67.78	More than 20 years	115.50	0.020
ii	Less than 2 years	67.78	6 to 10 years	91.72	0.009
iii	2 to 5 years	63.76	More than 20 years	115.50	0.011
iv	2 to 5 years	63.76	11 to 20 years	90.00	0.002
v	2 to 5 years	63.76	6 to 10 years	91.72	0.028

q) The perception of organisation utilizing BIM in design is higher in respondents with (i) 6 to 10 years' experience ($\bar{x}$ = 92.30) than less than 2 years' experience ($\bar{x}$ = 71.45) (ii) 6 to 10 years' experience ($\bar{x}$ = 92.30)

than 2 to 5 years' experience ($\bar{x}$ = 64.24). The significantly tested results are shown in Table 4.25.

Table 4.25: Differences of Mean Rank on Organisation Utilizing BIM in Design and Construction Projects (A20) according to Years of Working Experience

No	Years of Working Experience	Mean Rank ($\bar{x}$)	Years of Working Experience	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Less than 2 years	71.45	6 to 10 years	92.30	0.027
ii	2 to 5 years	64.24	6 to 10 years	92.30	0.002

4.6.4 Size of Company

The 21 pairs of two pairs hypotheses shown in table 3.7 are tested with four different groups of size of company. Among the 84 pairs of hypotheses tested with Kruskal Wallis test, 30 null hypotheses are rejected and shown significantly different between pairwise comparisons of the relevant pairs of size of company group as highlight below:

a) The perception of organisation's digital strategies is higher in respondents with (i) medium sized company ($\bar{x}$ = 88.97) than small sized company ($\bar{x}$ = 58.93) (ii) large sized company ($\bar{x}$ = 87.28) than small sized company ($\bar{x}$ = 58.93). The significantly tested results are shown in Table 4.26.

Table 4.26: Differences of Mean Rank on Definition of Organization's Digital Strategy (A1) according to Size of Company

No	Size of Company	Mean Rank ($\bar{x}$)	Size of Company	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Small	58.93	Medium	88.97	0.001
ii	Small	58.93	Large	87.28	0.005

b) The perception of senior leadership team championing is higher in respondents with (i) medium sized company ($\bar{x} = 83.57$) than small sized company ($\bar{x} = 54.72$) (ii) large sized company ($\bar{x} = 81.31$) than small sized company ($\bar{x} = 54.72$). The significantly tested results are shown in Table 4.27.

Table 4.27: Differences of Mean Rank on Senior Leadership Team Championing Digital Transformation Initiatives (A3) according to Size of Company

No	Size of Company	Mean Rank ($\bar{x}$)	Size of Company	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Small	54.72	Medium	93.57	0.000
ii	Small	54.72	Large	81.31	0.010

c) The perception of managing organisational change is higher in respondents with (i) medium sized company ($\bar{x} = 87.69$) than small sized company ($\bar{x} = 62.28$) (ii) large sized company ($\bar{x} = 86.95$) than small sized company ($\bar{x} = 62.28$). The significantly tested results are shown in Table 4.28.

Table 4.28: Differences of Mean Rank on Managing Organizational Change during Digital Transformation Initiatives (A4) according to Size of Company

No	Size of Company	Mean Rank ($\bar{x}$)	Size of Company	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Small	62.28	Medium	87.69	0.004
ii	Small	62.28	Large	86.95	0.015

d) The perception of using collaborative platforms and tools is higher in respondents with (i) medium sized company ($\bar{x} = 89.10$) than small sized company ($\bar{x} = 62.60$) (ii) large sized company ($\bar{x} = 84.61$) than small sized company ($\bar{x} = 62.60$). The significantly tested results are shown in Table 4.29.

Table 4.29: Differences of Mean Rank on Using Collaborative Platforms and
Tools (A5) according to Size of Company

No	Size of Company	Mean Rank ($\bar{x}$)	Size of Company	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Small	62.60	Medium	89.10	0.002
ii	Small	62.60	Large	84.61	0.028

e) The perception of effective information and documents sharing is higher in respondents with (i) medium sized company ($\bar{x} = 89.55$) than small sized company ($\bar{x} = 62.50$) (ii) large sized company ($\bar{x} = 83.94$) than small sized company ($\bar{x} = 62.50$) (iii) medium sized company ($\bar{x} = 89.55$) than micro sized company ($\bar{x} = 3.00$). The significantly tested results are shown in Table 4.30.

Table 4.30: Differences of Mean Rank on Effectiveness on Sharing
Information and Documents across Teams and Stakeholders (A6)
according to Size of Company

No	Size of Company	Mean Rank ($\bar{x}$)	Size of Company	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Small	62.50	Medium	89.55	0.002
ii	Small	62.50	Large	83.94	0.032
iii	Micro	3.00	Medium	89.55	0.045

f) The perception of providing training and development opportunities is higher in respondents with (i) large sized company ($\bar{x} = 91.34$) than small sized company ($\bar{x} = 62.99$) (ii) medium sized company ($\bar{x} = 84.76$) than small sized company ($\bar{x} = 62.99$). The significantly tested results are shown in Table 4.31.

Table 4.31: Differences of Mean Rank on Providing Training and
Development Opportunities for Digital Skills (A7) according to
Size of Company

No	Size of Company	Mean Rank ($\bar{x}$)	Size of Company	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Small	62.99	Large	91.34	0.005
ii	Small	62.99	Medium	84.76	0.012

g) The perception of addressing specific digital skills required is higher in respondents with (i) large sized company ($\bar{x}$ = 89.83) than small sized company ($\bar{x}$ = 63.09) (ii) medium sized company ($\bar{x}$ = 85.36) than small sized company ($\bar{x}$ = 63.09). The significantly tested results are shown in Table 4.32.

Table 4.32: Differences of Mean Rank on Addressing Specific Digital Skills Required for the Company's Digital Maturity with Training Curriculum (A8) according to Size of Company

No	Size of Company	Mean Rank ($\bar{x}$)	Size of Company	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Small	63.09	Large	89.83	0.008
ii	Small	63.09	Medium	85.36	0.011

h) The perception of effectiveness of training to support digital maturity roadmap is higher in respondents with (i) medium sized company ($\bar{x}$ = 92.59) than small sized company ($\bar{x}$ = 61.15). The significantly tested results are shown in Table 4.33.

Table 4.33: Differences of Mean Rank on Effectiveness of Training to Support the Overall Digital Maturity Roadmap of the Company (A9) according to Size of Company

No	Size of Company	Mean Rank ($\bar{x}$)	Size of Company	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Small	61.15	Medium	92.59	0.000

i) The perception of using data analytics for decision making is higher in respondents with (i) medium sized company ($\bar{x}$ = 90.80) than small sized

company ($\bar{x}$ = 57.60) (ii) large sized company ($\bar{x}$ = 85.11) than small sized company ($\bar{x}$ = 57.60). The significantly tested results are shown in Table 4.34.

Table 4.34: Differences of Mean Rank on Using Data Analytics to Gain Insights and Inform Decision-Making (A10) according to Size of Company

No	Size of Company	Mean Rank ($\bar{x}$)	Size of Company	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Small	57.60	Medium	90.80	0.000
ii	Small	57.60	Large	85.11	0.007

j) The perception of measuring impact of digital initiatives for decision making is higher in respondents with (i) medium sized company ($\bar{x}$ = 90.30) than small sized company ($\bar{x}$ = 59.79) (ii) large sized company ($\bar{x}$ = 83.35) than small sized company ($\bar{x}$ = 59.79). The significantly tested results are shown in Table 4.35.

Table 4.35: Differences of Mean Rank on Effectiveness on Measuring the Impact of Digital Initiatives on Project Performance (A12) according to Size of Company

No	Size of Company	Mean Rank ($\bar{x}$)	Size of Company	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Small	59.79	Medium	90.30	0.001
ii	Small	59.79	Large	83.35	0.021

k) The perception of user adoption and acceptance promotion is higher in respondents with (i) large sized company ($\bar{x}$ = 90.99) than small sized company ($\bar{x}$ = 58.93) (ii) medium sized company ($\bar{x}$ = 86.86) than small sized company ($\bar{x}$ = 58.93). The significantly tested results are shown in Table 4.36.

Table 4.36: Differences of Mean Rank on Organization Promoting User
Adoption and Acceptance of New Digital Tools (A13) according
to Size of Company

No	Size of Company	Mean Rank ($\bar{x}$)	Size of Company	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Small	58.93	Large	90.99	0.002
ii	Small	58.93	Medium	86.86	0.002

l) The perception of percentage of digitized construction is higher in respondents with (i) medium sized company ($\bar{x} = 88.36$) than small sized company ($\bar{x} = 60.94$) (ii) large sized company ($\bar{x} = 84.96$) than small sized company ($\bar{x} = 60.94$). The significantly tested results are shown in Table 4.37.

Table 4.37: Differences of Mean Rank on Percentage of Construction
Processes and Activities Digitized (A15) according to Size of
Company

No	Size of Company	Mean Rank ($\bar{x}$)	Size of Company	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Small	60.94	Medium	88.36	0.002
ii	Small	60.94	Large	84.96	0.017

m) The perception of prioritizing digital skills development is higher in respondents with (i) large sized company ($\bar{x} = 91.06$) than small sized company ($\bar{x} = 55.78$) (ii) medium sized company ($\bar{x} = 88.32$) than small sized company ($\bar{x} = 55.78$). The significantly tested results are shown in Table 4.38.

Table 4.38: Differences of Mean Rank on Effectiveness of Organization
Prioritizing Digital Skills Development and Provide Training
Opportunities (A17) according to Size of Company

No	Size of Company	Mean Rank ($\bar{x}$)	Size of Company	Mean Rank ($\bar{x}$)	Sig. (ρ)

No	Size of Company	Mean Rank ($\bar{x}$)	Size of Company	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Small	55.78	Large	91.06	0.001
ii	Small	55.78	Medium	88.32	0.000

n) The perception of promoting collaboration and knowledge sharing is higher in respondents with (i) large sized company ($\bar{x} = 93.33$) than small sized company ($\bar{x} = 59.15$) (ii) medium sized company ($\bar{x} = 86.96$) than small sized company ($\bar{x} = 59.15$). The significantly tested results are shown in Table 4.39.

Table 4.39: Differences of Mean Rank on Effectiveness on Organization Promoting Collaboration and Knowledge Sharing through Digital Platforms and Tools (A18) according to Size of Company

No	Size of Company	Mean Rank ($\bar{x}$)	Size of Company	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Small	59.15	Large	93.33	0.001
ii	Small	59.15	Medium	86.96	0.002

o) The perception of 3D modelling tools integration for project visualisation is higher in respondents with (i) large sized company ($\bar{x} = 90.64$) than small sized company ($\bar{x} = 54.29$) (ii) medium sized company ($\bar{x} = 88.40$) than small sized company ($\bar{x} = 54.29$). The significantly tested results are shown in Table 4.40.

Table 4.40: Differences of Mean Rank on Integrating 3D Modelling Tools for Visualizing Project Progress (A19) according to Size of Company

No	Size of Company	Mean Rank ($\bar{x}$)	Size of Company	Mean Rank ($\bar{x}$)	Sig. (ρ)
i	Small	54.29	Large	90.64	0.000
ii	Small	54.29	Medium	88.40	0.000

4.7 Open-Ended Questions

There are 18 out of 163 respondents provided inputs to the three open ended questions. Their insights are analysed qualitatively and summarised as follows:

4.7.1 Company Embracing Digitalisation in Daily Operations

Among the 18 responses from the respondents, nine (50%) agreed that their company is embracing digitalisation in daily operations while two (11.1%) agreed partially. Besides, five (27.8%) felt that their company is not embracing digitalisation with two (11.1%) only answering the second half of the question as shown in Figure 4.1.
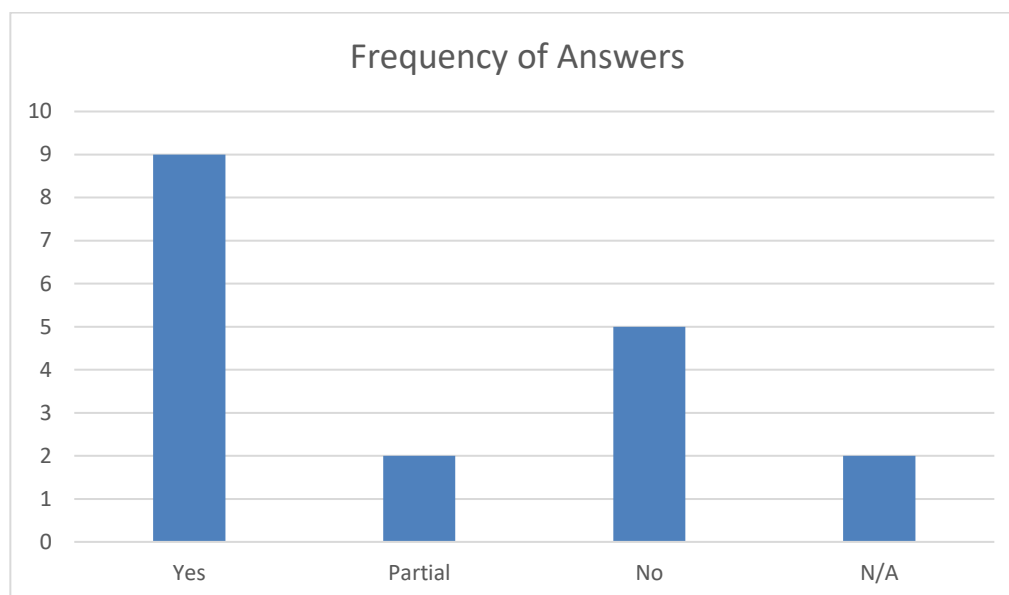
Figure 4.2: Perspective of Company Attached to Embracing Digitalisation in Daily Operations

The second part of question B1 asked about the areas for further enhancements to improve the digitalisation efforts. The answers given are analysed and tabulated in Table 4.39.

Table 4.41: Areas for Further Enhancement

No.	Areas of Enhancements	Frequency (n)
1	Software Management	4
2	Data Sharing and Analytics	3
3	Utilisation of BIM	2
4	Hardware Upgrade	1
5	Customer Service	1

4.7.2 Challenges Encountered when Striving to Enhance Digital Maturity

From the answers obtained from question B2 (n=17), there are five challenges encountered when striving to enhance digital maturity. The resistance to change is the most frequent quoted (35.3%) and the organisation's mindset is the only mentioned by a respondent (5.9%).

Table 4.42: Challenges Encountered

No.	Challenges Encountered	Frequency (n)
1	Resistance to Change	6
2	Cost	5
3	Training and Skills	3
4	Old Technologies	2
5	Organisation Mindset	1

4.7.3 Necessity for Further Improvement in Digital Maturity within Construction Supply Chain

According to question B3, a total of 17 respondents answered with 16 respondents agreeing to the statement and one disagreeing. Other than providing their agreement to the statement, 10 of them have provided their opinions on the fields to improve. Further explanation regarding this statement have been tabulated in Table 4.41.

Table 4.43: Necessity for Further Improvement

No.	Necessity for Further Improvement	Frequency (n)
1	Documentation / Time Saving	3
2	Blockchain / Transparency	2
3	Digital Platforms / Ease of Collaborations	2
4	Success in Other Industries / Awareness	2
5	Software / Useful Aid	1

4.8   Discussion

4.8.1   Digital Technologies Leads Maturity Level of Seven Digitalisation Dimensions in Malaysian Construction Industry.

Digital Technologies (H5, μ = 3.49) leads the maturity level of seven digitalisation dimensions, follow by Digital Organisation (H2, μ = 3.47), and Digital Training (H3, μ = 3.46). Digital Technology is the essentials to achieve digitalisation of the industry Malaysian construction industry. The significant technological advancements including Building Information Modelling (BIM) authoring tools, CAD measurement and project management software recently (Javaid et al., 2022). More and more companies are upgrading their in-house hardware and software to better handle their daily operations. In addition, digital technology is improving project visibility, reducing errors in works, and enhancing communication. The results also revealed that the company focuses on the digital organisation is also enhancing digital training at the same time. This means that they are not only investing in technology, but also in the people who use it. By providing training and development opportunities, companies can ensure that their employees are able to use technology to its full potential. The synergistic improvement of digital organization and digital training can lead to further gains in digital maturity.

4.8.2   The Four Pillars of Digitalisation: Digital Organisation, Digital Strategy, Digital Training and Digital Technology

The four digitalisation dimensions, Digital Organisation, Digital Strategy, Digital Training and Digital Technology are proving with the most frequent appearance on the top list of the 21 correlations coefficients. They are concluded as the four pillars of digitalisation.

First, technology is essential for a digital organization. Organizations need digital tools to enhance communication and enable data-driven decision-making. Digital technology can also automate repetitive tasks and streamline operations, which can reduce manual workloads and human errors. The high correlation coefficient of 0.7309 between variables A14 and A15 indicates that the percentage of digitized processes is highly correlated with the utilization of cloud infrastructure. This means that companies that invest in cloud computing are more likely to have a higher percentage of digitized processes. Cloud

computing provides scalability and accessibility, which are essential for digitized processes. For example, cloud computing can be used to store and process large amounts of data, which is necessary for data-driven decision-making. Cloud computing can also be used to provide access to applications and data from anywhere, which is important for collaboration and teamwork.

Second, a digital strategy drives a digital organization. The organization's goals and vision should be aligned with its digital strategy. This means that the organizational structure, processes, and culture should all be supportive of the digital strategy. A well-aligned organization can better allocate resources, such as budget and manpower, to support its digital strategy. A strong correlation coefficient of 0.7192 for the variables A3-A9 indicates that leadership is essential for a successful digital transformation. When leaders actively champion digital initiatives, it influences the organization's approach to training and development, leading to higher training efforts by the organization. This is because leaders set the tone for the team and their enthusiasm for digital transformation can motivate others to embrace change.

Third, digital training can help to foster a digital culture. When employees are trained on digital technologies, they can develop the skills and knowledge they need to thrive in a digital workplace. This can lead to a more adaptable and flexible workforce that is better able to embrace new technologies and changes. Digital training can also help to create a common language and understanding of digital concepts within the organization, which can improve communication and collaboration. A strong correlation coefficient of 0.7419 for the variables A9-A13 indicates that training can be a catalyst for promoting the adoption of new technologies in the construction field. Through training, employees can learn about digital skills and gain a broader understanding of the company's digital roadmap. This can make them more willing to adopt new digital technologies to address future challenges. Effective training programs also provide feedback mechanisms that allow employees to provide input, which the company can use to improve the implementation of new digital tools. As a result, employees are better equipped to embrace new technologies.

In conclusion, technology, digital strategy, and digital training are all essential for a successful digital organization. By investing in these areas,

organizations can create a more efficient, effective, and adaptable workforce that is better prepared for the challenges of the future.

4.8.3   Experience Drives Digitalisation Maturity

The results analysed in Section 4.6.3 revealed that more experience is associated with higher digital maturity. Respondents with more than 20 years of experience had the highest mean rank for most of the null hypotheses analysed. This is because they have had more time to develop their digital skills and knowledge, and they have seen firsthand how technology can be used to improve the construction industry. Experienced professionals are more likely to be involved in digital transformation efforts. They are more likely to understand the importance of digitalization and they are more likely to be willing to learn new skills. They are also more likely to be in leadership positions, where they can influence the adoption of new technologies. However, younger professionals are also embracing digitalization. They have grown up with technology and they are more comfortable using it. They are also more likely to be open to change. Overall, the findings suggest that years of working experience is a significant factor in digital maturity. However, other factors, such as leadership and culture, also play a role.

4.8.4   Company Size Affects Digital Maturity

The study found that company size has a significant impact on digital maturity in Section 4.6.3. Larger companies were more likely to be digitally mature than smaller companies. This is because larger companies have more resources, expertise, and experience in digital technologies. The study also found that the relationship between company size and digital maturity is not linear. Medium-sized companies were the most digitally mature, followed by large companies and small companies. This is because medium-sized companies have the resources and expertise of large companies, but they are also nimbler and more adaptable than large companies. The study's findings suggest that company size is an important factor to consider when developing a digital transformation strategy.

4.8.5   The Key to a Digitally Mature Construction Company

The study found that the following attributes of respondents had a significant impact on digital maturity:

- Years of working experience: Respondents with more years of experience were more likely to be digitally mature. This is because they have had more time to learn about and use digital technologies. (Section 4.6.3)

- Size of company: Respondents from larger companies were more likely to be digitally mature. This is because larger companies have more resources to invest in digital technologies. (Section 4.6.4)

- Business activities: Respondents involved in design-focused activities were more likely to be digitally mature. This is because these activities require the use of digital technologies to create and visualize designs. (Section 4.6.1)

- Profession: Respondents in certain professions, such as electrical and mechanical engineering, were more likely to be digitally mature. This is because these professions rely heavily on digital technologies to perform their work. (Section 4.6.2)

The study also found that the following relationships between respondent attributes and digital maturity were significant:

- Years of working experience and digital culture: Respondents with more years of experience were more likely to be part of organizations with a digital-first mindset. This is because they are more likely to be aware of the benefits of digital technologies and to be willing to adopt them. (Section 4.6.3)

- Size of company and utilization of BIM: Respondents from larger companies were more likely to use BIM (Building Information Modelling) software. This is because larger companies have the resources to invest in BIM software and to train their employees on how to use it. (Section 4.6.4)

- Profession and utilization of 3D modelling tools: Respondents in certain professions, such as electrical and mechanical engineering, were more likely to use 3D modelling tools. This is because these professions rely

heavily on 3D modelling tools to visualize and design their work. (Section 4.6.2)

The study's findings suggest that the attributes of respondents can have a significant impact on digital maturity. Organizations can improve their digital maturity by hiring and retaining employees with the right skills and experience, and by creating a culture that is supportive of digital transformation.

4.8.6   Future of Digitalisation of Construction

Through the response from the open-ended questions, we could identify that most respondents agree that their companies are adopting digital tools in their daily operations at (61.1%) but still suggest on ways to further improve the digitalisation efforts. The implication or upgrade of software is the most suggested followed by having a cloud database to share and analyse the data or documents with other parties. Some suggest improving on the utilisation of BIM to increase the BIM level of the company. To put it simply, the workforce should not only use BIM to visualise the building but also to track daily operations, calculate cost and profit as well as having clash detection. Moreover, there are suggestions on upgrading the hardware so that more advanced software could be used smoothly and improve on the customer service to have better communication and satisfaction on their services.

However, there are several challenges encountered through the implementation of digital tools such as resistance to change. As the workforce comprises of those working for many years, they have less acceptance to change as they had familiarized with the traditional methods and find it difficult to learn new digital skills. Moreover, certain companies do not have the extra cash flow to invest in such technologies and training programs for the workforce. As such, there is lack of competence of the workforce to operate or use new technologies as they do not undergo the required training and skills. Some companies are unwilling to change the old technologies to new as they think that the equipment is still usable, and it would be a waste to change. Following this statement, this is due to the organisations or leader's mindset whereby they do not have a big picture in mind and only think about short term expenses instead of long-term goals.

In the end, almost all respondents agreed that there is definitely necessity for the future improvement in digital maturity whether in a short duration or in the long run. They suggest improving on the documentation from manually handwritten to everything being kept online. Therefore, it is more time saving while being accessible anywhere, anytime by anyone. Furthermore, to incorporate blockchain technology into the supply chain. As a result, there is transparency while making sure every decision making or changes to the online documents or instructions could be tracked down and avoid disputes and miscommunication. A digital platform for open data environment is encouraged to promote communication and collaborations among team members or stakeholders. After seeing the success of digitalisation on other industry like agriculture, they have realised that repetitive daily operations could be replaced by machines and thus, have more time to resolve other problems. Finally, one suggested to first upgrade the software provided by the company and also have programs to learn the digital skills required by the software.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

The following section, Section 5.2, depicts the accomplishment of research aim and objectives in depth and elaborates on the findings as compared with the objectives. Section 5.3 discussed on the implication of this research in the industry for different personnel including individual, governing bodies and academic communities. In addition, Section 5.4 highlights the limitations regarding this research including sample size and number of responses for open ended questions. Section 5.5 provides recommendation for future research of similar field to be investigated such as increasing in sample size and not limiting the research to Malaysia only.

5.1   Accomplishment on Research Aim and Objectives

To conclude, the accomplishment of research aim and objectives will be stated accordingly. For research objective 1, the current digital maturity level is 3.43 out of 5 according to average of seven digitisation dimensions with digital technology leading the dimensions. For research objective 2, years of experience and size of company have a stronger impact as compared to business activities and profession. For research objective 3, digital training and digital technology is focused on as a means of improvements as they are the fundamentals for both man and machine. The research successfully accomplished the research aim.

5.1.1   Research Objective 1: To assess the current digital maturity level in construction supply chain

The digital maturity level in the construction supply chain is 3.4326 out of five according to the average of the seven digitalisation dimensions listed in Table 4.3. This research found that digital technology leads maturity level of seven digitalisation dimensions in Malaysian construction supply chain. The maturity of the seven-digitalisation dimension in descending order are: digital technology, digital organisation, digital training, digital strategy, digital metrics, digital

culture and utilisation of BIM. This research also identified the four pillars of digitalisation are digital organisation, digital strategy, digital training, and digital technology according to the correlation analysis.

5.1.2 Research Objective 2: To evaluate the impact of demographic background on the digital maturity

The research found that years of experience and company size are two more significant demographic attributes affecting the digital maturity of the company. Respondents with more years of experience were more likely to be digitally mature. This is because they have had more time to learn about and use digital technologies. Larger companies were more likely to be digitally mature than smaller companies. This is because larger companies have more resources to invest in digital technologies. The study also found that the relationship between company size and digital maturity is not linear. Medium-sized companies were the most digitally mature, followed by large companies and small companies.

5.1.3 Research Objective 3: To identify areas of improvement for the future of construction digitalisation

In a nutshell, construction supply chain can improve their digital maturity through invest in training and development programs that help employees learn about and use digital technologies, create a culture that is supportive of digital transformation, encouraging employees to use digital technologies and to be creative and innovative. In addition, organizations should make digital technologies accessible to all employees, regardless of their location or role, organizations should measure and track their progress in terms of digital maturity in order to identify areas of improvement. By taking these steps, organizations can improve their digital maturity and stay ahead of the competition.

5.1.4 Research Aim: To examine the digital maturity in the construction supply chain

This research concluded that digital maturity level of Malaysia construction supply chain is significantly above average. The Digital Technology leads the

other three digital dimensions (Digital Strategy, Digital Organisation and Digital Training) in the maturity of digitalisation of the industry. The years of experiences and size of company are mediating the maturity level, however the relationships of these two mediating variables and digital maturity are not linear. The following Figure 5.1 summarise the outcome of this research project.
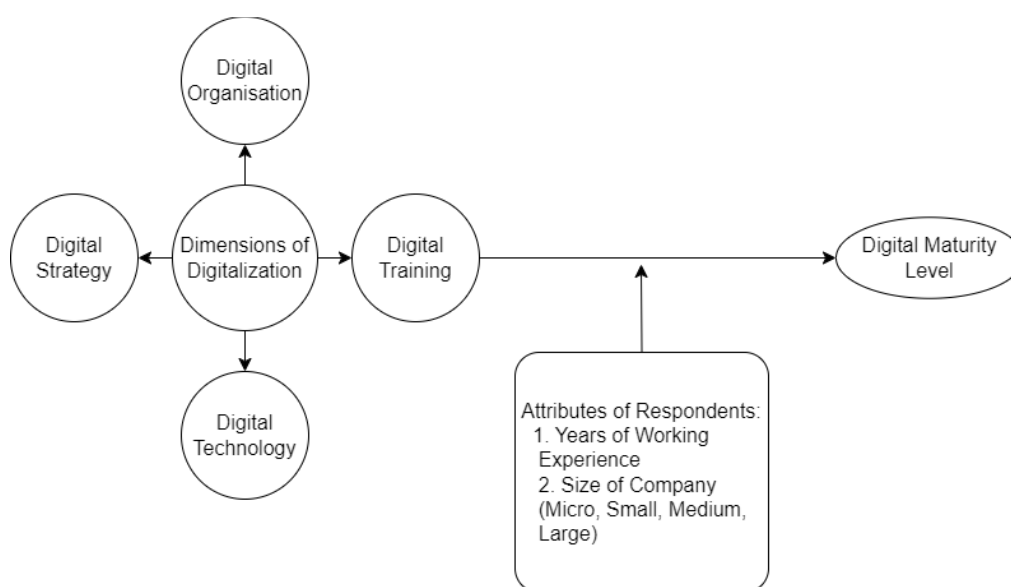
Figure 5.1: Digital Maturity Level in Construction Supply Chain

5.2   Research Implications

The implications of this research to the industry, governing bodies, and research or academic communities, respectively are outlined as follows:

a) Industry: The findings of this research can help industry leaders understand the factors that contribute to digital maturity. This knowledge can be used to develop strategies to improve their own organizations' digital maturity. For example, organizations can invest in training and development programs for employees, create a digital-first culture, and make digital technologies accessible to all employees.

b) Governing bodies: The findings of this research can help governing bodies develop policies and regulations that support digital transformation. For example, governing bodies can provide tax breaks or other incentives to organizations that invest in digital technologies.

They can also create regulations that protect consumers' privacy and security when using digital technologies.

c) Research or academic communities: The findings of this research can help researchers and academics develop new theories and models of digital maturity. This knowledge can be used to conduct further research on the topic and to develop new tools and resources to help organizations improve their digital maturity.

5.3 Research Limitations

The primary source of reliability for this research is the group of respondents who answered the questionnaire. However, the descriptive analysis is limited to internal comparisons only, as the descriptive statistics are insufficient to draw any definitive conclusions. This is because certain groups within the respondents' attributes have fewer than 30 respondents. As a result, the perspective of the construction industry on the digital maturity level may differ slightly depending on the respondents' attributes. Additionally, the data collected from the open-ended questions is small compared to the total number of respondents.

5.4 Research Recommendations

To further deepen and understand the digital maturity of the construction supply chain, data collection could be done through organizations or group discussions within the company, rather than by individual respondents. This is because individual respondents may be subject to personal experience and understanding. Additionally, the sample size should be larger to fulfil the requirements of certain respondents' attributes and to increase the overall number of respondents. Finally, this research could be conducted not only in Malaysia but also in other countries to define Malaysia's position in the global construction industry. This would allow us to learn from the mistakes of other countries and to ingest knowledge that is useful to the current industry. Some specific research questions that could be explored in future research:

- How do the factors that contribute to digital maturity vary across industries?

- How can organizations create a digital-first culture?
- What are the best practices for making digital technologies accessible to all employees?
- How can organizations measure and track their progress in terms of digital maturity?
- What are the long-term benefits of digital maturity for organizations?

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APPENDICES

Appendix A: The Google Form of Questionnaire

Examine the Digital Maturity in the Construction Supply Chain

Dear valued respondent(s),

I am Gordon Tay Zhi Wei and an undergraduate student pursuing Bachelor of Science (Honours) Quantity Surveying in University Tunku Abdul Rahman Sungai Long Campus. I am hereby conducting a research regarding examining the digital maturity in the construction supply chain. This questionnaire is structured to understand more details about the digital maturity in various companies in Malaysia and the thoughts of construction professionals towards the digitalisation of the construction supply chain.

The questionnaire consists of 3 sections:

Section A: Digital Infrastructure within the Company
Section B: Open Ended Questions
Section C: Demographic Information

I would be upmost grateful for your time and patience in answering this questionnaire. It would take a few minutes time and I would like to request that the answers are unbiased and based on personal experience. All personal information gathered would be private and confidential, and data received would be used for this study only.

Please do not hesitate to contact me at 012-869 9854 for further information

* Indicates required question

Section A: Digital Infrastructure within the Company

Please choose the most fitting description of your company from the options provided in each of the following questions.

1. A1 How well-defined is your organization's digital strategy? *

Mark only one oval.

◯ Undefined: Digital initiatives are ad-hoc or lack a cohesive and overarching plan.

◯ Vague: There may be some high-level goals or aspirations, but the strategy lacks detailed direction and objectives.

◯ Partially Defined: The digital strategy has been partially defined with some clear goals and objectives. However, there may be gaps in specific action plans or a lack of comprehensive implementation guidelines.

◯ Well-Defined: The strategy outlines a roadmap for digital transformation and provides a framework for decision-making and resource allocation.

◯ Highly Defined and Documented: The digital strategy is highly defined, documented, and widely communicated throughout the organization and includes comprehensive plans, specific initiatives, and performance metrics, serving as a guide for digital initiatives and fostering alignment with overall business objectives.

2. A2 How effectively does your organization communicate and align digital objectives with overall business goals? *

Mark only one oval.

○ No Communication or Alignment: Digital initiatives and business goals are treated as separate entities with little to no integration.

○ Limited Communication and Alignment: Digital objectives and business goals are partially connected and inconsistent, but there is room for improvement.

○ Partial Communication and Alignment: Efforts are made to connect digital initiatives with overall business strategies, but there are areas that need improvement.

○ Adequate Communication and Alignment: Digital initiatives are well-connected and aligned with overall business strategies, facilitating collaboration and synergy.

○ Strong Communication and Alignment: Digital initiatives are fully integrated with the organization's strategic objectives, enabling seamless coordination and maximizing value creation.

3. A3 To what extent does your senior leadership team champion digital transformation initiatives? *

Mark only one oval.

○ No Championing: There is a lack of support or active engagement from senior leaders in driving and advocating for digital transformation within the organization.

○ Limited Championing: There may be sporadic involvement or general awareness of digital transformation, but it is not a consistent or prominent focus for the senior leaders.

○ Moderate Championing: There are clear signs of support and commitment from senior leaders, with regular communication, resource allocation, and visible engagement in digital transformation efforts.

○ Strong Championing: Senior leaders actively promote and support digital transformation, allocate resources, and provide strategic guidance, demonstrating a clear commitment to driving the organization's digital agenda.

○ Highly Effective Championing: They lead by example, actively drive digital transformation, allocate resources strategically, foster a culture of innovation, and ensure that digital transformation is a top priority within the organization.

4. A4 How effectively do you manage organizational change during digital transformation initiatives? *

Mark only one oval.

○ Ineffectively: There is a lack of proper change management strategies, resulting in resistance, confusion, and disruptions to the transformation process.

○ Partially Effectively: Some change management strategies are implemented, but they may lack consistency or fail to address the full scope of organizational change, leading to challenges and delays.

○ Moderately Effectively: Change management strategies are employed to a reasonable extent, ensuring stakeholders are engaged, communication is clear, and adequate support is provided. However, some areas may require further attention.

○ Highly Effectively: Change management strategies are well-implemented, ensuring a smooth transition, proactive stakeholder engagement, effective communication, and comprehensive support to manage resistance and drive adoption of new digital practices.

○ Excellently Effectively: Mobile technology is fully integrated into reporting and issue tracking processes, with advanced features, user-friendly interfaces, and comprehensive functionalities, enabling accurate reporting, efficient issue tracking, and proactive management of project-related concerns.

8. A8 How well does the training curriculum address the specific digital skills required for the company's   *
digital maturity?

Mark only one oval.

  ◯ Inadequately: There is a mismatch between the skills covered in the training curriculum and the skills
necessary to support the company's digital transformation initiatives.

  ◯ Partially: Some relevant digital skills are included in the curriculum, but there may be gaps or limitations
in terms of comprehensiveness or alignment with the company's specific digital goals.

  ◯ Moderately: The curriculum covers a reasonable range of digital skills relevant to the company's digital
transformation goals, providing employees with a foundation to support digital initiatives.

  ◯ Effectively: The curriculum is tailored to the company's digital transformation goals, with a
comprehensive range of digital skills training that enables employees to contribute effectively to the
company's digital initiatives.

  ◯ Excellently: The curriculum is highly customized and designed to meet the exact digital skill requirements
of the company, ensuring employees are equipped with advanced and specialized skills necessary to drive
digital transformation and excel in their roles.

9. A9 How effectively does the training support the overall digital maturity roadmap of the company? *

Mark only one oval.

  ◯ Ineffectively: There is a misalignment between the training content and the specific skills and knowledge
required to achieve the company's digital maturity goals.

  ◯ Partially Effectively: Some aspects of the training are aligned with the digital maturity roadmap, but there
may be gaps or inconsistencies in addressing all the necessary skills and competencies.

  ◯ Moderately Effectively: The training content aligns reasonably well with the digital maturity roadmap,
covering a range of skills and competencies necessary to progress towards the company's digital goals.

  ◯ Highly Effectively: The training curriculum is closely aligned with the specific skills and knowledge
outlined in the digital maturity roadmap, providing employees with the necessary tools and capabilities to drive
digital transformation within the organization.

  ◯ Excellently Effectively: The training program is specifically designed and continuously updated to
perfectly align with the digital maturity roadmap, ensuring that employees receive comprehensive and targeted
training to support the company's digital transformation goals.

10. A10 To what extent do you use data analytics to gain insights and inform decision-making? *

Mark only one oval.

  ◯ No Utilization: Decisions are primarily based on intuition, experience, or limited data analysis.

  ◯ Limited Utilization: There may be occasional analysis of data, but it is not a widespread practice or
integrated into decision-making processes.

  ◯ Moderate Utilization: Data analysis is conducted on a regular basis to support decision-making, but it
may not be fully integrated or leveraged across all relevant areas.

  ◯ Substantial Utilization: Data analysis is a standard practice, and insights from data are actively used to
drive decision-making processes across various functions and levels.

  ◯ Comprehensive Utilization: Data analysis is deeply ingrained in the organization's culture, and data-
driven decision-making is the norm across all levels and functions.

11. A11 To what extent do you use data analytics for monitoring and controlling purposes? *

Mark only one oval.

◯ No Utilization: Data analytics is not employed to monitor or control various aspects of operations, and decisions are made based on other methods or limited data analysis.

◯ Limited Utilization: Data analytics is used sporadically or in specific areas of operations, but it is not consistently applied across the organization or integrated into decision-making processes.

◯ Moderate Utilization: Data analytics is employed in several areas of operations to monitor performance, identify trends, and inform decision-making, contributing to improved monitoring and control mechanisms.

◯ Substantial Utilization: Data analytics is systematically used across various areas of operations to monitor key performance indicators, track progress, detect anomalies, and optimize processes, resulting in effective monitoring and control mechanisms.

◯ Comprehensive Utilization: Data analytics is deeply ingrained in the organization's monitoring and control processes, with advanced analytics capabilities, real-time monitoring, predictive analytics, and comprehensive reporting, enabling proactive decision-making and precise control over operations.

12. A12 How effectively do you measure the impact of digital initiatives on project performance? *

Mark only one oval.

◯ Ineffectively: There is a lack of defined metrics, data collection methods, or analysis techniques to evaluate the specific impact of digital initiatives on project outcomes.

◯ Partially Effectively: There may be limited metrics or data collection processes in place, but the evaluation of the impact is not comprehensive or consistent across all projects.

◯ Moderately Effectively: There are established metrics and evaluation methods to assess the impact of digital initiatives, providing valuable insights into the improvements or changes observed in project performance.

◯ Highly Effectively: Robust measurement frameworks, well-defined metrics, and data-driven analysis techniques are employed to assess the direct impact of digital initiatives, enabling evidence-based decision-making and continuous improvement of project performance.

◯ Excellently Effectively: Measurement processes are ingrained in the organization's project management practices, with comprehensive data collection, sophisticated analysis methods, and regular reporting, resulting in a deep understanding of the direct and indirect effects of digital initiatives on project performance.

13. A13 To what extent does your organization promote user adoption and acceptance of new digital tools? *

Mark only one oval.

◯ No Promotion: There is little to no effort made to encourage employees to embrace and effectively use new digital tools.

◯ Limited Promotion: There may be minimal communication or training provided, but it is not consistently or comprehensively promoted.

◯ Moderate Promotion: There are efforts to communicate the benefits, provide training or resources, and address concerns to encourage employees to embrace new digital tools.

◯ Substantial Promotion: There are comprehensive training programs, change management initiatives, and ongoing support to facilitate smooth adoption and encourage employees to effectively use new digital tools.

◯ Comprehensive Promotion: User adoption is a strategic focus, with tailored training, extensive support, effective change management, and a strong emphasis on creating a positive user experience to ensure successful adoption of new digital tools.

14. A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities? *

Mark only one oval.

◯ No Utilization: All data and applications are stored and managed locally within the organization's infrastructure.

◯ Limited Utilization: There may be sporadic use of cloud services or limited adoption of data storage and network technologies.

◯ Moderate Utilization: There are dedicated efforts to leverage cloud services and utilize data storage and network technologies for specific purposes.

◯ Substantial Utilization: Cloud services are integrated into various aspects of the organization's operations, and data storage and network technologies are well-established and utilized across multiple functions.

◯ Comprehensive Utilization: Cloud services are deeply integrated into the organization's infrastructure, and advanced data storage and network technologies are utilized across the organization to drive efficiency, scalability, and collaboration.

15. A15 What percentage of construction processes and activities are digitized? *

Mark only one oval.

◯ 0% Digitized: All construction processes and activities are carried out manually or through traditional non-digital methods.

◯ Minimal Digitization: A small percentage (0-25%) and only a few selected processes or activities have been digitized, and the majority still rely on traditional methods.

◯ Partial Digitization: A moderate percentage (25-50%) of construction processes and activities are digitized.

◯ Substantial Digitization: A significant percentage (51-75%) of construction processes and activities are digitized and thus, leading to notable improvements in productivity, collaboration, and project outcomes.

◯ Extensive Digitization: A large percentage (76-100%) of construction processes and activities are digitized and thus, resulting in high levels of efficiency, accuracy, and integration across the organization.

16. A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements? *

Mark only one oval.

- Not at all: The organization does not prioritize or embrace digital technologies, and there is limited recognition of their potential benefits.

- Minimally: The organization has minimal focus on digital technologies and does not actively encourage a digital-first mindset among employees.

- Moderately: The organization recognizes the importance of digital technologies but has room for improvement in fostering a digital-first mindset across the organization.

- Significantly: The organization actively promotes a digital-first mindset and encourages employees to leverage digital technologies to drive innovation and efficiency.

- Fully: The organization has fully embraced a digital-first mindset and actively seeks out and adopts emerging digital technologies to stay ahead in the industry.

17. A17 How effectively does your organization prioritize digital skills development and provide training opportunities? *

Mark only one oval.

- Ineffectively: The organization does not effectively prioritize digital skills development or provide sufficient training opportunities, resulting in a lack of digital proficiency among employees.

- Partially effectively: The organization provides some training opportunities for digital skills development, but there is a need for more comprehensive and continuous support.

- Moderately effectively: The organization prioritizes digital skills development and offers regular training opportunities to enhance employees' digital competencies.

- Highly effectively: The organization actively invests in digital skills development, offering a wide range of training programs and resources to empower employees with the necessary digital skills.

- Excellently effectively: The organization excels in prioritizing digital skills development, providing extensive and tailored training opportunities to ensure employees possess advanced digital skills for the digital age.

18. A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools? *

Mark only one oval.

- Ineffectively: The organization does not effectively promote collaboration or knowledge sharing through digital platforms or tools, resulting in limited communication and siloed information.

- Partially effectively: The organization has some digital platforms and tools for collaboration and knowledge sharing, but their usage or adoption is not consistent or comprehensive.

- Moderately effectively: The organization promotes collaboration and knowledge sharing through various digital platforms and tools, enabling better communication and access to information.

- Highly effectively: The organization actively encourages and supports collaboration and knowledge sharing through a wide range of digital platforms and tools, fostering a culture of openness and continuous learning.

- Excellently effectively: The organization excels in promoting collaboration and knowledge sharing through robust and intuitive digital platforms and tools, resulting in seamless communication, enhanced collaboration, and efficient knowledge transfer.

19. A19 To what extent do you integrate 3D modelling tools for visualizing project progress? *

Mark only one oval.

◯ No Integration: Project progress is primarily communicated through traditional 2D drawings or other non-visual means.

◯ Limited Integration: 3D models may be used sparingly or in specific instances, but they are not widely utilized for tracking and communicating project progress.

◯ Moderate Integration: 3D models are utilized to some extent for tracking and visualizing project progress, but their use may not be consistent across all projects or stages.

◯ Substantial Integration: 3D models are regularly used to track, visualize, and communicate project progress, providing stakeholders with a clear and comprehensive understanding of the project's evolution.

◯ Comprehensive Integration: 3D models are integral to project management processes, serving as a primary means of tracking, visualizing, and communicating project progress throughout all stages of the project.

20. A20 How extensively does your organization utilize BIM in design and construction projects? *

Mark only one oval.

◯ No Utilization: Traditional design and construction methods are primarily employed, without leveraging the benefits of BIM technology.

◯ Limited Utilization: BIM is used in specific projects or certain phases of the design and construction process, but it is not fully integrated or consistently applied across all projects.

◯ Moderate Utilization: BIM is utilized in a significant number of projects or across multiple phases of the design and construction process, resulting in improved coordination, collaboration, and visual representation of projects.

◯ Substantial Utilization: BIM is fully integrated into the organization's design and construction workflows, enabling advanced clash detection, 3D modeling, data management, and enhanced collaboration among project stakeholders.

◯ Comprehensive Utilization: BIM is a standard practice and core component of the organization's design and construction processes, utilized across all projects and throughout the project lifecycle, leading to increased efficiency, accuracy, and improved project outcomes.

21. A21 How well do you leverage BIM and 3D modeling for clash detection and coordination? *

Mark only one oval.

    ◯ Poorly: Clash detection and coordination are not effectively conducted using BIM and 3D modeling tools, leading to frequent clashes, coordination issues, and rework.

    ◯ Partially: Some clash detection and coordination activities are performed using BIM and 3D modeling tools, but there is room for improvement in terms of accuracy, efficiency, and integration with the overall project workflow.

    ◯ Adequately: Clash detection and coordination activities are regularly conducted using BIM and 3D modeling tools, resulting in improved clash identification, coordination resolution, and overall project efficiency.

    ◯ Effectively: BIM and 3D modeling tools are seamlessly integrated into the clash detection and coordination processes, enabling efficient clash identification, timely issue resolution, and enhanced coordination among project stakeholders.

    ◯ Excellently: BIM and 3D modeling tools are extensively utilized, with advanced clash detection algorithms, automated coordination workflows, and real-time collaboration, resulting in highly accurate clash detection, streamlined coordination, and minimized rework.

Section B: Open Ended Questions

22. B1 Do you believe your company has adequately embraced digitalization in its daily operations? Please provide details on areas where further enhancements can be made to improve digitalization efforts.

    _____

23. B2 What are the primary challenges encountered when striving to enhance the digital maturity of your company further?

    _____

24. B3 Do you believe there is a need for further improvement in digital maturity within the construction supply chain? Please provide an elaboration on why it is necessary and how it can be achieved.

    _____

Section C: Demographic Information

25. C1 Which of the following business activities best describe your company? *

Mark only one oval.

( ) Property Development

( ) Business Consultancy

( ) Business Contracting

( ) Building Material Manufacturing

( ) Equipment Supply/Rent Business

( ) Other: _____

26. C2 Which of the following best describe your profession? *

Mark only one oval.

( ) Architect

( ) Chartered Builder

( ) Civil & Structural Engineer

( ) Mechanical & Electrical Engineer

( ) Quantity Surveyor

( ) Other: _____

27. C3 How many years have you been working in the construction industry? *

Mark only one oval.

( ) Less than 2 years

( ) 2 - 5 years

( ) 6 - 10 years

( ) 11 - 20 years

( ) More than 20 years

28. C4 How many employees are working in your company? *

Mark only one oval.

( ) Less than 5 employees

( ) More than 5 and less than 30 employees

( ) More than 30 and less than 75 employees

( ) More than 75 and less than or equal to 200 employees

( ) More than 200 employees

29. C5 What is the yearly sales turnover in your company? *

Mark only one oval.

◯ Less than RM300,000.00

◯ More than RM 300,000.00 and less than RM3 million

◯ More than RM3 million and less than RM15 million

◯ More than RM15 million and less than or equal to RM20 million

◯ More than RM20 million and less than or equal to RM50 million

◯ More than RM50 million

Consent of Participation

30. Dear Participants/Respondents, I would like to have your consent on your participation for this *
questionnaire. The answers given should be honest and based on your own opinion and experience.

All data collected from this questionnaire would be private and confidential and of use for this research paper and this research paper only. Please rest assure that no data would be disclosed for other purposes.

Thank you

Check all that apply.

☐ I acknowledge and give the permission to use the data collected for this research paper.

Appendix B: Rubrics of Questionnaire Design

Section A: Digital Infrastructure within the Company

Question No.	Rating Scale				
	1	**2**	**3**	**4**	**5**
A1 How well-defined is your organization's digital strategy?	Undefined: Digital initiatives are ad-hoc or lack a cohesive and overarching plan.	Vague: There may be some high-level goals or aspirations, but the strategy lacks detailed direction and objectives.	Partially Defined: The digital strategy has been partially defined with some clear goals and objectives. However, there may be gaps in specific action plans or a lack of comprehensive implementation guidelines.	Well-Defined: The strategy outlines a roadmap for digital transformation and provides a framework for decision-making and resource allocation.	Highly Defined and Documented: The digital strategy is highly defined, documented, and widely communicated throughout the organization and includes comprehensive plans, specific initiatives, and performance metrics, serving as a guide for digital initiatives and fostering alignment with overall business objectives.

A2 How effectively does your organization communicate and align digital objectives with overall business goals?	No Communication or Alignment: Digital initiatives and business goals are treated as separate entities with little to no integration.	Limited Communication and Alignment: Digital objectives and business goals are partially connected and inconsistent, but there is room for improvement.	Partial Communication and Alignment: Efforts are made to connect digital initiatives with overall business strategies, but there are areas that need improvement.	Adequate Communication and Alignment: Digital initiatives are well-connected and aligned with overall business strategies, facilitating collaboration and synergy.	Strong Communication and Alignment: Digital initiatives are fully integrated with the organization's strategic objectives, enabling seamless coordination and maximizing value creation.
A3 To what extent does your senior leadership team champion digital transformation initiatives?	No Championing: There is a lack of support or active engagement from senior leaders in driving and advocating for digital transformation within the organization.	Limited Championing: There may be sporadic involvement or general awareness of digital transformation, but it is not a consistent or prominent focus for the senior leaders.	Moderate Championing: There are clear signs of support and commitment from senior leaders, with regular communication, resource allocation, and visible engagement in digital transformation efforts.	Strong Championing: Senior leaders actively promote and support digital transformation, allocate resources, and provide strategic guidance, demonstrating a clear commitment to driving the organization's digital agenda.	Highly Effective Championing: They lead by example, actively drive digital transformation, allocate resources strategically, foster a culture of innovation, and ensure that digital transformation is a top priority within the organization.

A4 How effectively do you manage organizational change during digital transformation initiatives?	Ineffectively: There is a lack of proper change management strategies, resulting in resistance, confusion, and disruptions to the transformation process.	Partially Effectively: Some change management strategies are implemented, but they may lack consistency or fail to address the full scope of organizational change, leading to challenges and delays.	Moderately Effectively: Change management strategies are employed to a reasonable extent, ensuring stakeholders are engaged, communication is clear, and adequate support is provided. However, some areas may require further attention.	Highly Effectively: Change management strategies are well-implemented, ensuring a smooth transition, proactive stakeholder engagement, effective communication, and comprehensive support to manage resistance and drive adoption of new digital practices.	Excellently Effectively: Mobile technology is fully integrated into reporting and issue tracking processes, with advanced features, user-friendly interfaces, and comprehensive functionalities, enabling accurate reporting, efficient issue tracking, and proactive management of project-related concerns.
A5 To what extend does your organization use collaborative platforms and tools?	No Utilization: Collaboration primarily occurs through traditional communication channels such as emails, phone calls, or in-person meetings.	Limited Utilization: There may be sporadic use of certain collaboration tools, but it is not widespread or fully integrated into daily operations.	Moderate Utilization: There are dedicated efforts to utilize collaborative tools for specific purposes or within certain teams, but there is room for further	Substantial Utilization: Collaborative tools are widely used to facilitate communication, document sharing, and project collaboration,	Comprehensive Utilization: Collaborative tools are deeply integrated into the organization's workflow, enabling seamless collaboration, real-time

			adoption and integration across the organization.	contributing to enhanced teamwork and efficiency.	communication, and efficient project management across teams and stakeholders.
A6 How effectively do you share information and documents across teams and stakeholders?	Ineffective: There is a lack of standardized processes or tools, leading to difficulties in accessing and sharing relevant information and documents.	Partially Effective: There may be some established methods or tools for sharing, but they are not consistently utilized or optimized for seamless information exchange.	Adequate: There are established processes and tools for information sharing, enabling access to necessary documents and promoting collaboration.	Effective: There are streamlined processes and efficient tools that facilitate seamless sharing and access to information and documents, supporting effective collaboration.	Highly Effective: There are robust systems and advanced tools in place, ensuring secure and efficient sharing of information and documents, enhancing collaboration, and enabling quick and easy access to relevant resources.
A7 To what extent does your organization provide training and development	No Opportunities: The organization does not provide any training or development opportunities for digital skills.	Limited Opportunities: There may be occasional workshops or short-term training programs, but the scope and frequency are limited.	Moderate Opportunities: There are dedicated efforts to offer relevant training programs, courses, or resources to improve digital	Substantial Opportunities: There are comprehensive training programs, certifications, and continuous learning initiatives to enhance	Comprehensive Opportunities: Digital skills training is ingrained in the organizational culture, with a wide range of learning resources,

			competencies, although further expansion is needed.	digital capabilities across different job roles and functions.	mentorship programs, and upskilling initiatives to ensure employees have the necessary digital competencies for their roles.
opportunities for digital skills?					
A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	Inadequately: There is a mismatch between the skills covered in the training curriculum and the skills necessary to support the company's digital transformation initiatives.	Partially: Some relevant digital skills are included in the curriculum, but there may be gaps or limitations in terms of comprehensiveness or alignment with the company's specific digital goals.	Moderately: The curriculum covers a reasonable range of digital skills relevant to the company's digital transformation goals, providing employees with a foundation to support digital initiatives.	Effectively: The curriculum is tailored to the company's digital transformation goals, with a comprehensive range of digital skills training that enables employees to contribute effectively to the company's digital initiatives.	Excellently: The curriculum is highly customized and designed to meet the exact digital skill requirements of the company, ensuring employees are equipped with advanced and specialized skills necessary to drive digital transformation and excel in their roles.
A9 How effectively does the training support the overall	Ineffectively: There is a misalignment between the training content and the	Partially Effectively: Some aspects of the training are aligned with	Moderately Effectively: The training content aligns reasonably well	Highly Effectively: The training curriculum is closely aligned with the	Excellently Effectively: The training program is specifically designed and

digital maturity roadmap of the company?	specific skills and knowledge required to achieve the company's digital maturity goals.	the digital maturity roadmap, but there may be gaps or inconsistencies in addressing all the necessary skills and competencies.	with the digital maturity roadmap, covering a range of skills and competencies necessary to progress towards the company's digital goals.	specific skills and knowledge outlined in the digital maturity roadmap, providing employees with the necessary tools and capabilities to drive digital transformation within the organization.	continuously updated to perfectly align with the digital maturity roadmap, ensuring that employees receive comprehensive and targeted training to support the company's digital transformation goals.
A10 To what extent do you use data analytics to gain insights and inform decision-making?	No Utilization: Decisions are primarily based on intuition, experience, or limited data analysis.	Limited Utilization: There may be occasional analysis of data, but it is not a widespread practice or integrated into decision-making processes.	Moderate Utilization: Data analysis is conducted on a regular basis to support decision-making, but it may not be fully integrated or leveraged across all relevant areas.	Substantial Utilization: Data analysis is a standard practice, and insights from data are actively used to drive decision-making processes across various functions and levels.	Comprehensive Utilization: Data analysis is deeply ingrained in the organization's culture, and data-driven decision-making is the norm across all levels and functions.
A11 To what extent do you use data analytics for	No Utilization: Data analytics is not employed to monitor or control various aspects of	Limited Utilization: Data analytics is used sporadically or in specific areas of operations, but it	Moderate Utilization: Data analytics is employed in several areas of operations to monitor	Substantial Utilization: Data analytics is systematically used across various areas of	Comprehensive Utilization: Data analytics is deeply ingrained in the organization's monitoring

monitoring and controlling purposes?	operations, and decisions are made based on other methods or limited data analysis.	is not consistently applied across the organization or integrated into decision-making processes.	performance, identify trends, and inform decision-making, contributing to improved monitoring and control mechanisms.	operations to monitor key performance indicators, track progress, detect anomalies, and optimize processes, resulting in effective monitoring and control mechanisms.	and control processes, with advanced analytics capabilities, real-time monitoring, predictive analytics, and comprehensive reporting, enabling proactive decision-making and precise control over operations.
A12 How effectively do you measure the impact of digital initiatives on project performance?	Ineffectively: There is a lack of defined metrics, data collection methods, or analysis techniques to evaluate the specific impact of digital initiatives on project outcomes.	Partially Effectively: There may be limited metrics or data collection processes in place, but the evaluation of the impact is not comprehensive or consistent across all projects.	Moderately Effectively: There are established metrics and evaluation methods to assess the impact of digital initiatives, providing valuable insights into the improvements or changes observed in project performance.	Highly Effectively: Robust measurement frameworks, well-defined metrics, and data-driven analysis techniques are employed to assess the direct impact of digital initiatives, enabling evidence-based decision-making and continuous	Excellently Effectively: Measurement processes are ingrained in the organization's project management practices, with comprehensive data collection, sophisticated analysis methods, and regular reporting, resulting in a deep understanding of the

				improvement of project performance.	direct and indirect effects of digital initiatives on project performance.
A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	No Promotion: There is little to no effort made to encourage employees to embrace and effectively use new digital tools.	Limited Promotion: There may be minimal communication or training provided, but it is not consistently or comprehensively promoted.	Moderate Promotion: There are efforts to communicate the benefits, provide training or resources, and address concerns to encourage employees to embrace new digital tools.	Substantial Promotion: There are comprehensive training programs, change management initiatives, and ongoing support to facilitate smooth adoption and encourage employees to effectively use new digital tools.	Comprehensive Promotion: User adoption is a strategic focus, with tailored training, extensive support, effective change management, and a strong emphasis on creating a positive user experience to ensure successful adoption of new digital tools.
A14 To what extent does your organization utilises cloud computing, data	No Utilization: All data and applications are stored and managed locally within the organization's infrastructure.	Limited Utilization: There may be sporadic use of cloud services or limited adoption of data storage and network technologies.	Moderate Utilization: There are dedicated efforts to leverage cloud services and utilize data storage and network	Substantial Utilization: Cloud services are integrated into various aspects of the organization's operations, and data storage and	Comprehensive Utilization: Cloud services are deeply integrated into the organization's infrastructure, and

			technologies for specific purposes.	network technologies are well-established and utilized across multiple functions.	advanced data storage and network technologies are utilized across the organization to drive efficiency, scalability, and collaboration.
storage, and network capabilities?					
A15 What percentage of construction processes and activities are digitized?	0% Digitized: All construction processes and activities are carried out manually or through traditional non-digital methods.	Minimal Digitization: A small percentage (0-25%) and only a few selected processes or activities have been digitized, and the majority still rely on traditional methods.	Partial Digitization: A moderate percentage (25-50%) of construction processes and activities are digitized.	Substantial Digitization: A significant percentage (51-75%) of construction processes and activities are digitized and thus, leading to notable improvements in productivity, collaboration, and project outcomes.	Extensive Digitization: A large percentage (76-100%) of construction processes and activities are digitized and thus, resulting in high levels of efficiency, accuracy, and integration across the organization.
A16 To what extent does your organization foster a digital-first mindset	Not at all: The organization does not prioritize or embrace digital technologies, and there is limited	Minimally: The organization has minimal focus on digital technologies and does not actively encourage a	Moderately: The organization recognizes the importance of digital technologies but has room for improvement in	Significantly: The organization actively promotes a digital-first mindset and encourages employees to leverage	Fully: The organization has fully embraced a digital-first mindset and actively seeks out and adopts emerging digital

and embrace technological advancements?	recognition of their potential benefits.	digital-first mindset among employees.	fostering a digital-first mindset across the organization.	digital technologies to drive innovation and efficiency.	technologies to stay ahead in the industry.
A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	Ineffectively: The organization does not effectively promote collaboration or knowledge sharing through digital platforms or tools, resulting in limited communication and siloed information.	Partially effectively: The organization has some digital platforms and tools for collaboration and knowledge sharing, but their usage or adoption is not consistent or comprehensive.	Moderately effectively: The organization promotes collaboration and knowledge sharing through various digital platforms and tools, enabling better communication and access to information.	Highly effectively: The organization actively encourages and supports collaboration and knowledge sharing through a wide range of digital platforms and tools, fostering a culture of openness and continuous learning.	Excellently effectively: The organization excels in promoting collaboration and knowledge sharing through robust and intuitive digital platforms and tools, resulting in seamless communication, enhanced collaboration, and efficient knowledge transfer.

A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	No Integration: Project progress is primarily communicated through traditional 2D drawings or other non-visual means.	Limited Integration: 3D models may be used sparingly or in specific instances, but they are not widely utilized for tracking and communicating project progress.	Moderate Integration: 3D models are utilized to some extent for tracking and visualizing project progress, but their use may not be consistent across all projects or stages.	Substantial Integration: 3D models are regularly used to track, visualize, and communicate project progress, providing stakeholders with a clear and comprehensive understanding of the project's evolution.	Comprehensive Integration: 3D models are integral to project management processes, serving as a primary means of tracking, visualizing, and communicating project progress throughout all stages of the project.
A20 How extensively does your organization utilize BIM in design and construction projects?	No Utilization: Traditional design and construction methods are primarily employed, without leveraging	Limited Utilization: BIM is used in specific projects or certain phases of the design and construction process,	Moderate Utilization: BIM is utilized in a significant number of projects or across multiple phases of the design and	Substantial Utilization: BIM is fully integrated into the organization's design and construction	Comprehensive Utilization: BIM is a standard practice and core component of the organization's design and

	the benefits of BIM technology.	but it is not fully integrated or consistently applied across all projects.	construction process, resulting in improved coordination, collaboration, and visual representation of projects.	workflows, enabling advanced clash detection, 3D modeling, data management, and enhanced collaboration among project stakeholders.	construction processes, utilized across all projects and throughout the project lifecycle, leading to increased efficiency, accuracy, and improved project outcomes.
A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	Poorly: Clash detection and coordination are not effectively conducted using BIM and 3D modeling tools, leading to frequent clashes, coordination issues, and rework.	Partially: Some clash detection and coordination activities are performed using BIM and 3D modeling tools, but there is room for improvement in	Adequately: Clash detection and coordination activities are regularly conducted using BIM and 3D modeling tools, resulting in improved clash identification,	Effectively: BIM and 3D modeling tools are seamlessly integrated into the clash detection and coordination processes, enabling efficient clash identification, timely	Excellently: BIM and 3D modeling tools are extensively utilized, with advanced clash detection algorithms, automated coordination workflows, and real-

terms of accuracy, efficiency, and integration with the overall project workflow.	coordination resolution, and overall project efficiency.	issue resolution, and enhanced coordination among project stakeholders.	time collaboration, resulting in highly accurate clash detection, streamlined coordination, and minimized rework.

Section B: Open Ended Questions

Ref. Code	Questions
B1	Do you believe your company has adequately embraced digitalization in its daily operations? Please provide details on areas where further enhancements can be made to improve digitalization efforts.
B2	What are the primary challenges encountered when striving to enhance the digital maturity of your company further?
B3	Do you believe there is a need for further improvement in digital maturity within the construction supply chain? Please provide an elaboration on why it is necessary and how it can be achieved.

Section C: Demographic Information

Question No.	Answer Options					
C1 Which of the following business activities best describe your company?	Property Development	Business Consultancy	Business Contracting	Building Material Manufacturing	Equipment Supply/Rent Business	Other…
C2 Which of the following best describe your profession?	Architect	Chartered Builder	Civil & Structural Engineer	Mechanical & Electrical Engineer	Quantity Surveyor	Other…
C3 How many years have you been working in the construction industry?	Less than 2 years	2 - 5 years	6 - 10 years	11 - 20 years	More than 20 years	-
C4 How many employees are working in your company?	Less than 5 employees	More than 5 and less than 30 employees	More than 30 and less than 75 employees	More than 75 and less than or equal to 200 employees	More than 200 employees	-

C5 What is the yearly sales turnover in your company?	Less than RM300,000.00	More than RM 300,000.00 and less than RM3 million	More than RM3 million and less than RM15 million	More than RM15 million and less than or equal to RM20 million	More than RM20 million and less than or equal to RM50 million	More than RM50 million

Appendix C: Correlation of 21 Investigation Questions

Rank	Question 1	Question 2	Spearman Correlation
1	A9 How effectively does the training support the overall digital maturity roadmap of the company?	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	0.7419
2	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	A15 What percentage of construction processes and activities are digitized?	0.7309
3	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A9 How effectively does the training support the overall digital maturity roadmap of the company?	0.7192
4	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	A15 What percentage of construction processes and activities are digitized?	0.7186
5	A11 To what extent do you use data analytics for monitoring and controlling purposes?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.7129
6	A7 To what extent does your organization provide training and development opportunities for digital skills?	A11 To what extent do you use data analytics for monitoring and controlling purposes?	0.7101
7	A1 How well-defined is your organization's digital strategy?	A3 To what extent does your senior leadership team champion digital transformation initiatives?	0.7097

8	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	0.7073
9	A9 How effectively does the training support the overall digital maturity roadmap of the company?	A15 What percentage of construction processes and activities are digitized?	0.7070
10	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	0.7068
11	A7 To what extent does your organization provide training and development opportunities for digital skills?	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	0.7065
12	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	A11 To what extent do you use data analytics for monitoring and controlling purposes?	0.7061
13	A15 What percentage of construction processes and activities are digitized?	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	0.7044
14	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A10 To what extent do you use data analytics to gain insights and inform decision-making?	0.6995

15	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	0.6993
16	A1 How well-defined is your organization's digital strategy?	A10 To what extent do you use data analytics to gain insights and inform decision-making?	0.6989
17	A10 To what extent do you use data analytics to gain insights and inform decision-making?	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	0.6934
18	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.6926
19	A1 How well-defined is your organization's digital strategy?	A9 How effectively does the training support the overall digital maturity roadmap of the company?	0.6918
20	A20 How extensively does your organization utilize BIM in design and construction projects?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.6855
21	A10 To what extent do you use data analytics to gain insights and inform decision-making?	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	0.6781
22	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A5 To what extend does your organization use collaborative platforms and tools?	0.6781

23	A10 To what extent do you use data analytics to gain insights and inform decision-making?	A12 How effectively do you measure the impact of digital initiatives on project performance?	0.6773
24	A6 How effectively do you share information and documents across teams and stakeholders?	A10 To what extent do you use data analytics to gain insights and inform decision-making?	0.6767
25	A4 How effectively do you manage organizational change during digital transformation initiatives?	A15 What percentage of construction processes and activities are digitized?	0.6760
26	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A15 What percentage of construction processes and activities are digitized?	0.6755
27	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A6 How effectively do you share information and documents across teams and stakeholders?	0.6745
28	A5 To what extend does your organization use collaborative platforms and tools?	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	0.6734
29	A6 How effectively do you share information and documents across teams and stakeholders?	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	0.6721
30	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	0.6712

31	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.6700
32	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.6660
33	A9 How effectively does the training support the overall digital maturity roadmap of the company?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.6660
34	A9 How effectively does the training support the overall digital maturity roadmap of the company?	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	0.6634
35	A1 How well-defined is your organization's digital strategy?	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	0.6608
36	A1 How well-defined is your organization's digital strategy?	A5 To what extend does your organization use collaborative platforms and tools?	0.6598
37	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	0.6577

38	A9 How effectively does the training support the overall digital maturity roadmap of the company?	A10 To what extent do you use data analytics to gain insights and inform decision-making?	0.6565
39	A7 To what extent does your organization provide training and development opportunities for digital skills?	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	0.6561
40	A1 How well-defined is your organization's digital strategy?	A15 What percentage of construction processes and activities are digitized?	0.6557
41	A6 How effectively do you share information and documents across teams and stakeholders?	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	0.6546
42	A7 To what extent does your organization provide training and development opportunities for digital skills?	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	0.6538
43	A5 To what extend does your organization use collaborative platforms and tools?	A9 How effectively does the training support the overall digital maturity roadmap of the company?	0.6536
44	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	A15 What percentage of construction processes and activities are digitized?	0.6530
45	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	0.6526

46	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	0.6493
47	A7 To what extent does your organization provide training and development opportunities for digital skills?	A15 What percentage of construction processes and activities are digitized?	0.6490
48	A4 How effectively do you manage organizational change during digital transformation initiatives?	A10 To what extent do you use data analytics to gain insights and inform decision-making?	0.6489
49	A1 How well-defined is your organization's digital strategy?	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	0.6486
50	A9 How effectively does the training support the overall digital maturity roadmap of the company?	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	0.6480
51	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.6477
52	A4 How effectively do you manage organizational change during digital transformation initiatives?	A7 To what extent does your organization provide training and development opportunities for digital skills?	0.6475

53	A6 How effectively do you share information and documents across teams and stakeholders?	A15 What percentage of construction processes and activities are digitized?	0.6475
54	A11 To what extent do you use data analytics for monitoring and controlling purposes?	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	0.6470
55	A10 To what extent do you use data analytics to gain insights and inform decision-making?	A15 What percentage of construction processes and activities are digitized?	0.6456
56	A9 How effectively does the training support the overall digital maturity roadmap of the company?	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	0.6453
57	A1 How well-defined is your organization's digital strategy?	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	0.6446
58	A4 How effectively do you manage organizational change during digital transformation initiatives?	A9 How effectively does the training support the overall digital maturity roadmap of the company?	0.6438
59	A15 What percentage of construction processes and activities are digitized?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.6437
60	A7 To what extent does your organization provide training and development opportunities for digital skills?	A9 How effectively does the training support the overall digital maturity roadmap of the company?	0.6427

61	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.6424
62	A7 To what extent does your organization provide training and development opportunities for digital skills?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.6418
63	A7 To what extent does your organization provide training and development opportunities for digital skills?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.6415
64	A5 To what extend does your organization use collaborative platforms and tools?	A7 To what extent does your organization provide training and development opportunities for digital skills?	0.6414
65	A15 What percentage of construction processes and activities are digitized?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.6397
66	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A12 How effectively do you measure the impact of digital initiatives on project performance?	0.6389
67	A6 How effectively do you share information and documents across teams and stakeholders?	A9 How effectively does the training support the overall digital maturity roadmap of the company?	0.6382
68	A5 To what extend does your organization use collaborative platforms and tools?	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	0.6377

69	A1 How well-defined is your organization's digital strategy?	A4 How effectively do you manage organizational change during digital transformation initiatives?	0.6369
70	A15 What percentage of construction processes and activities are digitized?	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	0.6361
71	A4 How effectively do you manage organizational change during digital transformation initiatives?	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	0.6353
72	A11 To what extent do you use data analytics for monitoring and controlling purposes?	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	0.6330
73	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.6312
74	A5 To what extend does your organization use collaborative platforms and tools?	A15 What percentage of construction processes and activities are digitized?	0.6302
75	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	0.6296
76	A7 To what extent does your organization provide training and development opportunities for digital skills?	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	0.6296

77	A5 To what extend does your organization use collaborative platforms and tools?	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	0.6277
78	A4 How effectively do you manage organizational change during digital transformation initiatives?	A5 To what extend does your organization use collaborative platforms and tools?	0.6276
79	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.6275
80	A6 How effectively do you share information and documents across teams and stakeholders?	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	0.6273
81	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A9 How effectively does the training support the overall digital maturity roadmap of the company?	0.6272
82	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	A9 How effectively does the training support the overall digital maturity roadmap of the company?	0.6266
83	A1 How well-defined is your organization's digital strategy?	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	0.6263

84	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.6261
85	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	0.6261
86	A4 How effectively do you manage organizational change during digital transformation initiatives?	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	0.6255
87	A11 To what extent do you use data analytics for monitoring and controlling purposes?	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	0.6247
88	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.6244
89	A9 How effectively does the training support the overall digital maturity roadmap of the company?	A11 To what extent do you use data analytics for monitoring and controlling purposes?	0.6244

90	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	0.6238
91	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A4 How effectively do you manage organizational change during digital transformation initiatives?	0.6214
92	A6 How effectively do you share information and documents across teams and stakeholders?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.6214
93	A10 To what extent do you use data analytics to gain insights and inform decision-making?	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	0.6197
94	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	0.6193
95	A11 To what extent do you use data analytics for monitoring and controlling purposes?	A15 What percentage of construction processes and activities are digitized?	0.6174

96	A1 How well-defined is your organization's digital strategy?	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	0.6168
97	A12 How effectively do you measure the impact of digital initiatives on project performance?	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	0.6122
98	A12 How effectively do you measure the impact of digital initiatives on project performance?	A15 What percentage of construction processes and activities are digitized?	0.6119
99	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	0.6117
100	A1 How well-defined is your organization's digital strategy?	A6 How effectively do you share information and documents across teams and stakeholders?	0.6116
101	A11 To what extent do you use data analytics for monitoring and controlling purposes?	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	0.6116
102	A4 How effectively do you manage organizational change during digital transformation initiatives?	A11 To what extent do you use data analytics for monitoring and controlling purposes?	0.6101
103	A5 To what extend does your organization use collaborative platforms and tools?	A6 How effectively do you share information and documents across teams and stakeholders?	0.6099

104	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.6094
105	A1 How well-defined is your organization's digital strategy?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.6088
106	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A15 What percentage of construction processes and activities are digitized?	0.6054
107	A10 To what extent do you use data analytics to gain insights and inform decision-making?	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	0.6047
108	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	0.6040
109	A1 How well-defined is your organization's digital strategy?	A7 To what extent does your organization provide training and development opportunities for digital skills?	0.6020
110	A4 How effectively do you manage organizational change during digital transformation initiatives?	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	0.6018
111	A9 How effectively does the training support the overall digital maturity roadmap of the company?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.6015

112	A5 To what extend does your organization use collaborative platforms and tools?	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	0.5994
113	A15 What percentage of construction processes and activities are digitized?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.5985
114	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A10 To what extent do you use data analytics to gain insights and inform decision-making?	0.5978
115	A9 How effectively does the training support the overall digital maturity roadmap of the company?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.5967
116	A11 To what extent do you use data analytics for monitoring and controlling purposes?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.5967
117	A10 To what extent do you use data analytics to gain insights and inform decision-making?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.5939
118	A6 How effectively do you share information and documents across teams and stakeholders?	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	0.5932
119	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.5923

120	A1 How well-defined is your organization's digital strategy?	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	0.5923
121	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	0.5898
122	A5 To what extend does your organization use collaborative platforms and tools?	A10 To what extent do you use data analytics to gain insights and inform decision-making?	0.5897
123	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.5896
124	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.5894
125	A6 How effectively do you share information and documents across teams and stakeholders?	A12 How effectively do you measure the impact of digital initiatives on project performance?	0.5891
126	A7 To what extent does your organization provide training and development opportunities for digital skills?	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	0.5887
127	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A4 How effectively do you manage organizational change during digital transformation initiatives?	0.5885

128	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.5885
129	A1 How well-defined is your organization's digital strategy?	A12 How effectively do you measure the impact of digital initiatives on project performance?	0.5879
130	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.5875
131	A9 How effectively does the training support the overall digital maturity roadmap of the company?	A12 How effectively do you measure the impact of digital initiatives on project performance?	0.5870
132	A12 How effectively do you measure the impact of digital initiatives on project performance?	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	0.5849
133	A12 How effectively do you measure the impact of digital initiatives on project performance?	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	0.5838
134	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A5 To what extend does your organization use collaborative platforms and tools?	0.5822
135	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	0.5808

136	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.5804
137	A12 How effectively do you measure the impact of digital initiatives on project performance?	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	0.5799
138	A1 How well-defined is your organization's digital strategy?	A11 To what extent do you use data analytics for monitoring and controlling purposes?	0.5794
139	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	0.5793
140	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A6 How effectively do you share information and documents across teams and stakeholders?	0.5790
141	A4 How effectively do you manage organizational change during digital transformation initiatives?	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	0.5779
142	A12 How effectively do you measure the impact of digital initiatives on project performance?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.5779

143	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	0.5776
144	A1 How well-defined is your organization's digital strategy?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.5772
145	A5 To what extend does your organization use collaborative platforms and tools?	A11 To what extent do you use data analytics for monitoring and controlling purposes?	0.5760
146	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	0.5747
147	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A3 To what extent does your senior leadership team champion digital transformation initiatives?	0.5740
148	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.5736
149	A6 How effectively do you share information and documents across teams and stakeholders?	A11 To what extent do you use data analytics for monitoring and controlling purposes?	0.5726

150	A5 To what extend does your organization use collaborative platforms and tools?	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	0.5725
151	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A7 To what extent does your organization provide training and development opportunities for digital skills?	0.5698
152	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	0.5695
153	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	A12 How effectively do you measure the impact of digital initiatives on project performance?	0.5673
154	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.5671
155	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.5650
156	A15 What percentage of construction processes and activities are digitized?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.5649

157	A5 To what extend does your organization use collaborative platforms and tools?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.5647
158	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	A10 To what extent do you use data analytics to gain insights and inform decision-making?	0.5625
159	A11 To what extent do you use data analytics for monitoring and controlling purposes?	A12 How effectively do you measure the impact of digital initiatives on project performance?	0.5624
160	A10 To what extent do you use data analytics to gain insights and inform decision-making?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.5617
161	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A11 To what extent do you use data analytics for monitoring and controlling purposes?	0.5614
162	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A11 To what extent do you use data analytics for monitoring and controlling purposes?	0.5609
163	A4 How effectively do you manage organizational change during digital transformation initiatives?	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	0.5599

164	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.5583
165	A4 How effectively do you manage organizational change during digital transformation initiatives?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.5571
166	A4 How effectively do you manage organizational change during digital transformation initiatives?	A6 How effectively do you share information and documents across teams and stakeholders?	0.5568
167	A12 How effectively do you measure the impact of digital initiatives on project performance?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.5561
168	A10 To what extent do you use data analytics to gain insights and inform decision-making?	A11 To what extent do you use data analytics for monitoring and controlling purposes?	0.5557
169	A6 How effectively do you share information and documents across teams and stakeholders?	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	0.5553
170	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	0.5524
171	A5 To what extend does your organization use collaborative platforms and tools?	A12 How effectively do you measure the impact of digital initiatives on project performance?	0.5513

172	A6 How effectively do you share information and documents across teams and stakeholders?	A7 To what extent does your organization provide training and development opportunities for digital skills?	0.5512
173	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.5509
174	A14 To what extent does your organization utilises cloud computing, data storage, and network capabilities?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.5471
175	A10 To what extent do you use data analytics to gain insights and inform decision-making?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.5463
176	A12 How effectively do you measure the impact of digital initiatives on project performance?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.5447
177	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.5430
178	A9 How effectively does the training support the overall digital maturity roadmap of the company?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.5426
179	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.54160

180	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A12 How effectively do you measure the impact of digital initiatives on project performance?	0.5411
181	A11 To what extent do you use data analytics for monitoring and controlling purposes?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.5349
182	A7 To what extent does your organization provide training and development opportunities for digital skills?	A10 To what extent do you use data analytics to gain insights and inform decision-making?	0.5349
183	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A7 To what extent does your organization provide training and development opportunities for digital skills?	0.5335
184	A17 How effectively does your organization prioritize digital skills development and provide training opportunities?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.5307
185	A1 How well-defined is your organization's digital strategy?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.5291
186	A4 How effectively do you manage organizational change during digital transformation initiatives?	A18 How effectively does your organization promote collaboration and knowledge sharing through digital platforms and tools?	0.5269
187	A1 How well-defined is your organization's digital strategy?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.5263

188	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.5257
189	A2 How effectively does your organization communicate and align digital objectives with overall business goals?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.5244
190	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.5228
191	A13 To what extent does your organization promote user adoption and acceptance of new digital tools?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.5219
192	A16 To what extent does your organization foster a digital-first mindset and embrace technological advancements?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.5197
193	A10 To what extent do you use data analytics to gain insights and inform decision-making?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.5180
194	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.5129
195	A12 How effectively do you measure the impact of digital initiatives on project performance?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.5115

196	A8 How well does the training curriculum address the specific digital skills required for the company's digital maturity?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.5099
197	A3 To what extent does your senior leadership team champion digital transformation initiatives?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.5046
198	A11 To what extent do you use data analytics for monitoring and controlling purposes?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.4998
199	A6 How effectively do you share information and documents across teams and stakeholders?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.4928
200	A4 How effectively do you manage organizational change during digital transformation initiatives?	A12 How effectively do you measure the impact of digital initiatives on project performance?	0.4907
201	A5 To what extend does your organization use collaborative platforms and tools?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.4864
202	A4 How effectively do you manage organizational change during digital transformation initiatives?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.4829
203	A7 To what extent does your organization provide training and development opportunities for digital skills?	A12 How effectively do you measure the impact of digital initiatives on project performance?	0.4815

204	A6 How effectively do you share information and documents across teams and stakeholders?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.4776
205	A4 How effectively do you manage organizational change during digital transformation initiatives?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.4596
206	A5 To what extend does your organization use collaborative platforms and tools?	A19 To what extent do you integrate 3D modelling tools for visualizing project progress?	0.4522
207	A7 To what extent does your organization provide training and development opportunities for digital skills?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.4518
208	A6 How effectively do you share information and documents across teams and stakeholders?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.4444
209	A5 To what extend does your organization use collaborative platforms and tools?	A21 How well do you leverage BIM and 3D modeling for clash detection and coordination?	0.4335
210	A7 To what extent does your organization provide training and development opportunities for digital skills?	A20 How extensively does your organization utilize BIM in design and construction projects?	0.4154