



**INTEGRATED MODEL FOR ENHANCING VALUE MANAGEMENT
PERFORMANCE IN THE CONSTRUCTION INDUSTRY**

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**INTEGRATED MODEL FOR ENHANCING VALUE MANAGEMENT
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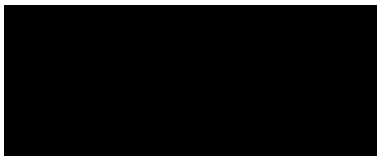
FEBRUARY, 2024

DEDICATION

This thesis is dedicated to God, the Almighty for His mercies, favour, and grace always granted upon my life.

DECLARATION

I, Comfort Olubukola Iyiola, affirmatively state that I have independently authored the thesis entitled "Integrated Model for Enhancing VM Performance in the Construction Industry." I have duly recognized and credited all the sources I've consulted in the reference section. This thesis is being submitted to the Durban University of Technology to fulfill the prerequisites for obtaining a Doctor of Philosophy degree in the Built Environment. Importantly, I have not presented this work, nor has anyone else on my behalf, for consideration in any other educational institution or examination.



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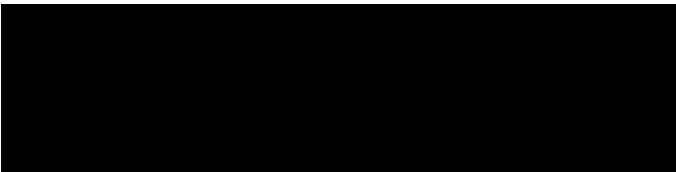
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EXECUTIVE SUMMARY

The introduction and integration of Value Management (VM), originally stemming from the manufacturing sector, has been actively promoted within the construction industry to enhance project delivery performance and its economic impact. Regrettably, the application of VM in construction faces several formidable challenges. These challenges can be attributed to various factors, including the transplantation of a management concept from manufacturing without adequate consideration of the specific variables and conditions conducive to VM's effective application in the construction sector. This research diligently investigated and formulated the variables essential for achieving optimal VM performance, thereby ensuring the appropriate application of VM principles in the construction industry.

The study employed a comprehensive research methodology, encompassing the sequential exploratory mixed-method research involving both qualitative and quantitative approaches. The qualitative aspect involved a Delphi study supported by relevant literature, engaging fourteen experts in a three-stage process. The insights obtained through the Delphi process aided in identifying the key dimensions (both primary and secondary) that contribute to the effectiveness of VM in the Nigerian construction industry. The findings derived from the Delphi study and the review of existing literature culminated in the development of a five-component model for enhancing VM performance in the Nigerian construction sector. These components comprise integration, collaboration, standardization, utilization of digital technologies, and the fostering of a conducive corporate culture. Subsequently, a quantitative survey employing questionnaires was conducted among professionals in the built environment. Over a three-month period, 202 completed questionnaires were collected through purposive and snowball sampling techniques. Initially, a descriptive statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 25 to present the demographic information of the respondents.

Furthermore, the study embraced structural equation modeling (SEM) utilizing the partial least squares (PLS) approach, leveraging the SmartPLS version 4 software. This analytical framework aimed to identify the constructs that most significantly influence effective VM performance and subsequently construct a model for improving VM performance in the Nigerian built environment. The methodological process, coupled with extensive analysis, pinpointed the constructs with direct influence and robust relationships with the outcome variables. This analysis encompassed assessments

of indicator reliability, internal consistency reliability, convergent validity, discriminant validity, collinearity, explanatory power of the model, predictive relevance of the model, goodness of fit indices, path significance, and several other quality checks, culminating in the formulation of the final VM performance model (referred to as Model 2.0). The questionnaire findings substantiated that these constructs collectively serve as predictors of VM performance in the Nigerian construction industry. Additionally, the study unearthed that the performance indicators for VM in construction are associated with the benefits of adopting VM, which include cost savings, efficient time management, improved project management, and the elimination of delays.

This study offers contributions to existing knowledge on three fronts: theoretical, methodological, and practical. Theoretical contributions encompass the recognition that existing constructs for modeling VM performance in construction are incomplete without the inclusion of corporate culture and digital technologies. Furthermore, the study highlights the most critical construct for predicting VM performance in the Nigerian construction industry. Methodologically, the study contributes by employing a mixed research approach, providing a comprehensive understanding of the issue at hand. The Delphi study enabled input from construction industry professionals to identify previously unaddressed indicators, while SEM effectively considers the indicators used in measuring the constructs and provides guidelines for adding or eliminating indicators. This methodological approach has facilitated the creation of a comprehensive VM model tailored to the Nigerian construction industry. On the practical front, the study aids construction stakeholders in improved project planning by identifying key variables that ensure VM performance.

In conclusion, this study recommends that similar research should be conducted in other developing countries. It also underscores the importance of corporate culture in promoting integration and collaboration within the Nigerian construction sector. Furthermore, the utilization of digital technologies is encouraged to facilitate stakeholder collaboration. Finally, stakeholders in the Nigerian construction industry are advised to align their VM practices with the five-factor model, with particular emphasis on integration, collaboration, and fostering effective corporate culture as pivotal components.

Keywords: Value Management, Delphi Technique, Construction Industry, PLS-SEM.

LIST OF ABBREVIATIONS

AVE	Average value extracted.
BDA	Big Data Analytics
BIM	Building information modelling
CA	Cronbach alpha
CC	Corporate culture
CR	Composite reliability
CVF	Competing value framework.
CVM	Construction value management
COL	Collaboration
DT	Digital technology
GDP	Gross domestic product
INT	Integration
IoT	Internet of Things
IQD	Interquartile deviation
PLS	Partial least square
RMSE	Root mean squared error
SEM	Structural equation modelling
SPSS	Scientific Package for Social Sciences
SRMR	Standardised root mean square residual
ST	Standardisation
TQM	Total Quality Management
VIF	Variance inflation factor
VM	Value management
VR	Virtual reality

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LIST OF PUBLICATIONS

Iyiola, C.O. and Mewomo, M.C. (2022). “Key Indicators for Successful Value Management Performance in the Built Environment: A Literature Review”. *Proceedings of the 12th International Conference on Construction in the 21st Century (CITC – 12)*, May 16-12, Amman, Jordan, pp. 248-256. CITC-12 PAPERS | citc (citcglobal.com)

Iyiola, C.O. and Mewomo, M.C. (2023). The Impact of Corporate Culture on Value Management Performance in the Construction Industry. In: Aigbavboa, C., Thwala, W., Aghimien, D. (eds) *Towards a Sustainable Construction Industry: The Role of Innovation and Digitalisation*. CIDB 2022. Springer, Cham.

Iyiola C.O. and Mewomo, M.C. (2023). Enhancing Construction Value Management Performance for the Future: The Need for Collaboration among Professionals. *Scientific African Journal* (Under review)
Benefits of Implementing Value Management Practices on the Performance of Construction Projects (Under review)

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

This chapter presents the background of value management (VM) practice in the built environment. Additionally, it suggests creating a VM model for the built environment sector. A VM model was proposed because a guideline is needed to show the variables supporting the performance of VM for the efficient completion of building projects in developing nations. The model developed from this study will ensure VM adoption in the built environment. Thus, this section shows the aim and objectives for developing the model. It also reveals the problems existing within the construction industry that created the need for adopting a VM concept for the construction industry.

1.2 GENERAL OVERVIEW OF THE STUDY

The building sector is instrumental in developing the built environment of economics around the world and this applies to the Nigerian building business as well (Aghimien *et al.* 2018b). The building sector contributes significantly to the economy, and its activities are essential to achieving the country's societal strategic priorities of fostering housing, infrastructure, and jobs (Fei *et al.* 2021). It is evident that the built environment is essential to the nation's continuous economic expansion and that its activities have a significant impact on almost every aspect of society (Oladinrin, Ogunsemi and Aje 2012b). In the same vein, it is the sector of the economy which transforms resources into constructed facilities through planning, design, construction, maintenance, and sustainability (Gunduz and Yahya 2018; Dosumu and Aigbavboa 2021).

Nevertheless, the construction industry of today has undergone substantial transformations compared to its state several decades ago. It now grapples with a range of challenges including heightened project complexity, inefficiencies in construction processes, cost and schedule overruns, project delivery delays, insufficient project planning, as well as increased uncertainty and lack of coherence (Ameri and Mohammadi 2013; Kahvandi *et al.* 2019; Bitamba and An 2020; Aigbavboa *et al.* 2022). Other factors include increased project targets and deliveries, environmental impact, shrinking project life cycles, changing organisational structures and designs, additional project players, more design iterations, poor quality of available equipment and raw materials, unavailability of resources, material shortage, etc. (Doloi *et al.* 2012; Iqbal *et al.* 2019). This circumstance runs counter to recent efforts by the majority of nations to ensure sustainability through the execution of sustainable building infrastructure (Aghimien *et al.* 2018b).

There is value when the clients' requirements are met, however, it is difficult for the project team to define value in terms of social, economic and environmental considerations (Zuofa and Ochieng 2016; Olanipekun *et al.* 2018; Lima *et al.* 2021; Stanitsas, Kirytopoulos and Leopoulos 2021). A fundamental shift in how building projects are delivered is required to fully address this, and various techniques that will help manage projects and deliver them sustainably must be adopted as well (Yılmaz and Bakış 2015; Cruz, Gaspar and de Brito 2019). Due to this, there has been advocacy for the implementation of VM for the successful delivery of construction projects (Hayles 2004; Abidin and Pasquire 2007; Al-Yami 2008a; Al-Saleh and Taleb 2010; Jaapar, Maznan and Zawawi 2012; Mohamad, Shen and Yu 2015; Noor 2015; Aigbavboa, Oke and Mojele 2016; Rachwan, Abotaleb and Elgazouli 2016; Oke and Aigbavboa 2017c; Aghimien, Oke and Aigbavboa 2018; Alshehri 2020; Kineber *et al.* 2020b).

Leung, Yu and Liang (2014) defined VM as an interdisciplinary approach that aims to maximize the efficiency of building project operations and satisfy customer requirements. It is a collaborative, structured, and empirical method that aims to analyze function in a systematic way (Oke and Aigbavboa 2017c). According to Oke and Aghimien (2018), VM is a strategic approach that entails managing participants, restructuring spaces and components, choosing the right resources, and streamlining the manufacturing process in order to achieve the project's objectives. Rachwan, Abotaleb and Elgazouli (2016) referred to VM as a systematic process to improve the value of a project through the analysis of its functions. Nevertheless, Aigbavboa, Oke and Mojele (2016) pointed out that VM is focused largely on a project or component activity rather than reducing costs. Oke and Aigbavboa (2017c) observed that when VM is employed on a project, significant economic sustainability can be attained since stakeholders have the chance to make sure that building projects generate prospects for getting the best value. This indicates that by deploying a various cost management technique at the least cost, it may be done without endangering project adoption and purpose.

Numerous research on the use and capability of VM to offer sustainability in building projects in developed and underdeveloped nations have been conducted. In the UK, Alalshikh (2009) mentioned that for the effective delivery of building projects that fit the country's values and economy, VM application is significant. According to Luvara and Mwemezi (2017), VM principles have helped improve how construction projects are delivered in the US. Utilization of the VM mechanism has been shown to be effective in achieving the building goals, i.e., to improve project design, execution, and budget (Othman *et al.* 2021). By advocating measures designed to reduce construction costs, VM can contribute to the sector's sustainability (Tutesigensi, Kibwami and Matege 2021). This is also in accordance with the suggestion of Tanko *et al.* (2018), who state

that the goal of VM should be to increase utilization and sustainability while reducing waste throughout project execution.

Also, VM has also been adopted by public sectors in most developed countries like USA, the UK, Hong Kong, China and Australia, to optimise public projects and achieve value for money invested (Bowen *et al.* 2010c; Kim *et al.* 2016; Kissi *et al.* 2017b). This opinion recognizes the importance of adopting VM (VM) practices for the construction industry. However, although VM has been suggested as a promising technique for achieving sustainable building projects in some countries, Al-Saleh and Taleb (2010) and Ezezue (2015) noted that this approach has not yet been fully implemented worldwide, especially in developing nations (Bowen *et al.* 2010c; Kim *et al.* 2016; Kissi *et al.* 2017b; Oke and Aghimien 2018; Sabiu, Mohamed and Mahmood 2020; Ojo, Ogunsemi and Ogunsina 2021). The concept of VM in Nigeria is still at the inception stage and confronted with numerous challenges and barriers (Aghimien, Oke and Aigbavboa 2018; Sabiu, Mohamed and Mahmood 2020). The potential of VM to produce sustainable buildings and the level of awareness that professionals in the construction industry have about it are likely contributing factors. Additionally, there hasn't been much study done to improve the performance of VM practices, which has discouraged many potential clients from using VM.

The implementation of VM and its advantages, as seen by building industry specialists are being brought to light by this study. Against this background, this study will develop a model for enhancing the VM performance in the Nigerian construction industry showing the variables that will enhance the practice of VM in Nigeria. It will also reveal the relationship between the variables and its impact on ensuring efficient VM adoption. The results can be generalized to other developing nations, particularly those in Africa, where construction projects are carried out using a similar method, style, and approach to the successful delivery of construction projects in the

Nigerian built environment. The findings are applicable not only to the country but can also be generalized to other developing nations.

1.3 PROBLEM STATEMENT

Ineffective VM practices result in poor project performance which could result in poor delivery of construction projects (Hwang, Zhao and Ong 2015). This poor performance can be attributed to; more design iterations, budget overrun, schedule overrun, the utilisation of new and unfamiliar materials, enormous wastes, cost overruns low-profit margin, budget overruns and delayed schedules which is affecting the sustainability of building projects (Oke and Ogunsemi 2011; Aigbavboa, Oke and Mojele 2016; Tanko *et al.* 2018). Consequently, projects with an ineffective VM processes that includes all uncertainty could not operate effectively (Oke and Ogunsemi 2011; Kineber *et al.* 2021d)

Prior research on the contribution of VM studies to greater productivity, sustainability and effective delivery of construction projects did not look into the possible ways in which the performance of VM practices can be enhanced and some moderating roles of people involved in VM. This research makes the argument that if thorough VM procedures are not implemented, the project's performance in the future will be impaired, and there is a low likelihood that construction projects will achieve their intended goals during the anticipated life span.

1.4 GAPS IDENTIFIED

Although, studies have been carried out on the barriers that influence the performance of VM practices (Shen and Ann 2012; Ezezue 2015; Luvara and Mwemezi 2017; Othman *et al.* 2021), sustainability and delivery of construction projects (Kineber *et al.* 2021d), the depth to which the different barriers affect the performance of VM practices neither confirmed nor widely accepted..

Establishing the crucial components will enhance the development a comprehensive integrated model that will enhance VM performance in the built environment. Lack of a detailed integrated model required that the most important elements that can enhance VM practices be undertaken. In addition, the pro and cons of the existing performance frameworks are examined in relation to VM research. Lin and Shen (2007) and Madushika *et al.* (2020) presented the performance measures of VM practices in the built environment and ascertained that the traditional performance measure of VM that focus on cost reduction is insufficient, rather, clarifying objectives and improving communication among stakeholders should be put into consideration but these studies did not reveal the result statistically.

Furthermore, the influence of collaboration and integration were investigated by Ojo, Ogunsemi and Ogunsina (2021) and Bennett and Mayouf (2021) to enhance VM performance in the construction industry. Although, this research was too shallow, excluding other important aspects of VM such as corporate culture and the use of innovative technologies which are the gaps this study filled. Collaborative relationship and integration among construction professionals during VM workshop can only be possible in the face of effective corporate culture which is an important prerequisite for achieving effective VM practices. Also, no study has been carried out in the construction industry relating VM with cultural dimensions in an organisation. Corporate culture (CC) will play an important role in the performance of value management because effective organisation culture will have an impact on inclusion and behaviours of participants in terms of information sharing, teamwork, collaboration, trust, decision making and risk taking amongst other (Cao *et al.* 2015). These CC-related characteristics are crucial for the efficient use and operation of VM since they will enhance workflow and direct decision-making. In addition to removing ambiguity hurdles, an excellent organizational culture will also encourage organized work

structures that will enable stakeholders to collaborate with purpose. When the support of an appropriate corporate culture is absent, firms may not achieve their desired objectives (Harrison and Bazy 2017). This implies that a building industry's corporate culture may have an impact on how VM is used.

Additionally, there hasn't been any analysis of the connection between VM procedures and the adoption of digital technologies. Through technology driven VM process, for example, project teams, including VM teams, can benefit from improved communication, and team cooperation that have the potential to provide more value to projects using BIM, cloud computing, IoT, etc. (Oke *et al.* 2021). Moreso, VM stakeholders can use digital technologies to identify any design conflicts that the project's design team may have missed initially with the use of Building Information Modelling (BIM) (Aghimien *et al.* 2022). Also, Baarimah *et al.* (2021) and Punnyasoma, Jayasena and Tennakoon (2019) mentioned that utilizing technological resources like Big Data Analytics (BDA) can make it easier for the VM participants to gather, retain, and analyze data so they can make critical decisions for the successful completion of a project. However, because of the numerous difficulties the building industry, particularly in developing nations, encounters, the adoption of these technological innovations has been extremely slow (Aghimien *et al.* 2022).

Apparently, several methods of construction management, such as VM, will also be subject to this sluggish adoption of digital instruments. Studies evaluating the application of digital technologies in VM process are therefore lacking. This assertion is further reinforced by a rapid literature search conducted using well-known databases like Scopus and Web of Science, which turned up no relevant publications when the keywords "VM" and "digital technologies" were combined. This demonstrated an area of VM studies' knowledge that must be filled. This will enhance value creation for clients and the performance of value delivery with the construction industry.

1.5 AIM OF THE STUDY

This research established a standard in the form of a model that will enable the practice and adoption of VM for effective delivery of building projects in the Nigerian built environment. The research also focused on constructs and variables that will foster the application of VM in the Nigerian construction industry. The construct extracted from the review of literature related to past VM models and theories supporting VM. After comprehensive review of literature, gaps were extracted from existing VM models to develop a holistic integrated VM adoption model for the Nigerian built environment. The study also took into consideration the impact of constructs identified from past models and gaps in predicting the implementation of VM for the delivery of sustainable building projects in the Nigerian construction industry. There is a positive relationship between VM and construction project performance; therefore, the absence of VM leads to poor project performance. In view of this, the model served as a guideline for the practice of VM in the Nigerian built environment. The model revealed the constructs that are most essential in predicting the adoption of VM in the Nigerian built environment.

1.6 RESEARCH OBJECTIVES

The specific objectives for the thesis are the following.

- R01 To establish key indicators for effective VM performance in the Nigerian construction industry.
- R02 To evaluate the factors (main and sub) that determines effective VM performance in the Nigerian construction industry.
- R03 To investigate the gaps in the existing VM model needed for consideration in the Nigerian construction industry.

R04 To determine the impact of the established variables on the performance of VM in the Nigerian construction industry.

R05 What measures can improve effective VM performance in the Nigerian construction industry?

1.7 RESEARCH QUESTIONS

The following questions serve as a guide for this study to address the identified problems:

R01 What are the key indicators for effective VM performance in the Nigerian construction industry?

R02 What are the factors (main and sub) that determines effective VM performance in the Nigerian construction industry?

R03 What are the gaps in the existing VM model needed for consideration in the Nigerian construction industry?

R04 What are the impact of the established variables on the performance of VM in the Nigerian construction industry?

R05 What model can be developed and validated for effective VM performance in the Nigerian construction industry.

1.8 SIGNIFICANCE OF THE STUDY

There is a gap in the literature concerning a model showing the variables supporting the adoption of VM in developing countries especially in Nigeria. Therefore, this study will contribute to the existing knowledge of VM studies in the construction industry. It will also establish the impact of each VM variables classified as independent on the dependent variable (construction VM

performance). The study will assist in identifying the variables that determine an efficient VM practice in the construction industry. These variables will assist in providing the adoption measurement criteria for VM practices for sustainable project delivery in the construction industry. The mixed methodology (Delphi and structural equation modelling) adopted by this study will contribute to improving supporting VM practices in construction.

The outcome will contribute to ensuring that the construction industry competes effectively with other industries in the country regarding its contribution to the country's GDP thereby facilitating the contribution of the construction industry to improving sustainable development in the country. This is achieved through the provision of an established and validated model for enhancing the practice of VM in the construction industry. The developed VM model will contribute to reducing the difficulty and complexities of the delivery of construction projects. The outcome of this study will provide the foundation for VM reconfiguration and re-engineering in Nigeria to ensure sustainable project adoption. Since the construction industry is regarded as the driver of the economy by virtue of its contribution to the country GDP. Therefore, a study designed to improve the adoption of VM in the built environment will also contribute to the economy. The study will contribute to the economy through the provision of cost-effective infrastructures achieved from designing a VM model capable of reducing the cost overrun derived from building projects in the construction industry. The study will contribute towards making Nigerian construction industry compete effectively regarding construction project delivery in comparison to other developed and developing countries. Therefore, the study will provide the opportunity for Nigerian construction industry to achieve its globalization dream.

The study provides immense benefit to the academia in the following areas: it serves as a road map providing opportunities for further research into VM practices. Moreover, it will provide literature

for students researching the VM concept in the built environment and other associated areas of VM. The study offers a functional definition of VM from the theoretical views thereby creating a new foundation for VM research. The robust literature review of this study that exposed the VM practices in developed countries such as the Hong Kong and Australia will further educate stakeholders on VM in other countries. Additionally, the findings of this research will be extremely helpful to those involved in the building industry because it will provide stakeholders the chance to assess their adoption. The outcomes of the study will provide the means for overcoming the challenges confronting construction professionals during the adoption of the VM practice towards achieving successful construction projects delivery. The study further provides the opportunity for proper management of construction projects in accordance with the world best practices. The knowledge of the influence or impact of the model's constructs would help construction stakeholders to plan better during the management of construction project activities.

The authorities, stakeholders, and government agencies for the building industry can develop software using the findings of the research. In order to forecast the implementation of VM in the Nigerian built environment, the program would serve as a pre-test. Finally, this thesis's findings are highly significant for developing nations and their regulatory bodies since they offer creative suggestions for enhancing building projects. This is because the research offers advice on essential components to consider for effective VM strategy for the effective completion of building projects in the Nigerian built environment.

1.9 RESEARCH MOTIVATION

Since no model for the adoption of VM in the Nigerian built environment has been developed, this research filled the gap. The various dimensions (exogenous variables) of the proposed VM model

include collaboration, standardization, integration features, organizational factors, corporate culture, knowledge of digital innovations, the latter two being the new dimensions considered in the proposed model and are absent in existing models across the context. It is worth noting that previous VM model have not tested these latent constructs in a multidimensional structure, which is a strong motivation for conducting this research. As an ultimate objective, this research will determine the possible outcome of improving building projects in meeting the expectations of the Nigerian built environment. The researcher is also motivated to conduct the study using a methodological approach that has not been previously used in VM studies. The mixed method adopted and rigorous iterations of the PLS will ensure that the study outcomes possess a high degree of reliability and validity. The findings of the research will be valuable to both educators and professionals in the built environment in ensuring the presence of the latent constructs that will be used in predicting the model.

1.10 RESEARCH HYPOTHESES

The general hypotheses postulated in this study using the conceptualised model was that the five-constructs directly and indirectly impact the performance of VM in the construction industry. The following broad hypotheses were postulated for testing using the structural equation modelling (SEM).

H1 – Collaboration factors have an impact on VM performance.

H2 – Integration factors have an impact on VM performance.

H3 – Standardisation factors have an impact on VM performance.

H4 – The use of digital technologies have an impact on VM performance.

H5 – Corporate culture factors have an impact on VM performance.

1.11 RESEARCH METHODOLOGY

This section states the method that was adopted for analysing the data collected and the form of data (quantitative and qualitative) used, including how the research objectives was achieved. The research objective (RO1) was attained by adopting a quantitative and qualitative research design. The qualitative aspect was attained through conducting extant literature reviews on international practices of VM while the quantitative aspect was achieved through distributing questionnaires to construction professionals within the study area. The research objectives (RO2) and (RO3) was attained by undertaking a comprehensive literature review on the subject matter (VM in the built environment). Research objective four (RO4) was accomplished by conducting a Delphi study. The fifth objective (RO5) was attained by arranging the findings of the Delphi study supported with literature reviews. The reason for adopting the Delphi study is provided in Chapter 7. RO5 was also achieved by distributing questionnaires to the respondents and modelling the result by adopting a structural equation modelling using SmartPLS software. The subsequent sections elucidated the motives for utilising quantitative and qualitative research methods and the limitations of the chosen methods.

1.11.1 Quantitative research

When focus is placed on measurement during data collection and analysis, quantitative research is best required or most suitable (Queirós, Faria and Almeida 2017). Apart from its role in providing statistical measures, a quantitative research process largely adopts a natural science model to determine knowledge (which refers to independent knowledge despite the perspectives and values of persons involved) (McCusker and Gunaydin 2015). Zou, Sunindijo and Dainty (2014) believed

that the frequent use of a quantitative research design could be related to the origin of construction management being linked with the engineering discipline. Authors such as Lee and Smith (2012) and Castro *et al.* (2010) stated that quantitative research is the procedure of assembling and analysing data in number form and adopting mathematical methods while generalising the findings across some large group of specific people. Brown (2010), Kilicoglu (2018) and Kyakuwa (2019) contended that quantitative research can test a theory or hypothesis based on its capability to examine the relationship between two or more variables. Usually, the quantitative research process relies on deduction, which means that the research occurs in tandem with an informed proposition or assumption and can be tested from existing theories. This implies that two or more variables can be tested for a possible relationship or correlation. This resonates with the factors of this study, which is aimed at determining the connection between; collaboration; integration, standardisation, corporate culture, and the use of digital technologies in predicting VM performance for the successful delivery of construction projects.

Furthermore, for this research, the quantitative method of data collection was carried out using structured questionnaire that was piloted by both academia and professionals in the built environment. The data obtained from the field survey was used to authenticate the VM model postulated after the Delphi survey. The questionnaire consisted of 2 parts (A and B). Section A consists of 6 questions, which contains the background information and demographics of the participants. Section B also had 5 questions and was used to establish the level of impact of each of the identified variables on effective VM performance as related to: integration, collaboration, standardisation, corporate culture, and the use of digital technologies. Lastly, Section C was used to measure the outcomes of improved VM performance. In the questionnaire, instructions and questions were kept plain and direct, with no complicated words used. PLS-SEM was used for the

data analysis, which helped in the development of VM model for effective delivery of construction projects in the Nigerian construction industry.

1.11.2 Qualitative research

Archer (2019) reported that a qualitative research design involves the process of making decisions about participants' experiences and opinions. Sotiriadou, Brouwers and Le (2014) described qualitative data as including transcripts obtained from interviews and recordings of audio or videos from the observation of peculiar activities. According to Ratcliff (2009), the focus of qualitative questions centred on the respondent's experience, opinion, feelings, and knowledge. This implies that the qualitative research design focuses on words rather than numbers and percentages when analysing and collecting data. Thus, it can be said that qualitative research design attempts to decide out of people's statements or opinions. It can also be deduced that qualitative research design entails the progression of a concept with the view to understanding a social phenomenon from people's experiences and opinions. The form of the qualitative method that was adopted for this study semi-structured adopting an interview approach. The output from the interview was subjected to Delphi study. The results from the Delphi study were used to form the questionnaire and were used to validate the model. Chapter 7 of this thesis elaborated more on the Delphi technique under the research methodology theme.

1.11.3 Mixed method research

Mixed-method research is one with different philosophical assumptions and inquiry methods in its approach and dimension (Strijker, Bosworth and Bouter 2020). As a methodology, it adopts several philosophical assumptions that support data collection and analysis and institute the combination of the above-named approaches (quantitative and qualitative) in different stages of

the research study process. Likewise, as a method, the mixed method emphasises data collection and analysis alongside combining data (quantitative and qualitative) in a research study or several studies. Furthermore, the mixed method ensures that a combination of both (quantitative and qualitative) offers a more solid understanding of the scope and research problems than the adoption of just one research as a stand-alone.

In a typical mixed method, the quantitative data may include closed-ended questions such as questions regarding behavioural patterns, norms, attitudes, and the like. A closed-ended checklist is used in the data collection process to register the type or manner of behaviour observed or seen. In some other cases, quantitative information can be obtained from archives, registers, records, or almanacs. During the analysis of quantitative data, scores collected on instruments are statistically analysed to answer research questions or to test hypotheses (Smith 2012). On the other hand, qualitative data in a typical mixed method may include open-ended questions that can be gathered through interview sessions. During these interviews, open-ended questions allow respondents to be flexible and respond to questions in their own words and ideas. These responses can be analysed thematically and converted (transformed and transcribed) into both qualitative and quantitative data. This is possible in the case of Delphi techniques where consensus is drawn based on parameters such as frequencies or measures of central tendencies. In other cases, qualitative information can be obtained from observation of respondents, research sites, private or public outlets, audio-visual outlets, and artefacts.

In our present day where generalisability of research results has become a major dimension, mixed method research plays a significant role in this aspect as well as providing more robust evidence for conclusions owing to its convergence approach and verification standards (Ramlo 2016; Zhou

and Wu 2022). This approach is more dependable and accurate than a single method owing to the combination of both deductive and inductive approaches (Johnson, Onwuegbuzie and Turner 2007; Povee and Roberts 2015; Hong and Pluye 2019). The advantage of combining both methods (quantitative and qualitative) lies with the fact that one method can complement the other. The mixed method also provides the opportunity for the researcher to analyse the research objectives effectively. This implies that a mixed research design allows the researcher to tackle the research problem more effectively than using only one method. It was also deduced that mixed research provides the opportunity for a researcher to adopt all the available methods for conducting the research. This, in turn enhances the generalisability of the result obtained from the research. The use of mixed research also has the capability of providing a better result and adding more understanding to the proposed model. This study adopted the mixed method and the justification for using the same is presented in Chapter seven.

1.11.4 Criteria governing data admissibility.

For this study, professionals in the construction industry from academic and the built environment were chosen as the sample frame during the questionnaire survey. To create the sample frame, a list of experts in the built environment working in the construction industry, and academia were obtained from the annual reports of the various professional bodies in Nigeria as provided by the Federation of the Construction Industry in Nigeria (FOCI). This study adopted a combination of purposive and snowball sampling methods that provides an opportunity to obtain knowledgeable opinions and responses from professionals with an idea about VM, which was a critical aspect of the proposed model for this research. Chapter 7 (Research Methodology) sheds more details on the target population and sample size considered for this research.

1.11.5 Empirical measures of data collection

In providing a robust background to the study, literature relating to VM theories and existing models, gaps in VM models, pedagogical approaches in developing VM model was reviewed. In achieving this, several sources were reviewed, including chapters in books, journal publications and both (published and unpublished) dissertations about VM model (secondary data). The collection of empirical data (primary data) was accomplished by two methods namely, the Delphi technique and the survey method (field questionnaire). These methods were adequately discussed in Chapter 7 of this research thesis.

Through the Delphi survey, data collected was used to determine the outcomes of improved VM in meeting the expectations of the Nigerian built environment and to predict the delivery process of construction projects that will be mostly used by professionals of the Nigerian construction industry in the near future. In the second phase of this research, the Delphi method was employed to identify the multiple dimensions, both primary and secondary, that play a role in enhancing VM performance within the Nigerian construction industry. These insights were gathered through a meticulously designed questionnaire interview, administered to experts within the built environment. This process facilitated the establishment of a consensus regarding the relative importance, significance, and impact of various factors and dimensions.

Moreover, the Delphi process encompassed two iterative rounds, with the primary aim of enabling specialists to achieve consensus on several key questions outlined in the questionnaires. Experts were also given the opportunity to provide explanations for any dissenting opinions they held. Subsequently, using spreadsheet software like Microsoft Excel, data obtained from the Delphi study were meticulously analyzed. This analysis yielded a variety of descriptive statistics,

including averages (mean), standard deviations, and their relevant derivatives. In the questionnaire survey, the collected data revolved around the diverse dimensions, encompassing both primary and secondary aspects that contribute to the enhancement of VM performance for effective project delivery in the construction industry. The data for the questionnaire survey were gathered from individuals within academia and professionals working in the Nigerian construction sector.

1.11.6 Data Analysis

The data obtained from the Delphi study was inputted into Microsoft Excel, a computer-based spreadsheet software program. The Excel was then used to generate output in the form of descriptive statistics such as mean, standard deviation, variance, and interquartile deviation. For this study, both descriptive and inferential (PLS-SEM) statistics were presented. The field questionnaire data was analysed using SmartPLS software package for conducting SEM analysis and the SPSS was used for descriptive purpose. 202 completed questionnaires satisfied the condition for using PLS-SEM analysis as more than 150 respondents is often regarded as the benchmark.

First, a descriptive statistics test was conducted to present the background data of the respondents. To obtain the full profile of the respondents, this study conducted frequency distributions of the data of the participants (professionals from academia, and the construction industry) using the Statistical Package for the Social Sciences (SPSS) version 25. Background data obtained information related to respondents' gender, level of education, years of experience, and number of projects respondents' are involved in. To increase the validity and reliability of data provided, it was necessary to collect this information in order to determine the respondents' experience and expertise. Using SPSS, the consistency of respondents' opinions was determined using parameters

such as the mean values. Through these measures, the background information of respondents were obtained and presented.

1.11.7 Result from the study

The study presented a model suitable for enhancing the performance of VM practices and the effective delivery of construction projects in the Nigerian construction industry. The model contributed towards improving the practices of VM in the built environment thereby providing the opportunity for enhancing the competitive capacity of the industry. The result of the study showed the key indicators for effective VM performance in the built environment. It also revealed the relationship among the variables supporting VM practices in the built environment. The influence of the relationship was presented in tables and charts. Finally, the study improved the understanding of VM through the synthesis of various theories related to VM.

1.11.8 Delphi specific objectives

The Delphi survey is conducted for this research study to determine the following VM related issues.

1. DS01 - To identify the impact of VM attributes for enhancing the performance of VM in the Nigerian construction industry.
2. DS02 - To determine the impact of collaboration on the performance of VM in the Nigerian construction industry.
3. DS03 - To evaluate the impact of integration on the performance of VM in the Nigerian construction industry.
4. DS04 - To examine the impact of standardisation on the performance of VM in the Nigerian construction industry.

5. DS05 - To determine the impact of corporate culture on the performance of VM in the Nigerian construction industry.
6. DS06 - To determine the impact of the use of digital technologies on the performance of VM in the Nigerian construction industry.

The result from the Delphi study shows the connection between the variables supporting VM in the Nigeria built environment. The model created for the research was also shaped by the study's conclusions. The model was validated through the result of the questionnaire survey.

1.11.9 Questionnaire-specific objectives

A questionnaire survey was conducted for this research study to determine the following VM-related themes:

- QS1 - To determine the constructs with the highest impact on the performance of VM in the Nigerian built environment.
- QS2 - To establish the individual influence of the independent variables on the performance of VM in the Nigerian construction industry.
- QS3 - To determine the goodness-of-fit of the hypothesized integrated VM model for the Nigerian construction industry.

1.11.10 Bias elimination

During the process of conducting a field survey (questionnaire study), the issue concerning bias cannot be ignored (Roulston and Shelton 2015). According to Roberts and Povee (2014), bias can occur in a research owing to data distortion based on certain conditions. For a research result to be generalised and replicated, the researcher must make contingency plans against bias as well as having necessary explanations to clarify ideas (Brown 2010). Based on this assertion, this study

adopted a mixed method approach. Through this method, both the Delphi study and questionnaire were compared (worked in tandem) which paved way for a robust use of PLS-SEM to analyse and for model development.

1.11.11 Reliability

Reliability deals with issues surrounding the consistency of data collection and research results. Reliability is attained and confirmed when the same research procedures are repeated, and similar outcomes are derived. According to Sudo (2019), reliability is adequate if another researcher carries out the same research, under the same conditions and arrives at the same conclusions. In obtaining a high degree of objectivity, this research study adopted a mixed method as earlier addressed. Moreover, the robust PLS-SEM analysis was conducted to improve the reliability of this research.

1.11.12 Validity

Validity in this context assesses whether the research findings can be adequately explained and if the study produces the expected results as outlined in the research objectives (Hishinuma, Horiuchi and Yanai 2016). Validity can be categorized into internal or external, and it can take various forms, such as content, construct, or criterion-related. Internal validity ensures that the identified constructs or variables lead to the anticipated outcomes. External validity, on the other hand, ensures that the research results can be applied to a broader population. Questionnaires have faced criticism from researchers over time due to concerns about their validity. This skepticism arises from the possibility that respondents may not provide honest answers and might interpret questions differently from the researcher's intended meaning (Ahmed and Ishtiaq 2021). To address these concerns, the questionnaires were pilot-tested on a small sample. Throughout the analysis, both the validity and reliability of the data were assessed using various measures, including the Kaiser-

Meyer-Olkin (KMO) measure of sampling adequacy, Bartlett's test of sphericity, and Cronbach's alpha. These measures were employed to ensure the robustness and trustworthiness of the data.

1.11.13 Ethical Statement

During the entire process of conducting this research, ethical issues was considered and meticulously adhered to. Respondents was not coerced into participating in this study. They were given the option to take part voluntarily and were presented with an informed consent. The privacy of the research experts and participants was confidential and was not disclosed to anyone who did not participate in the study. Throughout the study, participants remained anonymous.

1.12 ASSUMPTIONS

The following assumptions were made in this study:

- The participants were able to address the research inquiries due to their recognized expertise and/or experience in the field.
- The participants shared truthful information within the limits of their knowledge and experience.

1.13 STRUCTURE OF THE THESIS

The whole study is is organised along with the following themes and chapters:

Chapter 1 – Introduction

This chapter provides a comprehensive introduction to the study, emphasizing key components including the research problem, motivation, and the study's significance. It also outlines the research's overarching goal, research questions, and specific objectives.

Chapter 2 – Theoretical background for the study

In this chapter of the research, the theoretical and conceptual frameworks that form the foundation of the study are introduced and explored. A thorough literature review is conducted to provide a comprehensive understanding of the concept of VM. This review draws from a wide range of sources, including books, journal publications, and conference proceedings sourced from reputable databases. Through this extensive review, the chapter establishes a solid theoretical and conceptual framework for the study.

Chapter 3- Gaps in Construction VM Research

This chapter captured the gaps identified in construction VM research that have not been appraised in the previous models. The identified gaps were discussed and the means of incorporating them into the present conceptual framework of this study were examined.

Chapter 4 –VM in Developed Countries

This chapter of the thesis is concerned with VM in developed countries. The chapter also presents the discussion of methodological approaches to VM in developed countries. The countries selected include Hong Kong and Australia while also evaluating the development of VM practices. Lastly, this chapter ended with an outline of how VM was developed in both countries and evaluates VM practices within the countries.

Chapter 5 –VM in Developing Countries: An African Perspective

A common phenomenon and challenge in African countries is the difficulties and complexity encountered in the delivery of sustainable building projects in the construction industry as it is often characterized by budget overrun, abandonment, and delay in delivery, enormous wastes, and poor client satisfaction. Therefore, in this chapter, strategies adopted by African countries in improving the delivery of construction projects will be examined. Other challenges confronting the construction industry in African countries using Ghana as an example was appraised.

Chapter 6 – VM in the Nigerian Construction Industry

This chapter commenced by examining construction industries in Nigeria. It also appraised the challenges experienced by construction industries in delivering construction projects, the impact of construction project delays. The chapter also examined the implementation of VM within the country and its adoption in the construction industry.

Chapter 7 – Research Methodology

This chapter presented a concise description of the methodology, and tools adopted for collecting data for this study. It also revealed the characteristics of the respondents or participants of this study together with the comprehensive descriptions of the analysis of the results and the method in which the findings are presented in the subsequent chapters. This chapter also described the research design including the form of data collection. Finally, the chapter concluded with a description of the population used for the study, sampling techniques and the reliability test of the research instrument.

Chapter 8 – Delphi Study Result

This chapter also includes a discussion of the findings derived from the Delphi method. The results are presented in alignment with the objectives set for the Delphi process. Furthermore, the chapter culminates with a comprehensive discussion and interpretation of these Delphi results, offering insights and analysis to help readers understand the significance and implications of the findings presented earlier in the chapter.

Chapter 9 – The Conceptual Integrated VM Model

In this chapter, the discussion of findings from both the Delphi study and the review of existing literature is presented. These findings serve as the foundation for the development of the conceptual model's theory. Additionally, the chapter introduces the integrated VM model,

providing a detailed description of the model and its constituent variables. This chapter essentially combines the empirical insights from the Delphi study and the theoretical framework to construct and elucidate the integrated VM model.

Chapter 10 – Presentation and Data Analysis of Field Survey

Findings from the questionnaire survey was discussed in tandem with the identified constructs for the model development. The chapter draws on the knowledge and perceptions of professionals from the built environment from academia, and the construction industry in Nigeria. The chapter also presented the descriptive and inferential statistics, the reliability of the findings and in-depth analyses using PLS-SEM to determine the testing of the hypothesised VM model.

Chapter 11 – Discussion of Results

In this chapter, you will find a detailed discussion of the analysis and interpretation of the results obtained from the questionnaire. The chapter also includes discussions regarding the goodness-of-fit of the postulated VM model. Essentially, it delves into the examination and understanding of the data collected through the questionnaire, as well as how well the proposed VM model aligns with the empirical findings.

Chapter 12 – Conclusions and Recommendations

This chapter presented the various conclusions and recommendations that are based on the findings of this study. The chapter reviewed each research questions and summarises the processes of achieving the earlier stated objectives. General recommendations and areas for future research followed this. Finally, this chapter discussed the limitations of the study and conclusions were drawn.

CHAPTER TWO

THEORETICAL BACKGROUND FOR THE STUDY

2.1 INTRODUCTION

This chapter presents the theoretical framework that underpins the research study. This helps to review the underlying philosophies, assumptions, theories, and methodological techniques of the study. These provided the foundation for the development of instruments for data collection. This chapter further presented a thorough literature review on the concept of VM and its related dimensions, models and constructs which underpin the conceptual framework for the study.

2.2 HISTORICAL ORIGIN OF VM

Aghimien and Oke (2015) asserted that the drive to lower costs (manufacturing and overhead), waste, and greenhouse emissions as well as to enhance design, overall value, commercial viability, and delivery led to the development of VM. According to Cheah and Ting (2005), the United States is where VM first appeared as a result of a scarcity of parts and supplies during World War Two in the manufacturing industry. The concept was established in 1942, according to the author, in large part thanks to Mr. Lawrence Miles of The General Electric Company (then known as Value Analysis), and it has since gained widespread acceptance across a range of sectors.

Shen and Ann (2012) stated that, with no compromise on quality, VM offers substitutes for scarce products or even better adoption and the same capabilities. Beginning in the early 1960s, VM was implemented to the building sector in developed nations (Shen and Liu 2007). VM was introduced to the construction industry in developed countries in the early 1960s (Shen and Liu 2007). Scholars and government and private organizations in nations like the United States, the United Kingdom, and Australia have shown an interest in VM principles since they were first introduced,

with the utmost goal of increasing the functional adoption of building projects while lowering total costs (Bowen *et al.* 2010a; Aghimien, Oke and Aigbavboa 2018). According to Kelly, Male and Graham (2014) and Oke and Aghimien (2018), VM originated from the manufacturing sector. However, it has been applied in numerous industries such as agriculture, medical, engineering, construction industries and many others. VM is a diverse approach that aims to address the needs of the client and get the most out of the construction process. It is a collaborative, organized, and analytical method that aims to analyse performance in a detailed manner (Tahir, Nawi and Ibrahim 2016).

The best value or, when suitable, best value for money is achieved for projects, commodities, methods, operations, and procedures using the VM method, which is based on a coordinated, collaborative workshop comprising a diverse and inclusive group of individuals (Whyte and Cammarano 2012; Ezezue 2015; Hwang, Zhao and Ong 2015; Kissi, Boateng and Adjei-Kumi 2015b; Bola-efe, Ajayi and Ordu 2019; Oke, Stephen and Aigbavboa 2022c; Kineber *et al.*). The ability for interdisciplinary team concerned parties, such as clients, experts, legislators, end users, and the public at large, to actually engage in briefing and design, clarify their needs, better comprehend the project and the preferences of other parties involved, reach an understanding, establish an agreement, and foster a sense of ownership and responsibility to the solutions that come from the VM workshops is a crucial component of the process (Edwards *et al.* 2010; Mohamad 2014; Mohamad Ramly 2015; Zhao and Moh 2016; Subramani and Cherian 2018; Alshehri 2020; Bennett and Mayouf 2021; Ojo and Leung 2021; Lin *et al.* 2022a; Oke, Stephen and Aigbavboa 2022b; Oke, Stephen and Aigbavboa 2022a). The VM process outlines project goals, different stakeholder viewpoints, and how goals can be delivered successfully (Ojo, Ogunsemi and Ogunsina 2021; Lin, Mazlan and Ismail 2022). VM is an approach that can be

implemented to any building project and consider its functionality and economic requirements throughout its entire life span, albeit its approaches may differ based on the procurement approach adopted (Yu *et al.* 2018).

2.2.1. VM Workshop Phases

Regardless of the source of origin, Kineber *et al.* (2020b) asserted that VM workshop/job plan comprises five different phases. The first phase is the information phase in which VM team gathers information to a feasible extent about the scheme requirements, project design, background, restrictions, and forecasted costs (Alshehri 2020). This stage includes determining the spectrum of issues to be tackled, performance targets, and assessment methods while fostering team cohesion. The second phase is the function analysis phase. Kissi *et al.* (2017b) and Liyanage and Rupasinghe (2020) noted that function analysis affects project understanding by fostering focused dialogue and encouraging team members to consider elements that could otherwise go unnoticed. The second phase involved the use of a cutting-edge technique called FAST (Function Analysis System Technique), which creates a pictorial depiction to streamline the component functions and structures a crucial path made up of all main functions (Zhang and Mu 2013). Zhang and Mu (2013) revealed that FAST is an effective tool to accommodate a design purpose. Wao (2017) confirmed that the function analysis system technique (FAST) is another method of organising the phase as it conducts reviews of functions to determine those that need improvement, elimination, or creation to meet the project's goals. Studies suggest that FAST offers many advantages for the performance of VM.

The next phase is called the creativity phase where all individuals are given the chance to share their suggestions for better outcomes without fear of criticism or defamation. Kineber *et al.*

explained that in order to meet the required and desirable tasks of the projects, ideas are generated and constructed during the creativity phase. Wao (2016) submitted that the creativity stage helps in producing ideas that are then assessed to choose the best ones fit for a project and in coming up with different approaches to accomplish the objectives of systems. According to Kissi, Boateng and Adjei-Kumi (2015b), the VM workshop team members look into, verify, develop, and analyze alternate techniques and ways of carrying out tasks throughout these stages. At this stage, creative procedures are being used, such as side thinking and brainstorming.

The next phase is the evaluation phase. At this stage, the ideas drawn from the creative stage are analysed and examined by the VM team (Kissi, Boateng and Adjei-Kumi 2015a). The most brilliant concepts are developed and picked to become unusual value improvement suggestions (Jariri and Zegordi 2008; Singh, Garg and Sharma 2011; Chougule and Kallurkar 2012). At this phase, the proposals are analysed and assessed for each of the recommendations and ideas revealed in the creativity phase (Kineber *et al.* 2021c). According to Kam *et al.* (2016), a review, assessment and short-listing are carried out at this stage to examine less promising ideas, to necessitate the assessment of each idea against functional requirements.

Development and presentation phase which is the next phase is when the team presents the VM proposal to the client during an oral presentation at the conclusion of the evaluation phase (Singh, Garg and Sharma 2011). This stage's primary goal is to decide how the best program will be executed, as well as to oversee, monitor, and obtain feedback on the procedure to improve a seamless and effective rollout of the program (Zhao and Moh 2016). The VM team will make the necessary modifications to improve the program while proceeding to execute it to completeness if new scenarios and new issues emerge during the implementation process but are categorized as minor ones that do not influence its overall implementation (Kim *et al.* 2016). VM team will

address the new issues and return to the second stage (validation stage) for revitalized assessment, program creation, assessment, and execution to ensure the project is implemented successfully until completion. Possibly, new circumstances and difficulties will arise that have a substantial influence on its overall deployment (Mohamad, Shen and Yu 2015).

2.3 DEFINITION OF VM

VM is a heterogeneous approach that aims to meet the client's needs and get the most out of the project processes (Aigbavboa, Oke and Mojele 2016). It is a collaborative, organized, and intellectual method that aims to analyze function in a logical manner (Tahir, Nawi and Ibrahim 2016). Kelly, Male and Graham (2014) mentioned that the procedure makes use of structured, group-based activities that evaluate created or existing solutions to an issue considering the client's value expectations. According to the Institute of VM (2008), the term "VM" refers to a management approach that places a focus on encouraging employee motivation, skill development, and the promotion of synergies and innovation to increase an organization's adoption rate overall. According to the Society of American Value Engineers (SAVE) (2008), the notion of VM is a structured, collaborative effort focused on analyzing the functions of projects in order to get the best value at the lowest overall life-cycle cost. Abidin and Pasquire (2007) stated that these definitions serve as indicators that VM enhances service delivery by attaining project value for money while preserving function and fostering cooperation through enhancing working relationships within the team. According to Clifford (2013), VM is a tool that can be used to improve capital works projects, such as when preparing a feasibility study report or deriving a concept development statement. It can also be applied in a particular way, such as when comparing

design possibilities, assessing construction techniques, selecting sites, or determining access points.

VM is a cooperative, collaborative, operational, and holistic approach to promoting value-related clients or customers to advance their project objectives (Aini 2006). It has been confirmed to be a procedure that starts with the preliminary stage and lasts until successful delivery (Othman *et al.* 2020). VM can activate and eliminate undesirable costs while ensuring successful delivery of projects and budgetary conservation (Shen and Liu 2004). The research were further supported by Tanko *et al.* (2018), who made the case that VM helps to ensure the best performance and adoption without compromising the product's worth and quality. Additionally, VM enables a thorough assessment of a project's goals from the owner's perspective (Nicał *et al.* 2018), and aims to achieve the projected value at reduced costs without jeopardizing building quality (Alattiyh, Haider and Boussabaine 2019). VM appears to be regarded as a cost-effective and productive method in the global building industry (Kolo and Ibrahim 2010). This approval is based on prior data showing that VM's procedures had reduced building project costs by 5% to 10%. (Norton and McElligott 1995). Additionally, Ellis, Wood and Keel (2005) noted that if VM were properly implemented at the project's inception, the cost of capital for building projects might be decreased by 10% to 25%.

According to Oke and Aigbavboa (2017c), VM is a management process that includes managing project team members, remodeling spaces and components, choosing the right resources, and streamlining the manufacturing process to suit the project's objectives. The authors argued that VM embraces a systematic approach that is logical, methodical, and organized so that team members can easily engage, and that the strategy can be modified for subsequent exercises. VM is a holistic method of organizing all forms of resources, which distinguishes the practice from other

cost-cutting or cost-saving exercises. Clifford (2013) mentioned that the fundamental question of "what" should or might be done to increase incorporation is the core focus of VM.

VM is defined as an organized set of procedures and processes that are introduced (Abidin and Pasquire 2005), purposely to enhance the function of a designs, services, facilities or systems at the lowest possible total cost of effective ownership, taken cognizance of the client's value system for quality, reliability, durability, conformance, durability, aesthetic, time, and cost (Olanrewaju and Khairuddin 2007). Rachwan, Abotaleb and Elgazouli (2016) referred to VM as a systematic process to improve the value of a projects through the analysis of its functions.

Through the use of a diverse value squad, VM is a collaborative, problem-solving management approach that enhances the functional value of a project from the concept to the operation stage (Kelly, Male and Graham 2014). The VM approach also promotes the establishment of a value culture within the company, which makes it easier to bring about the desired transformation (Aghimien, Oke and Aigbavboa 2018). The goal of VM, an integrated, organized, and staged process lead by a professional facilitator, is to increase the value of a construction project rather than just reduce costs. According to (Rangelova and Traykova 2014), VM is a service that maximizes functional development from concept to completion by comparing and auditing all decisions against a value.

It is considered as a comprehensive, organized, and structured process, directed by an expert facilitator, and divided into different stages to increase the value of a construction project, not just by reducing costs (Rangelova and Traykova 2014). VM is a methodical, heterogeneous initiative designed to add value to a construction project in ways other than just reducing costs (Kineber *et al.* 2021d). VM has gained recognition on a global scale as a method for enhancing client value in

projects, products, procedures, and techniques for almost 40 years (Kelly, Male and Graham 2014). Abidin and Pasquire (2007) observed that VM occupies a key position to include sustainability considerations into building projects; that although it is one of the well-known methods used to aid in decision-making.

Table 2.1: Definitions of VM that were sourced from numerous literatures.

Author	Definition
Oke and Aigbavboa (2017c)	VM is a procedure that encompasses the management of members of the project team, redesigning of areas and components, choosing the right resources, and streamlining the production process to accomplish the project's objectives.
Subramani and Cherian (2018)	It is a comprehensive approach to resource planning, setting it apart from other cost-cutting or cost-saving strategies.
Rangelova and Traykova (2014)	VM is a structured framework that facilitates effective decision making regarding the best value.
Ekanayake (2019)	VM is an interdisciplinary approach that aims to satisfy the client's needs and get the best value out of the construction process.
Tahir, Nawi and Ibrahim (2016)	It is a collaborative, coordinated, analytical method that thoroughly examines function.
Oke and Ogunsemi (2013)	A comprehensive, multidisciplinary approach for evaluating projects' functions from initiation to completion with the goal of getting the most value for the money.
Ojo and Ogunsemi (2019)	In order to maximize an organization's adoption as a whole, VM is a style that is especially committed to inspiring employees, helping them discover new skills, and fostering creativity and synergy.
Othman <i>et al.</i> (2020)	The definition of VM also includes the concept of a procedure that starts in the initial stages till the completion
Tanko <i>et al.</i> (2018)	Without jeopardizing the value and quality of the project, VM helps to maximize performance and productivity.

Alattiyh, Haider and Boussabaine (2019)	The goal of VM is to deliver the desired value at a cheaper cost without reducing the quality and reliability of the project.
Edwards <i>et al.</i> (2010)	The VM procedure enables a thorough assessment of a project's goals from the perspective of a client.
Nnadi and Ezemerihe (2018)	VM is a rigorous analytical approach that frequently produces creative, all-encompassing answers to complex problems.
Oke, Stephen and Aigbavboa (2022a)	VM is the capacity to reduce a commodity's or projects overall cost by taking into account alternative inputs, concepts, or procedures to achieve the desired function while incurring a smaller overall cost.

2.4 THEORIES SUPPORTING VM

Randall and Mello (2012) affirmed that for a study to be valid, research needs to be supported by existing hypotheses. According to Defee *et al.* (2010), a field needs theories to be able to grow and change. This study acknowledges the necessity for theory to explain the variables and aspects underlying the application of VM in the building sector. Also, numerous VM researchers such as Ellis, Wood and Keel (2005), Daraban (2016), Ojo and Leung (2021), and Perera, Hayles and Kerlin (2011) have called for the integration of theories to create a solid knowledge foundation for VM since its inception. To support the principle of VM, two disparate but complimentary theories were combined to achieve this. The connection a study has to pre-existing theory and phenomena demonstrates its applicability. Theories act as searchlights to illuminate more significant or fundamental problems pertaining to the genesis of a research area. These theories include goal setting theory, and collaboration theory.

Table 2.2: Theories supporting VM.

Theory	Definition	Variables extracted	Sources
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Collaboration theory	According to this theory, collaboration is a vibrant process that involves many participants and is time-bound to address a significant issue. The term "collaboration" refers to cross-organisational efforts and contributions made to accomplish a challenging task that cannot be done alone. The benefits of teamwork outweigh those of individual effort.	Collaboration, integration, communication	Ojo and Ogunsemi (2019), Ojo, Ogunsemi and Ogunsina (2021), Miner (2015), Liu <i>et al.</i> (2020)
Goal- setting theory	Goal-setting theory holds that setting clear goals is less successful than goals that are explicit and quantifiable. The efficiency and involvement of the workforce can both be raised by implementing goal-setting theory. This concept offers a precise roadmap for how to define and accomplish goals in an efficient manner. According to the notion, employees are more driven by clear objectives and positive feedback, and they are more likely to reach their objectives if they are quantifiable and detailed.	Goal setting, Integration, coordination,	Leung and Liu (2003)

Source: Researcher’s review of literature

2.4.1 Collaboration Theory

Collaboration theory is a concept that focuses on understanding and exploring the dynamics of collaboration within various context (Barnes and Mattsson 2016). It seeks to explain how

individuals, groups, organisations, and even nations work together to achieve common goals, solve problems, and create value (Chiocchio *et al.* 2011). As its core, collaboration theory recognizes that no single entity or individual possesses all the necessary knowledge, skills, or resources to accomplish complex tasks or tackle intricate challenges (Deep, Gajendran and Jefferies 2021). Therefore, collaboration becomes essential to leverage diverse perspectives, expertise, and capabilities (Deep, Gajendran and Jefferies 2021), whether it's in the business world, academic research, public policy, or any other domain, collaboration theory emphasizes the power of collective intelligence and the benefits of pooling resources and ideas (Cao and Zhang 2011).

One of the fundamental principles of collaboration theory is that collaboration is not merely about cooperation or coordination (Mallett 2017). It goes beyond individuals working in parallel towards a shared objective. Collaboration involves active engagement, joint decision-making, and a deep level of interdependence among participants. It requires mutual trust, open communication, and a shared sense of purpose (Larsson and Larsson 2020). The theory recognizes that effective collaboration is influenced by a range of factors (Mallett 2017). These include organizational culture, leadership style, communication channels, incentives, and the presence of a supportive infrastructure (Ferme, Zuo and Rameezdeen 2018). Additionally, collaboration theory acknowledges the significance of individual characteristics such as cognitive diversity, emotional intelligence, and social skills in fostering successful collaboration (Zhang *et al.* 2023).

Different models and frameworks have been developed to understand and facilitate collaboration (Todeva and Knoke 2005). For example, the collaboration lifecycle model outlines the stages of collaboration, starting from the formation of a collaborative team, through goal setting, information sharing, decision-making, implementation, and evaluation (Donato and Shee 2015). This model helps identify the key activities and processes that need to be managed for effective

collaboration (Qiang *et al.* 2021). Another prominent concept of collaboration theory is the idea of boundary objects. Boundary objects are artifacts, tools, or concepts that help bridge the gap between different stakeholders in a collaborative effort (Oraee *et al.* 2019). These objects facilitate communication, knowledge sharing, and coordination across diverse perspectives and disciplines. Collaboration theory also recognises the importance of technology in enabling and enhancing collaboration (Xue *et al.* 2018). Digital platforms, communication tools, and collaborative software provide avenues for remote collaboration, real-time information sharing, and virtual teamwork (Lu, Zhang and Rowlinson 2013). Technology can break down geographical barriers, facilitate data exchange, and streamline collaboration processes (Körner *et al.* 2015).

Therefore, one important theory that form the conceptual framework of VM performance in this research is the collaboration theory. The established general ideas and concepts that have been produced by analyzing the phenomenon of many people or things cooperating make up collaboration theory (Ojo, Ogunsemi and Ogunsina 2021). Wood and Gray (1991) as stated in the study of Ojo, Ogunsemi and Ogunsina (2021) identified important factors that are essential while talking about collaboration as, the prerequisites that enables collaboration and encourage stakeholders to take part in the process, the method by which collaboration takes place, and the outcome of the collaboration.

Problem domain, numerous stakeholders, process, and cooperation outcome are the essential elements of the theory of collaboration. Multiple stakeholders are those with different perspectives on growth and variable degrees of influence over decision-making, according to Jamal and Stronza (2009). The mindset of issue resolution unites or offers the various stakeholders a unified focus. According to Ojo, Ogunsemi and Ogunsina (2021) and Wagner, Eggert and Lindemann (2010), collaboration theory provides a good theoretical framework to assess VM.

Practically, implementing VM begins with the pre-workshop selection of the appropriate facilitator and diverse participants (Mohamad 2014). This selection influences the success of the workshop and other outcome measures (Kelly, Male and Graham 2014). Collaboration amongst the participants is essential at the workshop stage (Ojo and Ogunsemi 2019). This is demonstrated by the participants' systematic VM approach and their commitment to collaboration (Hwang, Zhao and Ong 2015). Collaboration amongst the participants is essential at the workshop stage. This is demonstrated by the participants' systematic VM approach and their commitment to collaboration (Othman *et al.* 2021). The application of VM in the Nigerian construction sector necessitates collaboration from numerous organisations, including academia, construction professional associations, and government parastatals.

2.4.2 Goal Setting Theory

Goal setting theory is a widely recognised and influential theory in the field of organisation psychology that focuses on the effects of goal setting on motivation and performance (Liu *et al.* 2020). The theory was developed by Edwin A. Locke and Gary P. Latham in the 1960s and refined over the years, this theory has been extensively researched and applied in various domains, including business, education, sports, and personal development (Locke and Latham 2019).

According to goal setting theory, setting specific and challenging goals leads to higher levels of motivation and ultimately improves performance (Kurose 2015). The theory posits that individuals are motivated by clear objectives and strives to achieve them (Locke and Latham 2013). When goals are specific, measurable, achievable, relevant, and time-bound (SMART), individuals are more likely to exert effort, persevere in the face of obstacles, and perform at their best (Wauters 2015). The theory proposes several mechanisms through which goal setting influences motivation and performance. Firstly, goals provide a sense of direction and focus, helping individuals

prioritise their efforts and allocate resources effectively (Guo, Goh and Wong 2018). Clear goals clarify expectations and guide actions, reducing ambiguity and enhancing performance.

Secondly, goals serve as a source of feedback (Ashford and De Stobbeleir 2013). By setting specific targets, individuals can monitor their progress and evaluate their performance. Regular feedback allows individuals to adjust their strategies, make necessary improvements, and stay on track towards goal attainment (Hwang and Lim 2013). Feedback can also provide a sense of achievement and satisfaction, which further fuels motivation. Thirdly, goals influence individuals' effort and persistence (Fishbach and Finkelstein 2012). Challenging goals require individuals to exert more effort and use their skills and abilities to the fullest. The difficulty of the goal stimulates individuals to stretch beyond their current capabilities, leading to personal growth and development. Moreover, goal setting theory emphasises the importance of goal acceptance and commitment (Goffnett 2020). When individuals are involved in the goal-setting process and have a sense of ownership over their objectives, they are more likely to be committed to their goals (Karakowsky and Mann 2008). This commitment enhances their motivation, as they are more intrinsically driven to achieve what they perceive as personally meaningful. However, it is essential to note that goal setting theory also recognises the need for goal clarity and task complexity (Bipp and Kleingeld 2011). Complex tasks may require a more flexible approach to goal setting, allowing for adjustments and adaptations along the way. Additionally, feedback and goal revision are crucial to maintain motivation and avoid discouragement when faced with setbacks or changing circumstances.

Goal setting plays a crucial role in VM practices by providing a structured approach to aligning actions and decisions with core values (Leung, Yu and Liang 2014). Setting specific goals helps individuals or organisations clarify their values and identify what is truly important to them. Goals

provides a clear direction and focus, guiding actions and decisions towards desired outcomes that align with core values. By defining goals that reflect their values, VM team members can ensure that their efforts are directed towards what matters most. VM involves prioritizing values and making decisions based on their relative importance (Hwang, Zhao and Ong 2015). Goal setting helps in prioritizing goals in a similar manner. By setting goals that are aligned with values, individuals and organisations can prioritise their efforts and resources towards achieving those goals that have the greatest significance and impact in line with their values.

Value management practices recognize that values can evolve and change over time (Mohamad Ramly 2015). Similarly, goals can be adjusted and adapted as circumstances change or as new insights emerge. By regularly reviewing and revising goals, individuals and organisations can ensure that their actions and decisions continue to reflect their evolving values (Subramani and Cherian 2018). This adaptability promotes growth and development, both at an individual and organizational level. Goals also enable accountability, as progress towards goals are measured and reviewed regularly, ensuring that actions and decisions remain in line with values (Kineber *et al.* 2021a). Goal commitment is related to individual's motive to accomplish the goal since motive is characterised as an inclination to work toward a specific type of goal state, aim, or types of satisfaction (Kruglanski *et al.* 2018)..

2.5 BENEFITS OF ADOPTING VM IN THE CONSTRUCTION INDUSTRY

The significant benefits of implementing VM practices in building projects have also been drawn from literature.

2.5.1 Financial and Economic Benefits

Madushika *et al.* (2020) found that VM maximizes value for money while simultaneously focusing on the project's goals and working toward a more efficient design. VM basically detects excessive expenses in a construction project and evaluates alternate options without jeopardizing the security, attractive appearance, and functionality, while also benefiting the project's timeline and overall lifespan (Jaapar, Maznan and Zawawi 2012). Aigbavboa, Oke and Mojele (2016) noted that, as a cost management tool, VM is critical in the construction sector because it represent all the ideas that would guarantee that projects are executed with minimal finance while ensuring its worth and functionality. The adoption of VM on building projects, according to Abd-Karim *et al.* (2011) can assist detect excessive expenses. In the process, waste on the job site, duplication of effort, and wasteful spending are reduced through value analysis, which includes providing alternative ideas, reducing, or deleting superfluous products, and utilizing creative ideas. According to Tanko *et al.* (2018), VM aids in comprehending what value means to the project's owners and users, as well as providing a functional method and strategic planning for assessing value by highlighting financial and non-financial advantages, i.e., a good approach to evaluate value for money (Alshehri 2020). The relevance of VM in building project performance prompted several countries to guarantee that VM was adapted to fit their construction procedures. Othman *et al.* (2020) mentioned that using VM in building projects would increase performance, design, constructability, functionality, and quality while lowering costs. As a result, VM may be considered a dependable instrument for developing sustainable construction (Kineber *et al.* 2021b).

Table 2.3: Financial and economic benefits variables

Financial/economic benefits	Authors
Cost Management	Kelly, Male and Graham (2014), Kissi, Boateng and Adjei-Kumi (2015b), Oke and Aigbavboa (2017c), Ojo and Leung (2021), Hwang, Zhao and Ong (2015)
Optimise value for money	Olawumi, Akinrata and Arijeloye (2016), Zhao and Moh (2016), Alshehri (2020), Madushika <i>et al.</i> (2020)
Return on investment	Bowen <i>et al.</i> (2010c), Luvara and Mwemezi (2017), Madushika <i>et al.</i> (2020), Kelly, Male and Graham (2014)
Achieve value for money	Oke and Ogunsemi (2011), Hwang, Zhao and Ong (2015), Ezezue (2015), Oke, Aghimien and Olatunji (2015)
Reduction in overall cost while maintaining functions	Olawumi, Akinrata and Arijeloye (2016), Oke, Stephen and Aigbavboa (2022c), Ojo and Leung (2021)
Getting rid of superfluous items	Oke, Stephen and Aigbavboa (2022a), Omoregie, Emmanuel and Ohis , Perera, Hayles and Kerlin (2011)
Use of locally sourced materials	Aghimien, Aigbavboa and Oke (2020a), Olawumi, Akinrata and Arijeloye (2016), Aigbavboa, Oke and Mojele (2016)
Reduce life cycle costs	Edwards <i>et al.</i> (2010), Kelly, Male and Graham (2014), Bennett and Mayouf (2021), Madushika <i>et al.</i> (2020)
Project delivery in a cost-effective way	Aghimien and Oke (2015), Aghimien, Oke and Aigbavboa (2018), Kineber <i>et al.</i> (2021c), Kineber <i>et al.</i> (2021c)

Source: Researcher's review of literature

2.5.2 Planning and Design Benefits

VM guarantees that all project stakeholders are aware of the project brief and work towards meeting the needs of their clients (Al-Saleh and Taleb 2010). The VM framework provides an auditable decision-making procedure for participating stakeholders to analyze and review information (Lin and Shen 2007). A VM task plan is a strategy that allows team members and stakeholders to handle each technique one step at a time to make choices (Oke, Stephen and

Aigbavboa 2022a). It varies according on the project's schedule and scope of the research (Lin and Shen 2007). According to Oke and Aigbavboa (2017a), VM improves construction value, improves design efficiency and quality, maximizes value for money, and helps designers make better choices. According to Olawumi, Akinrata and Arijeloye (2016), VM is critical for the early detection of problems in a project, with the large increase in value obtained greatly outweighing the time and effort required. Ezezue (2015) mentioned that when utilized at the idea development and first design stages, a large positive impact would be obtained, with the capacity to meaningfully affect final project results rapidly declining as the project continues through the design development stage. Aigbavboa, Oke and Mojele (2016) further mentioned that it reduces the cost spent on a building project by identifying extra expenses, increasing customer engagement, providing a system for the project stakeholders to work collaboratively, advancing design decisions by highlighting various design options for selection, increasing design efficiency, and providing a credible review of the project. Olawumi, Akinrata and Arijeloye (2016) affirmed that VM enables improved design and performance in a collaborative environment, and it also serves as the foundation for enhancing the work plan, which reflects the sponsors' goals and expectations represented as a function.

Table 2.4: Planning and design benefits

Planning and design variables	Authors
Effective design	Kissi, Boateng and Adjei-Kumi (2015b), Aigbavboa, Oke and Mojele (2016), Aghimien and Oke (2015), Madushika <i>et al.</i> (2020)
Support information of project brief	Lin and Shen (2007), Zhao and Moh (2016), Ezezue (2015), Lin <i>et al.</i> (2011)
Highlight design options for selection	Olawumi, Akinrata and Arijeloye (2016), Ekanayake, Shen and Kumaraswamy (2019), Olaleye, Baba and Nazif

Advanced design decision	Kim <i>et al.</i> (2016), Oke and Aghimien (2018), Kineber <i>et al.</i> (2020a)
Improved design efficiency	Olanrewaju (2013), Alshehri (2020), Oke, Stephen and Aigbavboa (2022a)
Eliminating unnecessary designs	Luvara and Mwemezi (2017), Danjuma (2021b), Olawumi, Akinrata and Arijeloye (2016)
Developing innovative design solutions	Aghimien, Oke and Aigbavboa (2018), Subramani and Cherian (2018), Kineber <i>et al.</i> (2021b)

Source: Researcher's review of literature

2.5.3 Social Benefits

VM boosts team morale by improving team and client interactions; owing to interdisciplinary and multitask teamwork, more productivity may be attained (Othman *et al.* 2020). VM also confronts some of the project stakeholders existing beliefs and private agendas to increase customer engagement throughout the development stages of the project, as well as shared ownership of ideas and adherence to successful implementation (Bola-efe, Ajayi and Ordu), VM offers the system for the team to collaborate and take advantage of collaborative relationships; shared agreement and ensures that cooperation among relevant parties is improved; effective communication and team spirit among members of the professional team. It enables good relationship so that all parties involved are informed of the limits, restrictions, and requirements for making suitable trade-offs, as well as a way of maximizing the balance between the demands and aspirations of multiple stakeholders (Luvara and Mwemezi 2017). Ojo, Ogunsemi and Ogunsina (2021) mentioned that VM provides an environment for team members to collaborate.

Table 2.5. Social benefits variables

Social benefit variables	Author
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Mutual understanding between project stakeholders	Oke and Ogunsemi (2011), Kelly, Male and Graham (2014), Lin and Shen (2007)
Provide clear definitions of responsibilities	Jaapar <i>et al.</i> (2009), Al-Saleh and Taleb (2010), Perera, Hayles and Kerlin (2011)
Collaboration between team members	Ojo, Ogunsemi and Ogunsina (2021), Ojo and Ogunsemi (2019), Omoregie, Emmanuel and Ohis
Provide the structure for the team to gain the benefits of partnering	Kineber <i>et al.</i> (2020b), Madushika <i>et al.</i> (2020), Ojo and Leung (2021), Othman <i>et al.</i> (2021)
Consensus between stakeholders is enhanced	Kineber <i>et al.</i> (2021a), Jaapar, Maznan and Zawawi (2012), Khodeir and El Ghandour (2019)
Improves working relationship	Rangelova and Traykova (2014), Oke and Ogunsemi (2011), Kineber <i>et al.</i> (2020b)
Enhance competitiveness by facilitating technical and organizational innovations	Perera, Hayles and Kerlin (2011), Kineber <i>et al.</i> (2021d), Clifford (2013)
Enhance communication and efficiency through multi-task teamwork	Lin <i>et al.</i> (2011), Hwang, Zhao and Ong (2015)

Source: Researcher's review of literature

2.5.4 Project development benefits

According to Jaapar, Maznan and Zawawi (2012), the objective of VM is to boost the functional performance of building projects while also addressing resources other than cost. It also brings the project's objectives into greater perspective, reveals project challenges, impediments, and hazards, and gives an authoritative evaluation of the project (Zhao and Moh 2016). Yu *et al.* (2018) also mentioned that VM implementation early in the construction procedure can be used to save funds, resolve issues, and make funds, as well as conduct routine site reviews, achieve project objectives, choosing the most appropriate alternatives, minimize expenses, plan at the tender stage, and harmonize resource efficiency and effectiveness. According to Alshehri (2020), VM offers the greatest return for each function, resulting in a decrease in project discontinuation. The advantages

of using VM for a sustainable built environment, according to Olanrewaju (2013), include the capacity to detect potential challenges initially, removing irrelevant designs, reducing wastage, and guaranteeing that the project is completed in the most cost-effective manner. Similar concerns were backed by Kineber *et al.* (2021a), that VM provides a comprehensive assessment of the project's objectives from the perspective of the client. Liyanage and Rupasinghe (2020), endorsed up this claim by stating that VM improves value for money, clarifies construction goals, works toward more effective design, works on similar or more beneficial components, and identifies extra expenses through superfluous design, material, labor, and equipment.

Table 2.6: Project development benefits

Project development benefits	Authors
Creates a better focus of the project goal	Yu <i>et al.</i> (2018), Subramani and Cherian (2018), Kim <i>et al.</i> (2016), Olawumi, Akinrata and Arijeloye (2016)
VM discovers project issues, constraint and risk involved	Yuan <i>et al.</i> (2013), Ranesh, Zillante and Chileshe (2012), Nnadi and Ezemerihe (2018)
Clients' involvement is enhanced	Kineber <i>et al.</i> , Tanko <i>et al.</i> (2018), Olanrewaju (2013), Madushika <i>et al.</i> (2020)
Enhance clear definition of roles	Omoriegie, Emmanuel and Ohis , Olanrewaju (2013), Tutesigensi, Kibwami and Matege (2021)
Enhance risk management measures	Nnadi and Ezemerihe (2018), Yuan <i>et al.</i> (2013), Nnadi and Ezemerihe (2018)
Early identification of problem in project	Aigbavboa, Oke and Mojele (2016), Bola-efe, Ajayi and Ordu (2019)

Source: Researcher's review of literature

2.6 VM PROCESSES IN THE CONSTRUCTION INDUSTRY

The initial stages of a project's development is the ideal time to execute VM according to a number of studies, while larger and more complicated projects will reap the most benefits (Rangelova and

Traykova 2014; Oke and Aigbavboa 2017b; Punnyasoma, Jayasena and Tennakoon 2019; Perera and Gunatilake 2020; Sabiu, Mohamed and Mahmood 2020; Kineber *et al.* 2021d; Lin *et al.* 2022a; Lin *et al.* 2022b). A VM process usually involves a workshop where representatives can participate from different fields, e.g., clients, end-users, design team, project managers, and contractors. VM stages is divided into: Pre-workshop stage, workshop stage (information stage, function analysis phase, creativity phase, evaluation phase, and development phase) and the post-workshop stage (Rangelova and Traykova 2014; Kineber *et al.* 2020a). Kissi, Boateng and Adjei-Kumi (2015b) and Rachwan, Abotaleb and Elgazouli (2016) also mentioned that the job plan approach in the workshop phase can be divided into 6 stages which are interwoven.

2.6.1 Pre-workshop Stage

The scope of the study is decided in the pre-workshop phase (Olawumi, Akinrata and Arijeloye 2016). Any VM study's immediate or anticipated success at this point depends on involving the right people to tackle the right issue at the right time (Oke and Aigbavboa 2017c). The meeting with the study's clients or sponsors to discuss the study's scope is crucial. In this phase, stakeholders are also identified. Engaging the proper stakeholders for the study is the workshop's most sensitive task; the study's success will depend on their in-depth knowledge of construction or the project market (Oke and Ogunsemi 2011). As changes will affect them, the end-users, and their community, an initial assessment of the issues that are expected to occur will help identify the people who will make dependable contributions and have the necessary technical capabilities (Aigbavboa, Oke and Mojele 2016). While the schedule should include all phases of the VM process, the tools to be used may vary according on the specific project, the structure and size of the participants, and the length of the workshop (Ojo and Leung 2021). The plan workshop agenda can also be decided upon at this time. Before the workshop began, participants will be instructed

on their responsibilities and the roles of the attendees (Lin and Shen 2007). Participants could be asked to supply background information or technical information that will be presented and assessed (Oke, Stephen and Aigbavboa 2022a). As a formal manner of informing all stakeholders, this briefing may include a systematic description of the activities to be expressed at the workshop with the assistance of pertinent professions and facilitators (Oke, Stephen and Aigbavboa 2022c). The amount of information distributed before to the workshop will improve participants' comprehension of the project and what to anticipate (Omoriegbe, Emmanuel and Ohis)

2.6.2 Workshop Stage

The workshop stage comprises of five different stages which is the information phase, function analysis phase, creative phase, evaluation phase, and development phase.

2.6.2.1 Information Phase

Jaapar, Maznan and Zawawi (2012) noted that all stakeholders can gain a better understanding of the VM workshop's procedure and the structure of the projects during the information phase of a VM. Finding components that don't match up in the project is ensured by the insights gained during this phase, which also serves as the foundation for looking for alternatives during the subsequent procedure. Perera, Hayles and Kerlin (2011) mentioned that in the information phase, which is the first stage of the study, all pertinent data relating to the project is acquired from all parties in order to establish a thorough comprehension of the project. The team gathered the necessary data for requirements, standards, cost estimates, and client requirements during the information phase of the VM approach to confirm that the customer had a proper understanding of the project's goals and specifications (Othman *et al.* 2020). Kissi, Boateng and Adjei-Kumi (2015b) divided the phases of VM into pre-study stage which was classified into preparation stage which entails selecting area to be studied, training members, arranged venue, and commissioning of team

briefing; information stage which involves collecting latest and correct information; functional analysis which identifies, classify and document functions and analytical stage which involved generating alternative ideas.

Kineber *et al.* (2021b) noted that it is fundamental for the application of VM that the information phase promotes and encourages its use. Every VM study includes three different stakeholders: members of the team, VM team leaders (facilitators), and the client or clients' spokesperson. Sharing of information is essential at this phase of the workshop study, and customers and professional participants should clearly and unambiguously define the nature, purposes, specifications, and expectations of the anticipated projects. These stakeholders also outline the methods for purchasing, project length, and location. Additionally, various green options are incorporated into the preliminary design stage during the information phase (Oke, Aghimien and Olatunji 2015), and clients are permitted to reveal their expectations.

The likelihood of inspiring owners to contribute to sustainability is increased through communication between clients and VM facilitators (Zainul-Abidin 2008). As a result, specifics and information about the project's setting, design, anticipated expenses, and restrictions are given (Chougule and Kallurkar 2012). According to a study by Yuan *et al.* (2013), the facilitator's team and other construction workers at this time supplied crucial information on their respective specialties. However, several individuals might potentially have noted project shortcomings (Chen and Liao 2010).

2.6.2.2 Function Analysis Phase

Function analysis is at the epicenter of VM. By outlining the functions and performance standards that may be used to measure services and costs, a project can be evaluated (Sabiou, Mohamed and

Mahmood 2020). To provide a more exact understanding and acknowledgment of the project's aim and the interplay between tasks at different hierarchical levels, function can also be expressed in hierarchies (Aghimien and Oke 2015). Jaapar, Maznan and Zawawi (2012) mentioned that understanding the project from the standpoint functionality of the project is the goal of this phase. It places emphasis on the query of what precisely the project is to accomplish. The widely used Function Analysis System Technique (FAST) method involves breaking down the fundamental operations of the project's components into a logic model.

In the functional analysis phase, the VE team begins the workshop to analyze the current design in terms of cost, according to Kelly, Male and Graham (2014). The function analysis will assist the VM team in making an accurate decision regarding whether to remodel the structural parts or alter the way of work execution with respect to the function. Perera, Hayles and Kerlin (2011) opined that the functional analysis forces a broader and more comprehensive understanding of the project by stimulating intense discussion and by compelling the team to view aspects they might not normally have considered. The author mentioned that the Functional Analysis System Techniques (FAST) diagram is used as the technique for the evaluation of functions.

Kelly, Male and Graham (2014), as referenced in Kineber *et al.* (2020b), categorized four variables relevant to the functional phase: mission, space, elements, and shape. Concerning the task phase, the focus lies on how key project stakeholders like sponsors, owners, clients, and other primary parties perceive and define a specific project task, as discussed by (Aigbavboa, Oke and Mojele 2016). This step's objective is to generate, identify, and classify primary and secondary functions, as emphasized by (Mohamad Ramly, Shen and Yu 2015). Team members are encouraged, during this phase, to document the intended functions of the buildings, with an eye toward their relevance over the next five decades, as highlighted by (Yu *et al.* 2018). In this manner, the primary and

secondary functions, along with their associated costs, are delineated and grouped together to gain an understanding of the project's sustainability aspects. Sustainability dimensions, including factors such as user comfort, environmental impact, accessibility, societal considerations, and life cycle costs, become integral components of the project's objectives and functions, as indicated by (Oke, Aghimien and Olatunji 2015). Furthermore, this phase demonstrates the incorporation of sustainability dimensions into the VM decision-making matrix.

2.6.2.3 Evaluation Phase

In VM, the evaluation phase is an important step that occurs after the identification, analysis, and selection of value improvement opportunities (Perera, Hayles and Kerlin 2011). Kineber *et al.* (2021c) mentioned that it involves assessing the potential benefits, costs, risks, and feasibility of implementing the identified value options. The potential benefits of each value options are examined and quantified (Oke and Aigbavboa 2017b). Mohamad, Shen and Yu (2015) mentioned that this analysis may include financial metrics such as cost savings, revenue generation, return on investment (Khanna, Laroiya and Sharma), or non-financial benefits like improved customer satisfaction, increased efficiency, or reduced environmental impact. The costs associated with implementing the value options are evaluated (Tanko *et al.* 2018). This includes direct costs like equipment, materials, labor, and indirect costs such as training, maintenance, or any additional expenses that may arise according to Rachwan, Abotaleb and Elgazouli (2016). The risks associated with each value option are also identified and assessed. This involves considering potential obstacles, uncertainties, and challenges that could impact the successful implementation of the value options. Risk mitigation strategies may be developed to address these potential issues (Aigbavboa, Oke and Mojele 2016).

In the evaluation phase, the feasibility of implementing the value options is analysed (Olawumi, Akinrata and Arijeloye 2016). This includes evaluating technical feasibility (whether the required technology or resources are available), operational feasibility (whether the organisation has the capacity to implement the changes), and organizational feasibility (whether the proposed changes align with the organisation's goals, culture, and resources). Based on the information gathered through benefit analysis, cost analysis, risk assessment, and feasibility study, a decision is made regarding the implementation of the value options, modifying, or combining options, or even rejecting some options if they are deemed unfeasible or do not provide sufficient value (Mohamad Ramly, Shen and Yu 2015). Once the value options are selected, the implementation plan is developed (Kineber *et al.* 2021b). This plan includes defining the implementation timeline, allocating resources, identifying responsible individuals or teams, and outlining the necessary steps and milestones for successful execution (Nasir *et al.* 2016). The evaluation phase ensures that value options are thoroughly examined and that informed decisions are made regarding their implementation (Madushika *et al.* 2020). It helps the organisation determine which options are most viable and likely to deliver the desired outcomes, thereby maximizing the value they can derive from their projects, processes, or initiatives (Jaapar, Maznan and Zawawi 2012).

2.6.2.4 Creativity Phase

In the context of VM, the creativity phase refers to a specific stage in VM process where innovative ideas and solutions are generated (Yu *et al.* 2018). The creativity phase typically follows the information gathering and analysis phases of the VM process (Munyasya and Chileshe 2018). During this phase, a diverse group of stakeholders, including subject matter experts, designers, engineers, and other relevant team members, come together to brainstorm and generate new ideas and alternatives (Hwang, Zhao and Ong 2015). The purpose of this phase is to generate as many

ideas as possible and proposals that emphasize alternative means or methods for performing a specified function (Bowen *et al.* 2010c). In this phase, the VM facilitator need to ensure positive atmosphere is created among the participants i.e. not criticising each other, brainstorm and obtain as much as possible ideas and to record all the ideas contributed (Jaapar, Maznan and Zawawi 2012). Usually, group creative thinking techniques can be used to get fresh ideas, for example, brainstorming (Oke, Aghimien and Olatunji 2015). In this segment, broad ideas on diverse alternatives are needed in the problem-solving process, and participants are responsible for producing various ideas. Ideas are raised in creative thinking, however, only 2 out of 10 of the ideas may be taken into consideration (Oke, Stephen and Aigbavboa 2022a). Performance can also be compared in the creativity phase by ranking alternatives with the same criteria but in its capacity to generate improved value over and above the standard (Kineber *et al.* 2021b). Alternatives are then ranked against acceptable measures requirements as the yardstick for scores should be recorded.

The creativity phase often begins with brainstorming sessions, where participants are encouraged to think freely and generate as many ideas as possible (Lin, Mazlan and Ismail 2022). This can be done through group discussions, facilitated workshops, or even individually (Olawumi, Akinrata and Arijeloye 2016). Various idea generation techniques may be employed during this phase to stimulate creativity and encourage out-of-the-box thinking (Nasir *et al.* 2016). These techniques can include mind mapping, analogies, random stimuli, role-playing, and more (Zhao and Moh 2016). The emphasis during the creativity phase is on divergent thinking, which involves exploring a wide range of ideas, perspectives, and possibilities (Mohamad, Coffey and Attan 2012). Participants are encouraged to suspend judgement and explore unconventional approaches to uncover innovative solutions (Kineber *et al.* 2022). Once a considerable number of ideas have

been generated, the next step is to evaluate and select the most promising ones (Othman *et al.* 2021). This can involve criteria such as feasibility, potential impact, cost-effectiveness, and alignment with project goals (Alshehri 2020).

After selecting the most promising ideas, the creativity phase moves into concept development (Mohamad 2014). This involves refining the selected ideas into well-defined concepts or proposals, including initial designs, specifications, and plans. The creativity phase often involves collaboration and iterative feedback loops (Iyiola and Mewomo 2023). Team members collaborate to refine and improve the selected concepts through discussions, prototyping, and testing. Jaapar *et al.* (2009) mentioned that iterations help evolve the ideas towards more viable and effective solutions. Throughout the creativity phase, it is important to document all generated ideas, concepts, and iterations (Lin, Mazlan and Ismail 2022). This documentation serves as a reference and helps in the subsequent phases of the VM process, such as implementation and monitoring (Kineber *et al.* 2021b). By fostering creativity and encouraging the generation of innovative ideas, the creativity phase in VM enables teams to explore and identify value-adding opportunities that may have otherwise been overlooked (Sabiou, Mohamed and Mahmood 2020). It sets the stage for further analysis, decision-making, and implementation of the selected concepts to enhance value and achieve project objectives (Perera, Hayles and Kerlin 2011).

2.6.2.5 Development Phase

The focus of the last workshop session is on developing activities and logically evaluating enhanced enhancement choices (Oke, Stephen and Aigbavboa 2022a). Even after the workshop, this phase can still be ongoing, especially if more research or information is required before the chosen course of action is to be taken (Oke, Stephen and Aigbavboa 2022c). The accuracy of the options and recommendations is confirmed. Additionally, a first execution plan is developed for

the selected alternative. The risk associated with achieving each step in this approach is then assessed, and mitigation measures are built into the plan (Oke, Stephen and Aigbavboa 2022a). The concepts that were considered during the procedure evolved into options that raise the value of projects. This approach is represented by diagrams and sketches and is backed up by calculations, data from the maker or producer, and other items (Jaapar, Maznan and Zawawi 2012). The stakeholders and/or experts of the professional team professionally create and analyze the suggestions discovered in the evaluation phase during the development phase. Each succinct idea is viewed as a workable, useful, and realistic answer. This stage addresses all the limitations, advantages, and potential of the concepts and theories in the recommendations, projections, and price of life-cycles measures. Additionally, every component or duty of the development phase is included in the strategic plan. The development phase was acknowledged to be a vital part of the VM study by Oke, Aghimien and Olatunji (2015), and it should be taken into account to guarantee that the development and presentation phases are carefully studied and taken into consideration. However, some authors suggested the presentation stage as the final VM step. However, the objective of this stage is to submit these recommendations to the organization that approved the study as a basic form of feedback (Oke and Aigbavboa 2017b).

The goal of this stage is to further analyze the list of concepts from the evaluation phase with the greatest merit into viable alternatives (Oke, Stephen and Aigbavboa 2022a). The concepts were expanded upon to create value options that were plainly described, allowing the participants to grasp the ramifications, cost reductions, and implications on value (Rachwan, Abotaleb and Elgazouli 2016). A thorough report will be developed following the VM workshop to summarize the data gathered and the ideas generated, as well as to evaluate and further it (Oke, Stephen and Aigbavboa 2022a). The VM workshop report will provide the implementation strategy. The

facilitator is frequently asked to give the report to the client or project owner. The VM workshop report is an important record of the dialogues that occurred throughout the workshop and provides a path for choosing recommendations (Lin and Shen 2007). This thorough report ought to be a crucial planning resource that project managers can access and use in the future (Aghimien and Oke 2015).

2.6.2.6 Presentation Phase

The workshop's conclusion is at this point. This stage's goal is to notify top management, participants, and other authorities about the suggestions and findings of the workshop activities (Jaapar, Maznan and Zawawi 2012). Participants are expected to present their report to the owner (Oke, Stephen and Aigbavboa 2022a). This is a genuine way to determine the dedication of the team and the feasibility of the suggestions. The details of the report will depend on what the client wants to use the report for.

2.6.3 Post-workshop Stage

Client representatives should see to the implementation of the study recommendation and suggestions, make available resources, keep too the period suggested and implement appropriate controls.

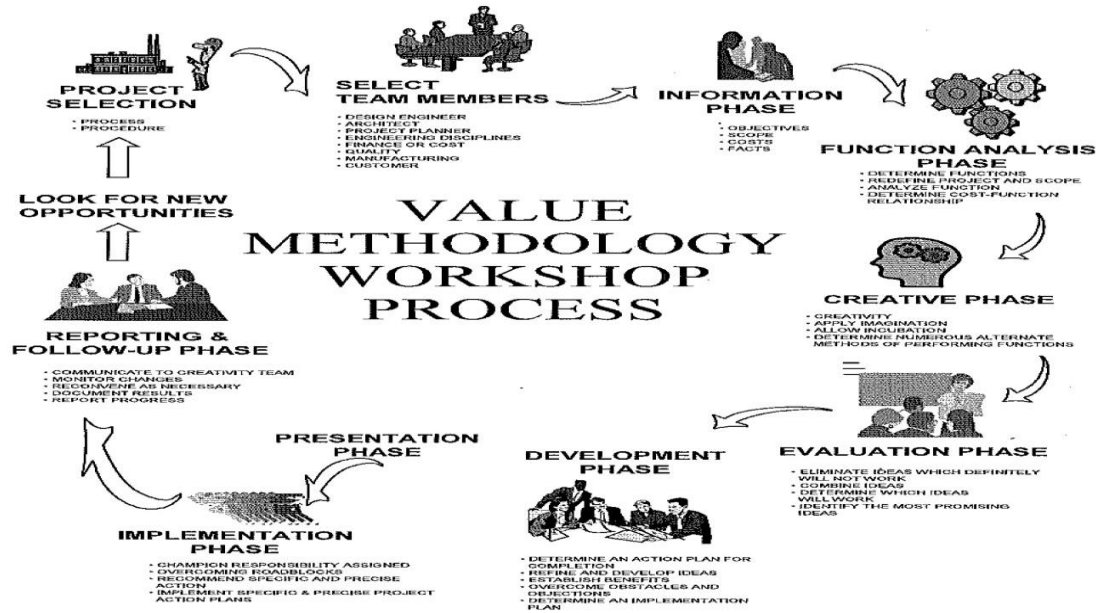


Figure 2.1. VM workshop process.
Source: Rains (2008)

2.7 VARIABLES THAT ENHANCE EFFECTIVE VM PERFORMANCE

This section provides a discussion on implementation of VM in the built environment also known as VM performance factors. These factors were obtained through the synthesis of several articles such as (Kissi, Boateng and Adjei-Kumi 2015a; Tanko *et al.* 2018; Alshehri 2020; Kineber *et al.* 2020a; Kineber *et al.* 2020b; Madushika *et al.* 2020; Othman *et al.* 2020; Sabiu, Mohamed and Mahmood 2020) among others. These factors include: VM integration, collaboration, and standardization.

2.7.1 Integration

Olanipekun *et al.* (2018) mentioned that integration in VM is the process of incorporating various elements, perspectives, and stakeholders into the management of value within an organisation. It involves aligning the activities, goals, and decisions across different functional areas and levels of the organisation to maximise value creation and delivery. The method of combining various

expertise, personnel, skills, and technological capabilities, known as the "integration process" is crucial for ensuring the successful execution of building projects (Isa, Kamaruzzaman and Mohamed 2019; Bennett and Mayouf 2021; Ojo and Leung 2021) and retains the maximum productivity throughout all concept, manufacturing, and construction methods, it offers clients greater value Ilayaraja and Eqyaabal (2015) and Kineber *et al.* (2021a) affirmed that in order to achieve VM adoption, it is crucial to have the necessary knowledge, experience, and knowledge of the VM approach, such as life-cycle costing, innovative thinking, and the Function Analysis System Technique (FAST) diagram.

Ranesh (2012) described integration is a thorough procedure used in construction to reduce costs and enhance the completion of a project, performance, or overall value. The extent of proactive collaboration between VM professionals to manage inter- and intra-organizational activities was how the author defined integration process (Pervin 2018). This viewpoint acknowledges that integration processes take place both inside and outside of the company. Also, the studies conducted by Cao *et al.* (2015) and White and Marasini (2014) acknowledged the significance of involving professionals in the built environment.

Integration ensures cross-functional collaboration which requires collaboration and coordination across different functions within an organisation, such as marketing, operations, finance, and human resources (Pervin 2018). Integration ensures that these functions work together towards a common goal of delivering value to customers and achieving organisational objectives (Lop *et al.* 2014). Successful VM also involves understanding and addressing the needs and expectations of various stakeholders (Owusu-Nanah 2016). This includes, engaging with customers, suppliers, employees, shareholders, regulators, and communities. Integration ensures that the interest and

perspectives of different stakeholders are considered in value-related decisions and actions (Aigbavboa, Oke and Mojele 2016).

Effective VM requires access to relevant and timely data and information (Wagner, Eggert and Lindemann 2010). Integration involves establishing systems and processes for sharing and analysing data across different functions and departments (Liyanage and Rupasinghe 2020). This allows for a comprehensive understanding of the value creation process and facilitates informed decision-making (Fan and Shen 2011). Strategy alignment is also identified by Martinsuo and Killen (2014) and Kelly, Male and Graham (2014) to ensure that the organisation's VM efforts are aligned with its overall strategic direction. It involved linking value-related objectives, initiatives, and performance metrics with the broader strategic goals of the organisation. This alignment helps prioritize value-adding activities and resources, ensuring that they are in line with the organisation's long-term vision (Male *et al.* 2007).

In addition, integration enables the organisation to adopt a continuous improvement mindset in VM (Bennett and Mayouf 2021). By fostering collaboration, sharing insights, and learning from various stakeholders and functions, organisations can identify and implement opportunities for enhancing value creation and delivery (Pervin 2018). This iterative approach allows for ongoing refinement and optimization of VM processes. From the reviewed literature, it was discovered that integration in VM is an attribute for ensuring the adoption of VM. These are but not limited to awareness/knowledge of VM participants which is a paramount attribute that must be considered before VM can be successfully implemented in the built environment (Olawumi, Akinrata and Arijeloye 2016). Increased awareness among professionals can improve the adoption of VM in the built environment (Lin and Shen 2007). Teamwork on a construction project was identified by

(Kissi, Boateng and Adjei-Kumi 2015b) to have an important component for VM integration process.

Table 2.7: Integration Practice in the Construction Industry

Integration Practice	Source
Professional's commitment	Kamal and Irani (2014), Sabiu, Mohamed and Mahmood (2020), Ojo, Ogunsemi and Ogunsina (2021)
Continuous training	Kamal and Irani (2014), Kim and Ballard (2010), Aigbavboa, Oke and Mojele (2016)
Early goal definition	Kineber <i>et al.</i> (2021b), Lin and Shen (2010), Lin <i>et al.</i> (2011), Al-Gahtani <i>et al.</i> (2015), Madushika <i>et al.</i> (2020)
Joint planning for VM activities	Lin and Shen (2007), Ojo, Ogunsemi and Ogunsina (2021), Ojo, Ogunsemi and Ogunsina (2021)
Early involvement of professionals	Thneibat, Thneibat and Al-Tamimi (2021), Lin <i>et al.</i> (2022b), Kineber <i>et al.</i> (2021c), Othman <i>et al.</i> (2021)
Regular workshop report	Oke and Ogunsemi (2011), Oke, Aghimien and Olatunji (2015), Othman <i>et al.</i> (2021), Kineber <i>et al.</i> (2021a)
Clear objectives of workshop	Coetzee (2009), Lin and Shen (2007), Madushika <i>et al.</i> (2020), Mohamad, Shen and Yu (2015)
Year of experience of facilitator	Coetzee (2009), Al-Gahtani <i>et al.</i> (2015), Tanko <i>et al.</i> (2018), Khodeir and El Ghandour (2019), Bennett and Mayouf (2021), Oke, Stephen and Aigbavboa (2022a)
Accelerating decision making	Jaapar <i>et al.</i> (2009), Al-Gahtani <i>et al.</i> (2015), Al-Saleh and Taleb (2010), Al-Yami (2008b), Thneibat, Thneibat and Al-Tamimi (2021), Yu <i>et al.</i> (2018)
Efficiency of idea generated	Madushika <i>et al.</i> (2020), Lin and Shen (2007), Oke, Stephen and Aigbavboa (2022a), Al-Gahtani <i>et al.</i> (2015)

Dedicated personnel	Lin and Shen (2007), Kineber <i>et al.</i> (2020b), Ojo and Leung (2021), Kineber <i>et al.</i> (2021b), Kineber <i>et al.</i> (2021c), Al-Gahtani <i>et al.</i> (2015), Lin <i>et al.</i> (2022b)
Equal contribution of participants	Al-Gahtani <i>et al.</i> (2015), Madushika <i>et al.</i> (2020), Lin <i>et al.</i> (2011), Thneibat, Thneibat and Al-Tamimi (2021)
Constant communication	Kissi, Boateng and Adjei-Kumi (2015b), Othman <i>et al.</i> (2020), Kineber <i>et al.</i> (2021b), Kineber <i>et al.</i> (2021c)

Source: Researcher’s review of literature

Risk-sharing is mentioned by Ahmed, John and Nicholas (2012) as another integration technique used in VM. The key principle of risk-sharing in VM is to allocate risks to the parties best equipped to manage them. This process involves identifying potential risks, assessing their potential impact, and assigning responsibilities for their management (Ahmed, John and Nicholas 2012; Ranesh 2012). By distributing risks across multiple parties, the overall risk exposure of the project can be reduced, leading to more effective risk management and better project outcomes (Abd-Karim *et al.* 2011).

2.7.2 Collaboration

Kineber *et al.* (2023b) referred to construction value management as the process of creating value in construction projects by identifying and maximizing opportunities to enhance performance, minimize costs and improve project outcome. However, Whyte and Cammarano (2012) and Mohamad (2014) mentioned that a lack of involvement by team member have a detrimental impact on the effectiveness of VM study. This brings about the essence and importance of integrating collaborative relationship into the VM process. Collaborative relationship is one of the critical VM process that have to be fulfilled for ensuring VM adoption (Ojo, Ogunsemi and Ogunsina 2021).

Similarly, Zhao and Moh (2016) believed that towards enhancing the adoption and delivery of construction projects in building firms through VM, collaboration in the form of cross-sectional team effort is of utmost importance.

Zhao and Moh (2016) mentioned that adversarial relationships are the cause of many issues that still exist in the construction industry such as fragmentation, delays, toxic working environment, and underperformance of construction projects (Ojo, Ogunsemi and Ogunsina 2021). Improving relationships and moving away from a win-lose culture could result in significant improvements in performance (Ahn *et al.* 2016), whether this is financial performance for construction companies or asset performance for clients (Qiang *et al.* 2021). Collaborative relationships allow stakeholders to develop a shared vision for the project by aligning goals and objectives, focusing on creating value, rather than competing for their own interests (Chiocchio *et al.* 2011). When all stakeholders share a common vision, it enables working together more effectively towards the same goals leading to a more efficient and effective project delivery process (Deep, Gajendran and Jefferies 2021). This will also allow a more focused effort and reduce the risk of conflicts and misunderstandings that could impact project delivery (Donato 2016).

Mohamad (2014) also stated the role of collaboration in encouraging early involvement of stakeholders, in the project planning phase. This allows for input on constructability, quality, cost, time, safety, sustainability, and schedule during the design phase, which can lead to improved outcomes and contribute to the overall value of the project (Koolwijk *et al.* 2018). Collaboration also promote communication, transparency, among trust among stakeholders (Gomes and Tzortzopoulos 2020). Clearly, by fostering open dialogue and effective communication, stakeholders can mitigate conflicts, identify, and resolve issues more quickly, and make better decisions during the VM process (Iyiola and Mewomo 2023). By collaborating closely, VM

members can identify potential conflicts or coordination issues early, thereby preventing costly rework or delays (Botton and Forgues 2017). Enhanced innovation is also another important benefit of collaborative relationships in VM (Park *et al.* 2017; Aghimien *et al.* 2022). This promotes innovation by encouraging stakeholders to share ideas and expertise.

Fostering a culture of innovation, stakeholders can explore new technologies, materials, and processes, leading to improved project outcome (Aghimien *et al.* 2022). Collaboration is also beneficial for motivation (Olanipekun *et al.* 2018). Increased motivation among value members can enhance more engaged and committed team. Everyone works towards the same goal and create a sense of purpose and drive among the project team. When stakeholders share a common vision, opportunities to create value will be identified more effectively which will promote innovative solution, streamlines processes, and reduced costs, ultimately enhancing the overall value of the project. Trust creates an environment where effective collaboration and open communication can flourish (Chalker and Loosemore 2016).

When stakeholders trust each other, they are more likely to share information, ideas, and concerns openly, leading to improved decision-making, problem-solving, and overall project coordination (Iyiola, 2023 #735). Koolwijk, van Oel and Bel (2022) mentioned that it encourages stakeholders to support and rely on each other, promoting a sense of shared responsibility for project success. According to Faris, Gaterell and Hutchinson (2022), stakeholders are more willing to engage in open dialogue, listen to different perspectives, and find mutually beneficial solutions in a trust environment. Building and maintaining trust among stakeholders is essential for fostering successful project outcomes, long-term partnerships, and a positive reputation within the construction industry (Larsson and Larsson 2020).

Construction projects involve numerous details, specifications, and requirements. It is vital to communicate these aspects clearly and promptly to all relevant parties (Aghania, Ramzani and Raju 2019a). This ensures that everyone has accurate and up-to-date information, reducing the likelihood of misunderstandings, errors, and delays (Aghania, Ramzani and Raju 2019b). Effective communication enables project stakeholders to work together, share insights, coordinate activities, and align their efforts towards achieving project goals (Huang *et al.* 2020). Regular meetings, discussions, and digital collaboration tools can facilitate this process of communication (Aghimien *et al.* 2022).

Effective communication includes maintaining accurate records and sharing them with relevant parties, and ensuring accountability (Huang *et al.* 2020). Xie *et al.* (2010) affirmed that open and constructive dialogue helps in finding mutually acceptable solutions and avoiding costly disputes. Mallett (2017) mentioned regular updates, progress reports, and addressing clients concerns help build trust and ensure that the project aligns with the client’s expectations. Transparent communication also helps manage client expectations and allows for necessary adjustments throughout the construction process. These and other forms of collaboration are presented in Table 2.8.

Table 2.8: Collaboration Practice in the Construction Industry

Factors	References
Management commitment and support	Lin, Mazlan and Ismail (2022), Kim <i>et al.</i> (2016), Hwang, Zhao and Ong (2015), Kineber <i>et al.</i> (2021d), Danjuma (2021b), Aigbavboa, Oke and Mojele (2016), Salazar <i>et al.</i> (2022)
Communication	Coetzee (2009), Kim <i>et al.</i> (2016), Kim <i>et al.</i> (2016), Faris, Gaterell and Hutchinson (2022), Aghania, Ramzani and Raju (2019b), Amarnath, Sawhney and Maheswari (2011), Lu, Zhang

	and Rowlinson (2013), Goswami <i>et al.</i> (2023), Oraee <i>et al.</i> (2019)
Interpersonal relationship	Jaapar <i>et al.</i> (2009), Xie <i>et al.</i> (2010), Prajogo and McDermott (2005), Tanko <i>et al.</i> (2018), Zhao and Moh (2016), Kokkonen and Vaagaasar (2018), Oke, Stephen and Aigbavboa (2022c), Bodika and Aigbavboa (2018)
Coordination	Lin <i>et al.</i> (2011), Kim <i>et al.</i> (2016), Kineber <i>et al.</i> (2021b), Kineber <i>et al.</i> (2021d), Kineber <i>et al.</i> (2021c), Amarnath, Sawhney and Maheswari (2011), Chen <i>et al.</i> (2021)
Continuous improvement	Coetzee (2009), Aigbavboa, Oke and Mojele (2016), Aghimien and Oke (2015), Jaapar, Maznan and Zawawi (2012), Amarnath, Sawhney and Maheswari (2011), Berardi and de Brito (2021)
Trust	Deep, Gajendran and Jefferies (2021), Garcia and Murguia (2021), Mallett (2017), Chiocchio <i>et al.</i> (2011); Faris, Gaterell and Hutchinson (2022), Gomes and Tzortzopoulos (2020), Aghania, Ramzani and Raju (2019b), Amarnath, Sawhney and Maheswari (2011)
Stakeholders' engagement	Ojo, Ogunsemi and Ogunsina (2021), Kineber <i>et al.</i> (2021a), Othman <i>et al.</i> (2020), Aigbavboa, Oke and Mojele (2016), Amarnath, Sawhney and Maheswari (2011)
Resources sharing	Madushika <i>et al.</i> (2020), Lin, Mazlan and Ismail (2022), Othman <i>et al.</i> (2021), Thneibat, Thneibat and Al-Tamimi (2021), Hosseinnezhad, Nugroho and Heavey (2023)
Innovative ideas and alternatives	Lin, Mazlan and Ismail (2022), Kineber <i>et al.</i> (2021c), Kineber <i>et al.</i> (2021a), Danjuma (2021b)
Conflict resolution	Garcia and Murguia (2021), Lai (2011), Faris, Gaterell and Hutchinson (2022), Vaux and Kirk (2018), Lecuyer <i>et al.</i> (2018), Ptschelinzew <i>et al.</i> (2020), Thilakarathne <i>et al.</i> (2022), Valdes-Vasquez and Clevenger (2015)

Shared vision	Chi, Chong and Xu (2022), Matinheikki, Rajala and Peltokorpi (2017), Xu, Chi and Chong (2022),
Teamwork	Adu and Opawole (2020), Tabassi, Ramli and Bakar (2012), Kandaswami and Subbaiyan (2020), Yap, Leong and Skitmore (2020), Mendo-Lázaro <i>et al.</i> (2017), Riazi <i>et al.</i> (2019),Necchi <i>et al.</i> (2020), Ellis <i>et al.</i> (2022)

Source: Researcher’s review of literature

2.7.3 Standardisation

Standardisation in VM is the establishment of consistent guidelines, principles, and best practices that organisations follow when managing and optimising value (Kineber *et al.* 2023a). Standardisation for VM helps organisations achieve greater efficiency, transparency, and effectiveness in their VM practices (Kineber *et al.* 2023b). It provides a framework for organisations to align their processes, methodologies, and metrics with established industry or regulatory standards (Kineber *et al.* 2021d). This ensures that VM activities are carried out consistently and in accordance with recognised principles, regardless of the specific context. This study recognises the impact of standardisation as one of the adoption indicators of VM. Standardisation helps establish governance mechanisms and compliance frameworks for VM (Ojo, Ogunsemi and Ogunsina 2021). It ensures that organisations adhere to legal and regulatory requirements, industry standards, and ethical guidelines (Ojo and Ogunsemi 2018). This promotes accountability, risk management, and responsible value creation practices. Standardisation also supports continuous improvement in VM practices. Organisations can learn from standardised approaches and leverage best practices to optimise their value creation processes. By benchmarking against industry standards, organisations can identify areas for improvement, implement corrective actions, and drive ongoing enhancement of their VM capabilities.

Standardisation in this study was categorized into; input by relevant governmental and local authorities, VM study plan for implementation, clients' enforcement ability to communicate requirements to design team, government commitment to implement VM, regular attendance of decision-makers, and active client's support and participation. From reviewed literature, evidence have demonstrated the importance of standardisation as a body of knowledge to contribute to VM adoption. This supports the findings of Kim *et al.* (2016) and Aghimien, Oke and Aigbavboa (2018) who recognised government interest in VM adoption, preparedness, client participation, and public awareness of VM advantages as adoption criteria for VM. Kineber *et al.* (2021d) also mentioned that the proactive efforts of the US government and its public agencies enabled the enhancement and implementation of VM throughout the United State (US) construction sector. Jaapar *et al.* (2009) highlighted the Malaysian government's efforts by mandating VM approval for all government construction projects. When working on building projects for the US and Australian governments, similar VM approval rules are necessary. This demonstrates how government actions have contributed to the broad adoption and adoption of VM among building professionals. Kineber *et al.* (2021a) also recommended client support and active involvement with the successful implementation of VM. According to Perera and Gunatilake (2020), a key impediment to the implementation of VM is the lack of participation from project owners. As a result, the client's involvement and commitment are critical to the success of VM's deployment and adoption (Lin 2009). Similarly, policymakers in the built environment should be determined to integrate this as a part of their corporate culture. The government can generate all VM's initiatives and regulations because it is the largest consumer and investor (Oke, Aghimien and Olatunji 2015). It also has a significant amount of capital development in the form of property and infrastructure development assets (Tanko *et al.* 2018). Policy makers, government agencies and

leadership of the built environment are significant organizer and administrators in order to include a wide choice of options to support the adoption of sustainable materials and technological innovations (Hwang, Zhao and Ong 2015). As a result, the government's support and active engagement in the application of the VM on current construction development will be critical (Tanko *et al.* 2018). Also, improvements in VM implementation techniques will be noted. Zainul-Abidin (2008) further revealed that engagement between stakeholders and experts increases the likelihood of clients and end-users respecting sustainability achievement. According to Jaapar, Maznan and Zawawi (2012), inadequate expert engagement and poor facilitation skills might have a detrimental impact on VM activities.

2.8 VM MODEL

Across the literature, there have been numerous frameworks and models which have been proposed. As noted earlier, this study focuses specifically on the various ways in which VM can be used to improve the delivery process of construction projects for sustainable built environment in Nigeria. Based on the various arguments and definitions regarding the concepts, it is essential to develop a framework that will increase the understanding of VM concept, especially in Nigerian context.

2.8.1 Soft VM Model

The model was initially developed by Liu and Leung (2002) for application in the field of engineering and aimed at the economic and managerial aspects of project development where project goals are achieved through effective interaction between the client and the project team members, by aligning, the values and goals of the client and the team members. The model consists of five components; **input from the stakeholders** (client and team members); **values of the client**

and team members (and potential value conflicts); **goals; actions and outcomes of the project.**

The *input* of the client and team members is represented in their personal *values* driven by past experiences, future wishes, fears, the present actual situation (which includes an individual's ability and knowledge, the hierarchy of values and the difficulty of tasks), as well as the environmental pressures such as economic realities and regulatory prescriptions. The *goals* decided on are underpinned by an individual's value system and require specificity for high performance. Project goals are set to initiate required actions for project realisation. Finally, VM is depicted as triggered by the internal and external input factors in the environment leading to a decision-making process, which produces decision *outcomes*. Output of this VM system becomes input to other systems.

The applicability of soft VM model to construction activities lies in the relevance of the underlying components to the delivery of construction projects (Green and Sergeeva 2019). Internal values and environmental pressures drive the input of both internal and external stakeholders. In the process, value conflicts may be experienced. Goals are set (cost savings, service levels and increased productivity) and actions, through the aggregate behaviours of stakeholders (in setting policies, controlling expenditure, and managing corporate construction processes), taken, producing desired outcomes, the results of which are fed back into the system for improved performance and effective delivery of construction projects. An adaptation to this model was made in defining the internal and external inputs for application to construction activities where the internal input is defined as stakeholders within the organisation and the external input as stakeholders external to the organisation. This allows for a clearer identification of the values of the internal and external stakeholders and of their relationships and the conflicts that may exist within this relationship.

The conceptual model of VM in construction within the framework of goal-setting theory considered that VM is aimed at the economic and managerial aspects of project development to focus the definitions of project goals which are obtained through the interaction between the client and the project team members. The model emphasized a social constructivist perspective to solve conflicts, establish a shared understanding, and achieve consensus among all involved parties. The author postulated that goal setting is a critical management process, as clear goals would provoke appropriate actions and hence lead to desired outcomes. The model also claimed that VM must focus greater attention on the phase of team goal definition by explicitly clarifying the clients and participant's values and goals. The model assumed that project goal specificity at the commencement of the project enhances participants' commitment and facilitates clear cognised decision making by the participants throughout the project realisation stage.

The model assumed that a problem exists when the values and objectives of different VM members involved in the construction process conflict with each other. These conflicts need to be managed to reach the desired outcome of the management process. Only when conflicts have been properly managed can common goals be set. Ultimately, the stakeholders in the construction process will strive to reach a common outcome; successful, effective construction project that will meet the need of each stakeholder involved in the process.

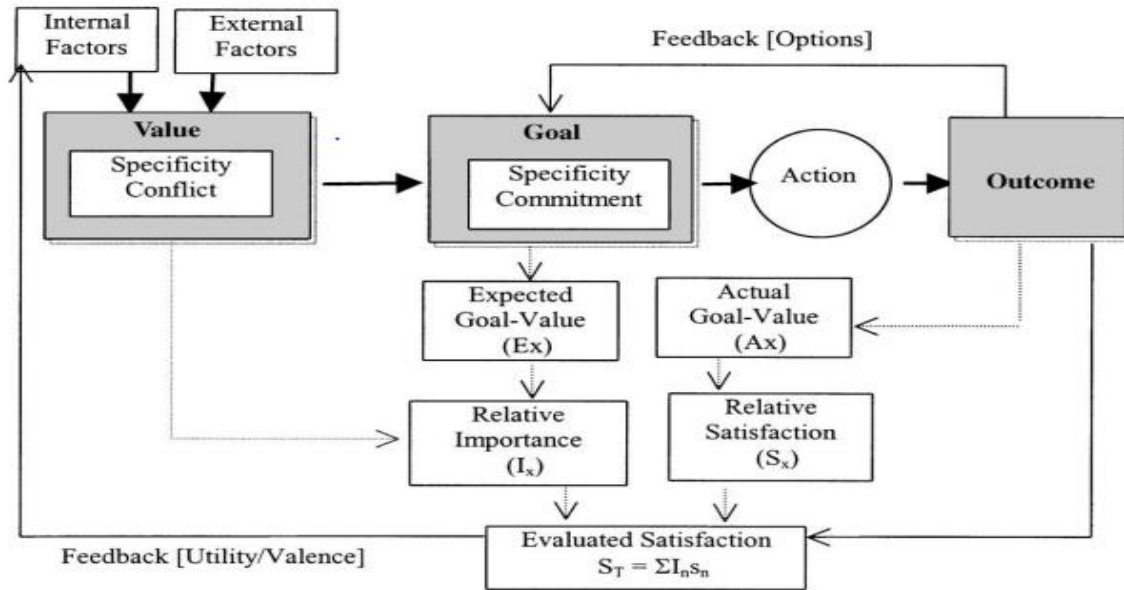


Figure 2.2: Soft VM Model
Source: Liu and Leung (2002)

2.8.2 Balanced Scorecard Framework (BSC) by Kaplan and Norton (1992)

The Balanced Scorecard is a strategic management framework that provides organisations with a balanced view of their performance by considering multiple perspectives beyond just financial measures. It was first introduced by Robert Kaplan and David Norton (1992). Traditionally, firms primarily focused on financial metrics such as revenue, profitability, and shareholder value (Dobrovič *et al.* 2018). However, the Balanced Scorecard recognises that financial performance is influenced by various other factors, including customer satisfaction, internal processes, and organizational capacity for innovation and learning (Phadtare 2010). According to Kaplan and Norton (1992), the balanced scorecard incorporates four key perspectives, which are;

1. Financial Perspective: This perspective looks at the financial indicators that measure the organisation's success and profitability. It includes metrics such as revenue growth, profitability, return on investment (Khanna, Laroiya and Sharma), and cash flow (Vukomanovic and

Radujkovic 2013). Generally, financial performance measures can be regarded as the most important component in applying company strategy (Dobrovič *et al.* 2018); this is due to main role of supporting and improving companies. The main financial perspective goal is to increase shareholders value, growth, and profitability (Gunduz and Al-Naimi 2022). Long-term financial growth can be attained by using the BSC to set objectives that measure financial performance combined with a series of activities that can be used to engage with employees, systems, financial processes, internal process, and the customer (Lin and Shen 2010).

2. Customer Perspective: The customer perspective focuses on the organisation's ability to deliver value to its customers and meet their needs (Nørreklit *et al.* 2012). It includes metrics related to customer satisfaction, customer retention, market share, and customer acquisition (Seal and Ye 2014). In more recent years, most of the organization has developed their vision based on their customer; as customer focus and satisfaction are regarded very important for any sector (Llach *et al.* 2017). The main aim of an organisation based on a customer perspective is to provide excellent services, quality and to ensure customers are satisfied so that the business can maintain a good reputation amongst their customers (Perramon *et al.* 2016).

3. Internal Process Perspective: This perspective examines the internal operations and processes that are critical to delivering value to customers and achieving financial goals (Kunz, Siebert and Mütterlein 2016). It involves identifying key processes and measuring metrics related to operational efficiency, quality, innovation, and process improvement. Internal factors can be used to categorize the customers and organization objectives (Perramon *et al.* 2016). Measuring the company's process in order to reach the best performance outcome is important in this perspective (Dobrovič *et al.* 2018). By implementing the internal process perspective, customer and financial strategic targets can be attained (Seal and Ye 2014).

4. Learning and Growth Perspective: This perspective recognizes that an organisation’s ability to innovate, learn, and adapt is crucial for long-term success (Perramon *et al.* 2016). It includes metrics related to employee training and development, employee satisfaction, knowledge management, and the ability to attract and retain talents (Gunduz and Al-Naimi 2022). While some consider this last factor as not as important as the other three, learning and growth perspective is the foundation that firms must produce in order to determine long-term enhancements and growth (Seal and Ye 2014). This factor not only encompasses employee skills, framework, and structure but also the efficiency of data and activities that support the achievement of company’s aims (Phadtare 2010). Learning and growth factors constitute the basis for achievement of any learning associations (both present and future learning) (Llach *et al.* 2017).

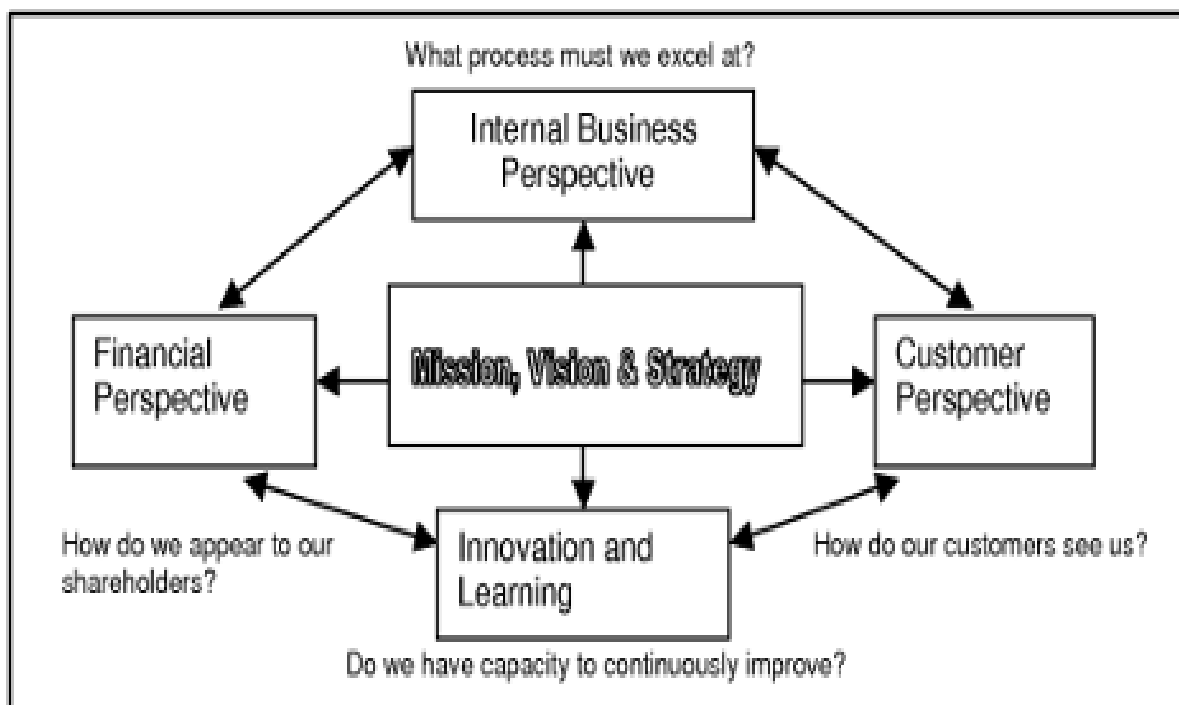


Figure 2.3: Balanced Scorecard Framework

Source: Kaplan and Norton (1992)

2.8.3 VM Framework by Ojo *et al.* (2021)

This framework put forward by Ojo, Ogunsemi and Ogunsina (2021). The concept considers collaboration between stakeholders as a key element in the adoption of VM studies. The framework is designed to make clear the actions required for important stakeholders to foster implementation. From a broad perspective, they argued that when it comes to training and carrying out the requisite VM practice, partnership with the construction industry of developed nations is essential. The study also mentioned that the government, universities, and professional organisations involved in construction should work together to coordinate all of the procedures for implementing the application of VM. The construction clients will benefit from being able to monitor the performance of VM adoption on projects by experiencing the advantages of VM. This will therefore assist in determining the benchmark or threshold of construction activities in which VM must be implemented, which would in turn aid in decision-making. From the framework of VM in Figure 2.4, the framework explains the essence of collaboration in VM through three interconnected groups of stakeholders which are the academics, construction professional bodies and the government. The framework shows that the interactions between each of the components are of utmost importance. Therefore, this model offers an understanding of the wider influences on the concept of VM and can be described as comprehensive and all-encompassing (Ojo *et al.*, 2021).

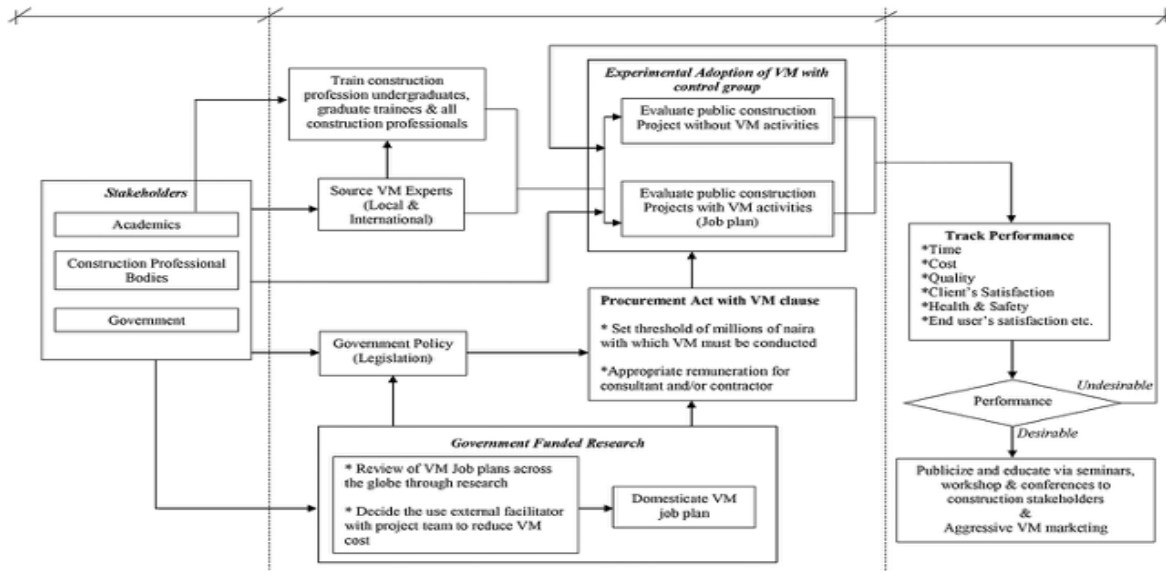


Figure 2.4: Conceptual Framework for VM

Source: Ojo, Ogunsemi and Ogunsina (2021)

2.8.4 Strategic VM Model

The concept of strategic VM model was developed by Thiry (2014). The model presupposed that VM needed to be strongly integrated with portfolio, program, and project management required to drive strategic decisions and aid in the delivery of business advantages. According to the model, employing VM at the strategic level will help you comprehend strategic choices and company advantages. It targets all managers who want to deliver business benefits that are in line with the organisations' strategy, while making sure that these strategies are achievable. The model opined that high value can be derived from the balance between four elements of; expected benefits (the satisfaction of the stakeholders' needs and expectations); necessary abilities (the tools that must be employed to get that satisfaction); however, the more crucial question is: What capacities are offered? (materials, expertise, and knowledge, etc.) and what can be offered regarding these capabilities. Strategic value management's overall goal is to achieve the greatest possible balance

between these factors to provide the specific sequence between anticipated and actual benefits while taking accomplishment into account, not particularly to minimize resources (Thiry 2014).

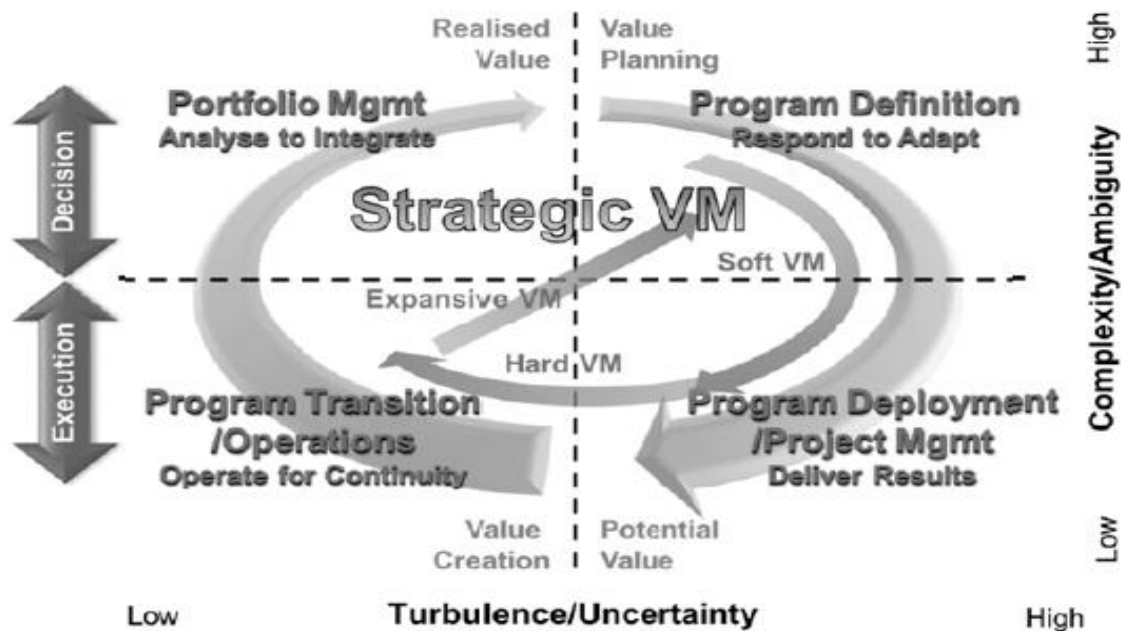


Figure 2.5: Strategic Value Management Model
Source: Thiry (2014)

2.9 SHORTCOMINGS OF THE EXISTING VM MODELS

The limitations of the current models are highlighted in this section. The application of the VM model for the Nigerian built environment is based on the limitations. There were four major models that are considered. These models were examined because they serve as the foundation for VM practices found in literature.

The framework or model created by Ojo et al. (2018) encouraged collaboration but failed to highlight the importance of corporate culture which have been identified as a crucial factor to collaboration. Generally, the participants in a VM process are selected on the basis of their technical or managerial expertise, rather than their skills in contributing to a collaborative effort.

Also, the model tends to rely on predefined sets of values and principles that guide decision-making. However, corporate cultures are dynamic and ever evolving. The model may struggle to adapt to changing societal norms, emerging trends, or evolving stakeholder expectations. This cause can hinder organisations from effectively responding to new challenging and opportunities. Therefore, to improve the performance of VM practices, implementing advanced management models and methods in a positive and favourable environment is crucial. For industries that lack that environment, it is a huge project that needs to start by changing personnel's perception.

The soft VM model involves subjective judgements and decision-making, which can lead to varying interpretations of what constitutes "value". Different stakeholders may have different opinions on what aspects of a project are valuable, making it challenging to reach a consensus. Also, the soft VM model focuses on cost reduction and value optimization, which can lead to a narrow perspective on project goals. It may not adequately consider other critical aspects, such as collaboration, corporate culture, and long-term performance. As a result, important factors may be overlooked or undervalued.

3.0 CONCLUSION

This chapter provided an understanding of VM practice in the construction industry. It commenced by reviewing the history of VM, followed by assessing the definition and applications of VM in the construction industry. The review from the definition of VM shows that the practice of VM has been in existence for a while although, limited research is available on VM and it has cut across different disciplines such as manufacturing, medical, and others. Also, there are different school of thought regarding the definition of VM as some scholars describe VM as activities, benefits, and a combination of benefits and activities.

Towards a proper understanding of VM, the study review three theories, namely collaboration theory, resource-based theory, and goal-setting theory. Each of the theories has a complementing description of the practice of VM. Also, different variables were extracted from the theories such as integration, collaboration, and standardisation. The study proceeds further by examining the practice of VM practice in the construction industry. It was discovered that VM processes is divided into three stages; Pre-workshop phase, workshop phase which is further classified into; information stage, function analysis phase, creativity phase, evaluation phase, and development phase), and post-workshop phase. The benefits of implementing VM practices during construction projects was also reviewed in the literature.

The chapter concluded with reviewing various VM models in the construction industry. The review of the model confirmed that the adoption of VM is beneficial for the construction industry. Despite the benefits of the existing models, there are some gaps in the variables used in developing the past models. For instance, the past models did not examine the behaviour of value members in an organisation such as corporate culture and the use of digital technologies in VM activities. The gaps in the existing VM model for the construction industry are reviewed in the next chapter.

CHAPTER THREE

GAPS IN VM RESEARCH

3.1 INTRODUCTION

After reviewing the various VM model, frameworks and their corresponding constructs, this chapter extensively address the gaps observed in a bid to satisfy the objectives and purpose of the study. The critical examination and justification of these gaps form the basis upon which the conceptual framework for this study was achieved. In ensuring the preparedness of construction professionals for the future of the Nigerian built environment, these two gaps and dimensions need to be included in the proposed VM model. They are “corporate culture” and the need for construction professionals to utilise “digital technologies”. The gaps are discussed in connection to their contribution to the improvement of VM model.

3.2 GAPS IN VM FRAMEWORK

The considered models above are legitimate and accepted by the construction industry across the globe and provides varied perspectives on the scope of VM which can be adopted for effective delivery of construction projects. The four models also contain constructs which apply to the realisation of this study, such as integration, collaboration, and standardisation (Othman *et al.* 2020; Bennett and Mayouf 2021; Ojo, Ogunsemi and Ogunsina 2021). However, some of these frameworks have become dated since the concept of VM is constantly evolving as construction projects need to possess more sustainability to function effectively in this dynamic era of work, coupled with the recent wave of digital transformation. In addition, the fact that the various model constructs correlate with other models implies that any perceived weakness in any model will be addressed. Meanwhile, there has been little mention of VM model specifically for the built environment, a gap which this study addressed. This section addressed the two gaps which have

been identified, namely the roles of ‘corporate culture’ and the impact of ‘digital technologies’ for the delivery of construction projects through VM practices. The idea that these gaps should be considered is centered on the fact that VM practices can only be improved in the face of effective corporate culture and the use of digital innovations. Hence, effective corporate culture and the use of digital technologies must be established to create improvement and implementation strategies. Also, it is paramount that construction professionals should require a plethora of skills as automation continues to advance.

Evaluation from past articles and models in advanced countries showed that VM has been structured using factors such as integration, collaboration, and standardization. This research made the claim that the current constructs are insufficient for evaluating VM performance. It forecast that for integration, collaboration, and other constructs to sufficiently predict VM, an enabling corporate culture is needed. This is because corporate culture acts as a norm or supportive atmosphere for integration, collaborative relationship, and others within the construction value chain. Consequently, it was believed that corporate culture can enhance the relationship between professionals involved in VM workshop by virtue of its ability to provide consistent attitudes among VM crew.

3.3 GAP ONE: CORPORATE CULTURE

3.3.1 Definition of Corporate Culture

There are various definitions that has been given to corporate culture in literature depending on the context in which it is to be used. Various scholars have described corporate culture as a behavioural trend displayed in an organisation, firm, or enterprise. For example, Fang *et al.* (2020) defined corporate culture as the collection of values, expectations, and practices that guide and

inform the actions of all team members. Zheng *et al.* (2019) referred to corporate culture as a reflection of the basic assumptions shared by members of a group which defines the group's view of itself and its environment as well as its way of performing daily activities.

Coffey (2010) submitted that CC is the shared values, beliefs, attitudes, and behaviours that characterize an organisation. It represents the collective personality and identity of the company, influencing how employees interact with one another and how they approach their work (Cadden, Marshall and Cao 2013). Corporate culture is shaped by various factors, including the organisation's mission, vision, and core values, as well as its history, leadership style, and the people it attracts and retains. There are different views of corporate culture.

However, some researchers view corporate culture as essential for organizational success (Yang 2010; Gajendran *et al.* 2012; Gao 2017). They believe that a strong culture can foster employee engagement, loyalty, and productivity. These researchers see it to create a cohesive and motivated workforce, enhance teamwork, and improve overall performance. Others have a more critical perspective on corporate culture. They argue that an overly strong culture can stifle individuality, limit creativity and innovation, and discourage diversity of thought (Linnenluecke and Griffiths 2010; González-Rodríguez *et al.* 2019; Fang *et al.* 2020). They view it as a mechanism for conformity, bureaucracy, and control within the organisation (Giritli *et al.* 2013; Nikpour 2017; Zheng *et al.* 2019). A further review of literature surrounding corporate culture revealed that some scholars perceived corporate culture through an adaptive view. This perspective recognizes that corporate culture should be dynamic and adaptable to change. Supporters of this view believe that a flexible culture can enable organisations to respond to evolving market conditions, technological advancements, and customer preferences. They emphasise the importance of continuously shaping and adjusting the culture to stay competitive. Some other view argues that understanding and

managing subcultures is important for fostering collaboration, resolving conflicts, and leveraging diverse perspectives (Freiling and Fichtner 2010; Gad and Shane 2012; Stock, Six and Zacharias 2013; Adelekan 2016; Harrison and Bazzy 2017).

This study identified corporate structure and strategy as subsets of an organisation culture because of its capacity to provide two basic distinct functions. First, it helps an organization integrate employee behavior, and second, it helps an organization relate to its surrounding environment. Hence, corporate culture is defined in this study as the common fundamental presumption that a stakeholder in a construction project has acquired for resolving its issues and that has proven effective enough to be accepted as true. Since integration and collaboration have been identified as the essence of VM, this research also posits that corporate culture serves as the glue bringing construction professionals together (Jaapar *et al.* 2009; Edwards *et al.* 2010; Aigbavboa, Oke and Mojele 2016; Mallett 2017).

3.3.2 The Moderating Role of Corporate Culture

The concept of corporate culture (CC) has garnered significant attention in the field of organizational theory, as evidenced by the works of (Cheung, Wong and Wu 2011; Gimenez-Espin, Jimenez-Jimenez and Martinez-Costa 2013; Willar, Trigunarsyah and Coffey 2016; Chen, Jiao and Harrison 2019). CC is often described as the social or normative glue that binds an organization together, a definition put forth by (Arditi, Nayak and Damci 2017). According to Yang (2010), CC represents a long-term collection of shared attitudes, beliefs, and meanings that shape the thoughts and behaviors of an organization's members. Cameron and Quinn (2011) have noted that implementing change initiatives while preserving the existing CC can be challenging, even when an organization possesses fundamental capabilities, methodologies, and change strategies. Linnenluecke and Griffiths (2010) argued that the successful adoption of change

programs within a firm is primarily determined by CC, including the values and principles that underlie the organizational culture. Given that CC can provide insights into internal aspects such as managerial qualities, human resource management, and organizational behavior, it becomes a crucial area of focus in the pursuit of sustainable goals (Linnenluecke and Griffiths 2010).

As per Eccles, Ioannou and Serafeim (2014), corporate culture (CC) encompasses a firm's codes of conduct, organizational standards, processes, and management systems. Building on this, Galpin, Whittington and Bell (2015) have argued that organizations must emphasize their mission, values, norms, and strategy to successfully achieve sustainable development goals. Lozano (2015) has suggested that sustainable efforts should be gradually integrated into CC, necessitating cultural changes within an organization. Arditi, Nayak and Damci (2017) delved into the impact of organizational culture on delays in construction projects and found a significant correlation between corporate culture and the extent of project delays. Similarly, Albayrak and Albayrak (2014) investigated the influence of organizational culture on the adoption of construction practices in Turkey and reported a substantial effect.

Prior research has extensively explored the connection between CC and adoption, as exemplified by the work of (Martínez-Caro, Cegarra-Navarro and Alfonso-Ruiz 2020). For instance, CC-related characteristics such as resistance to change, information sharing among employees, and resistance to external innovation have been found to influence a firm's ability to innovate, as noted by (Büschgens, Bausch and Balkin 2013). Consequently, Hogan and Coote (2014) stressed the role of management in encouraging employees to exhibit innovative behaviors to cultivate a CC that fosters innovation. Numerous other researchers have also focused on the impact of CC on areas such as innovation Büschgens, Bausch and Balkin (2013), knowledge management (Zheng, Yang and McLean 2010), and job satisfaction (Wiener, Gattringer and Strehl 2018). The existing

literature demonstrates that professionals and researchers have recognized the significant influence of CC on the long-term adoption of construction projects, change initiatives, and overall organizational performance. However, there is a limited body of research examining the effects of CC on the integration and adoption of Value Management (VM) in the construction industry.

3.3.3 Corporate Culture Dimension

Cameron and Quinn (2011) recommended that corporate culture occurs in different dimensions. Corporate culture dimensions is the various aspects that define the culture within an organisation. These dimensions provide insights into the values, beliefs, attitudes, and behaviours that are prevalent within the firm. While different models and frameworks exist to categorise corporate culture dimensions, one commonly used framework is the Competing Values Framework (CVF). The CVF identifies four primary dimensions of CC, which are.

Clan Culture: This culture emphasizes collaboration, teamwork, and employee empowerment. Organisations with a clan culture often prioritize employee development, loyalty, and a sense of community (Harrison and Bazzzy 2017). Decision-making tends to be more participative, and there is an emphasis on building relationships and maintaining a supportive work environment (Ginevičius and Vaitkūnaite 2006). In a clan culture, there is strong kinship ties which is typically based on blood relations, and kinship ties which play a crucial role in defining one's identity and social status within the clan (Gao 2017). Also, clans often have a set of shared values, beliefs, and customs that guide their behaviour and decision-making processes. Clan cultures often involve collective decision-making processes, where important decisions are made through consultation and consensus among clan members (Ramdhani, Ramdhani and Ainsiyifa 2017). Key stakeholders within the clan may hold significant influence in decision-making. In addition, clan culture emphasise the idea of interdependence and mutual support among members (Coffey and Willar

2010). Clan members are expected to help and support to each other, especially during times of need or crisis.

Adhocracy Culture: Adhocracy culture is characterized by innovation, creativity, and risk-taking. Organisations with this culture value flexibility, adaptability, and a willingness to experiment (Martínez-Caro, Cegarra-Navarro and Alfonso-Ruiz 2020). Decision-making tends to be decentralized, and employees are encouraged to take risks and pursue new ideas. This culture is often found in dynamic and entrepreneurial organisations (Giritli *et al.* 2013). Adhocracies value flexibility and adaptability over rigid structures and processes. Participants can respond quickly to changing circumstances and market conditions. This cultural dimension encourages innovation and creativity among employees (Hofstede *et al.* 1990). They provide a supportive environment for experimentation and risk-taking. Employees are empowered to make decisions and take responsibility for their work (Coffey 2010). Adhocracies typically have a flat organizational structure with fewer hierarchical layers. This allows for better communication and faster decision-making. Communication in an adhocracy culture is often informal and open (Abdelrahman and Papamichail 2016). This promotes collaboration and cross-functional learning. Learning and knowledge sharing are highly valued in adhocracy cultures (Ramdhani, Ramdhani and Ainisyifa 2017). Employees are encouraged to continuously develop their skills and knowledge. Adhocracies thrive in environments with high levels of ambiguity and uncertainty (Iyiola and Mewomo 2023). They are comfortable with taking risks and adapting to change. Different teams within an organisation may have varying degree of adhocracy depending on their specific needs and goals (Naranjo-Valencia, Jiménez-Jiménez and Sanz-Valle 2019).

Market Culture: Market culture is focused on achieving results, competitiveness, and external orientation. Organisations with a market culture prioritise goal achievement, customer satisfaction,

and profitability (Patyal, Ambekar and Prakash 2020). Decision-making tends to be driven by data and market forces, and there is a strong emphasis on performance measurement and accountability. Customer satisfaction and meeting their needs are paramount (Kim and Jung 2022). The organisation places a high value on understanding customer preferences, delivering superior products or services, and building long-term customer relationships (Olanipekun, Abiola-Falemu and Aje 2014). Also, there is a strong emphasis on achieving measurable results, such as sales growth, market share, and profitability. Employees are motivated to achieve and exceed targets, and performance is often rewarded based on objective outcomes (Low, Abdul-Rahman and Zakaria 2020). The organisation fosters a competitive mindset, both internally among employees and externally with competitors. There is a constant drive to outperform rivals and gain a competitive edge through innovation, quality, and efficient operations (Cadden, Marshall and Cao 2013; Wiener, Gattringer and Strehl 2018). Individuals are held accountable for their performance and results. There is a culture of ownership, where employees take responsibility for their actions and are encouraged to make decisions that align with the organisation's goals. Market cultures value flexibility and the ability to respond quickly to changing market conditions (Naranjo-Valencia, Jiménez-Jiménez and Sanz-Valle 2019). The organisation encourages innovation, risk-taking, and learning from failures to stay ahead in the market. Compensation and recognition are often tied to individual and team performance (Körner *et al.* 2015). High-performing employees are recognized and rewarded, reinforcing the importance of achieving business objectives.

Hierarchy Culture: Hierarchy culture emphasizes stability, control, and efficiency. Organisations with a hierarchy culture have formalized processes, clear roles and responsibilities, and a strong emphasis on rules and procedures (Atuahene and Baiden 2018). Decision-making tends to be centralized, and there is a focus on efficiency, predictability, and maintaining order. In a hierarchy

culture, there is a clear chain of command, with well-defined levels of authority and decision-making power (Coelho *et al.* 2022). Power and control are concentrated at the top of the hierarchy, with the leaders and managers having the final say in most matters. Decision-making authority is concentrated at the top of the hierarchy, and individuals at lower levels of the organisation have limited autonomy or discretion in making decisions (Adelekan 2016). Hierarchy culture tend to have formal rules, procedures, and policies that dictate how work is to be done. There are clear job descriptions, reporting relationships, and lines of communication (Arditi, Nayak and Damci 2017). There is a strong emphasis on following established procedures and adhering to prescribed roles. Communication flows predominantly from the top of the hierarchy downward, with leaders and managers providing instructions and guidance to subordinates (Low, Abdul-Rahman and Zakaria 2020). Feedback from lower levels is often limited and may not have a significant impact on decision-making. Hierarchy cultures typically emphasise respect for authority and expect individuals to follow directives from their superiors without question (Coffey 2010). The authority and status of leaders are highly valued and acknowledged. Hierarchy cultures tend to prioritise stability and predictability, with an emphasis on maintaining order and consistency (Harinarain, Bornman and Botha 2013). Change may be perceived as disruptive or challenging to the established structure and may require approval from higher levels (Atuahene and Baiden 2018). Performance evaluations in hierarchy cultures often follow a formal and structured process, with clear metrics and criteria for assessing performance (Cheung, Wong and Wu 2011). Advancement and rewards are typically based on adherence to rules and meeting predetermined targets (Cao *et al.* 2015). Table 3.1 presents the latent variables and their sources that were used in developing the questionnaire for this study.

Table 3.1: Latent variables for Corporate Culture Dimensions

Cultural dimension	Literature source
Clan culture	
Early involvement of participants	Cao and Zhang (2011), White and Marasini (2014),
Teamwork	Ramly <i>et al.</i> (2015), Kokkonen and Vaagaasar (2018),
Cooperation	Ramly <i>et al.</i> (2015), Kokkonen and Vaagaasar (2018), Kostina and Torgasheva (2018),
Decision alignment	Carvalho and Rabechini, (2017), Yu <i>et al.</i> (2018), Koolwijk <i>et al.</i> (2018)
Skills development and acquisition	Cadden <i>et al.</i> (2013), Musanzikwa and Ramchander (2018)
Adhocracy culture	
Acquisition of new technology	Kim <i>et al.</i> (2016), Kucia <i>et al.</i> (2021)
Motivation	Kim <i>et al.</i> (2016)
Reward and incentive system	Cao <i>et al.</i> (2010), Norrman and Naslund (2019)
Innovation	Coetzee (2010), Kim <i>et al.</i> (2016), Othman <i>et al.</i> (2021)
Updated technology systems	Coetzee (2010), Othman <i>et al.</i> (2021), Kucia <i>et al.</i> (2021)
Hierarchy culture	
Leadership control	Maes <i>et al.</i> (2012), Taghizadeh <i>et al.</i> (2012), Berawi <i>et al.</i> (2013)
Regulation of activities	Chen and Liao (2010), Kineber <i>et al.</i> (2021)
Assertiveness on policies	Chen and Liao (2010), Kineber <i>et al.</i> (2021)
Efficiency among project team members	Lavikka <i>et al.</i> (2015), Zhang <i>et al.</i> (2015), Dixit <i>et al.</i> (2018), Prachi and Mahesh (2020), Ojo <i>et al.</i> (2021), Othman <i>et al.</i> (2021)
Smooth VM action plan	Bowen <i>et al.</i> (2009), Jaapar <i>et al.</i> (2012), Mohamad and Shen (2012), Al-Gahtani <i>et al.</i> (2015)
Market Culture	
Result oriented	Ankrah and Langford (2005) and Harinarain <i>et al.</i> (2013)
Client satisfaction	Cameron and Quinn (2011), Albayrak and Albayrak (2014) and Atuahene and Baiden (2018)

Emphasis on goal accomplishment	Zheng (2005) and Harinarain <i>et al.</i> (2013)
Ensuring a large market size	Patyal <i>et al.</i> (2019)
Health competition	Harinarain <i>et al.</i> (2013)

Source: Author’s review of literature

3.4 GAP TWO: USE OF DIGITAL TECHNOLOGIES

Another gap observed in the reviewed models of VM is the need for incorporating digital technologies in VM practices. With the advent of high- speed networks and smart infrastructures dominating our present-day world, there is a new transformation not experienced.

3.4.1 Concepts of Digital Technologies

The current trend of data sharing, computerisation, and automation in manufacturing technologies is commonly referred to as "digital innovations." Recently, the term has gained popularity and has since become a regular topic in the academic field, social groups as well as industry. Several studies have described digital innovation as the blending of technologies of the digital, physical, and even biological world, which leads to the creation of innovative opportunities that influence the economic, political, and social systems. The availability of new technological achievements has led to certain terminologies such as artificial intelligence (AI), digitalisation and robotics, cloud manufacturing, augmented reality, the Internet of Things (IoT), the internet of services (IoS), big data analytics (BDA), and cyber-physical systems (CPSs), the 4IR basically transforms modern production (Olanipekun and Sutrisna 2021).

Digital technology refers to the combination of cybernetic (digital) and physical systems. These systems are interactive in that everything which happens in the physical has bearing on the virtual systems and vice versa in enabling increased efficiency and improvement among firms who adopt

this new paradigm (Van Dyk and Van Belle 2019). The adoption of the above-named technological terminologies is critical to the advent of more intelligent manufacturing processes that comprises devices and production modules that can exchange information, control each other, and trigger actions independently to enable an intelligently working manufacturing environment (Lu and Xu 2019). Digital tools, according to Ibem and Laryea (2014), include software, methodologies, hardware, networks, networking systems, as well as intelligent systems that foster cooperation, teamwork, and communication. The usage of these digital tools can assure the successful and efficient operation of the VM process (Aghimien *et al.* 2022).

Globally, technological development is quickly transforming how construction activities are carried out. Building information modelling (BIM), an example of digital technology is redefining how construction industry players work on projects, enhancing the productivity of the completed building projects significantly (Aghimien *et al.* 2018a). By lowering the cost of raw materials, maintaining worker safety, and increasing production, robotics and automation (R&A) are simultaneously providing cost-effective construction (Kim *et al.* 2015). Similar to how big data analytics (BDA) enables rapid project decision-making, cloud computing and the internet of things (IoT), along with building information modeling (BIM), are significantly enhancing business communication and collaboration (Crnjac, Veža and Banduka 2017; Ammar, Russello and Crispo 2018). It is not surprising that research have persisted to concentrate on the use of these technologies in the management of building works, given their significance (Huang *et al.* 2020). VM, however, is a management function in the construction industry that has received less attention in terms of using digital tools.

In order to develop alternative strategies that would fulfill the functional purpose of constrained resources, VM was created in the late 1940s (Alshehri 2020). Due to the requirement to provide

value for clients' constrained budgets, this strategy has become more popular over time in the construction industry (Jaapar, Maznan and Zawawi 2012). According to Madushika *et al.* (2020), VM is the process of providing construction clients with cost efficiency by providing high-quality products at affordable price. According to Subramani and Cherian (2018), VM can maximize functional benefits in projects by carefully managing a project's evolution from conception to completion utilizing effective assessment of all actions against a value system established by the client. Nevertheless, the effective implementation of the Value Management (VM) process has encountered its fair share of challenges. Notably, there have been issues concerning inadequate communication among pertinent stakeholders and within VM teams. Additionally, shortcomings in technological advancements have been observed as contributing to these challenges (Coetzee 2010; Jaapar, Maznan and Zawawi 2012; Aghimien *et al.* 2022).

However, construction participants have a significant opportunity to enhance the value delivered in projects by leveraging technology-driven Value Management (VM) processes. Technologies such as Building Information Modeling (BIM), cloud computing, and the Internet of Things (IoT) can play a pivotal role in improving communication and promoting team collaboration among project teams, including VM teams (Dave *et al.* 2018). Additionally, the VM team has the chance to use BIM to identify any design issues that the project's design team may have missed at an early stage of the project (Aghimien *et al.* 2022). This will enable changes to be made as soon as possible, saving money, time, and materials that might otherwise be wasted during construction (Punnyasoma, Jayasena and Tennakoon 2019). The VM team can simply gather, store, and analyze data using BDA (big data analytics), which enables them to make critical decisions for the successful completion of a project (Niu *et al.* 2021). Regrettably, due to a number of issues the industry is facing, the adoption of digital technologies in the construction sector of emerging

nations like Nigeria has been particularly slow (Yusuf *et al.* 2022). Evidently, different construction management techniques, such as VM, will also be subject to this sluggish adoption of digital technologies. Research evaluating the application of digital solutions in the VM process within the building sector is therefore lacking (Aghimien *et al.* 2022). This claim is further supported by literature searches conducted using well-known databases like Scopus and Web of Science, which turned up no relevant articles when the keywords "VM" and "digital technologies" were combined. This demonstrates an area of VM studies' knowledge that must be filled. More specifically, the lack of technological adoption has hindered the effectiveness of the VM process in the construction sector of underdeveloped nations like Nigeria, and this has prevented the sector from providing value to majority of clients (Punnyasoma, Jayasena and Tennakoon 2019). Based on the insights provided, the objective of this study was twofold: firstly, to identify digital technologies that can augment the Value Management (VM) process, and secondly, to assess the challenges that may hinder their adoption in the quest for efficient VM practices within the construction sector. The ultimate goal was to leverage digital technology to create added value for clients in the construction industry and to optimize the performance of value delivery within the sector.

3.4.2 Digital Technologies in Construction

Olanipekun and Sutrisna (2021) have highlighted that digital tools encompass a wide range of components, including software, methodologies, hardware, networks, and intelligent systems, all of which facilitate communication, collaboration, and teamwork. The utilization of these digital tools is crucial in ensuring the effective and efficient execution of the Value Management (VM) process. Several digital technologies are rapidly transforming how construction operations are managed (Aghimien *et al.* 2022). For example, Building Information Modeling (BIM), a

technology that simulates the design and construction of projects using computer models (Fadeyi 2017), has demonstrated its effectiveness in cost reduction and project timeline extension. Additionally, this technology has promoted productive teamwork on projects (Olanipekun and Sutrisna 2021) and enabled the industry to create more sustainable designs (Yusuf *et al.* 2022).

Furthermore, the Internet of Things (IoT), a technology that connects devices through the internet using predefined protocols, including data sensors, has been shown to improve communication among project participants during various project activities (Ammar, Russello and Crispo 2018). Anumba *et al.* (2021) also emphasized the significance of cyber-physical systems in facilitating the effective and efficient execution of construction projects. In addition, BDA provides improved forecasting of future events on construction projects because it entails analyzing complicated and enormous amounts of data to uncover the essential patterns and trends required to make informed judgments (Crnjac, Veža and Banduka 2017; Ammar, Russello and Crispo 2018). Using cloud computing to successfully complete construction projects has also been noticed (Oke *et al.* 2021). Utilizing this technology, various users can share computing resources. (Olanipekun and Sutrisna 2021). Additionally, utilizing visualization techniques like augmented reality (AR) and virtual reality (VR), which offer a highly immersive vision of the actual world combining both virtual data and a virtual experience, can drastically lower inaccuracies in projects (Zhang *et al.* 2020). Research have also shown that employing VR-enabled products, VR can improve site safety and efficiency (Li *et al.* 2018).

In addition to IoT, construction projects can also benefit from the use of various sensing and data gathering instruments, such as sensors, laser scanners, and drones, as noted by (Ogunseiju, Akanmu and Bairaktarova 2021). Laser scanning, for instance, provides high-quality data for project information because it can capture precise construction scenes, allowing for the creation of

a virtual environment, as highlighted by (Rahimian *et al.* 2020). Moreover, laser scanning enables accurate detection of geometric deviations in construction, providing the advantage of comparing as-designed building information models with the actual products, which is invaluable in construction quality control and assurance. (Guo, Wang and Park 2020). Due to its diverse applications, blockchain technology can also assist in achieving sustainable construction and guarantee projects are completed within specified budgets and timelines (Prakash and Ambekar 2020). The blockchain is a shared digital record that is secured to enable transactions, and its use in a variety of industries, including construction, is growing (Nawari and Ravindran 2019).

3.4.3 Components of Digital Technologies

This section shows the several types of digital technologies that can be used in the construction industry.

3.4.3.1 Internet of Services (IoS)

This present concept will create new opportunities for the service industry because IoS is focused on creating business networks between clients and service providers. The concept of IoS is similar to the Internet of Things in terms of approach, but it places a greater emphasis on services than on physical objects (Xu *et al.* 2020). IoS is considered as a new business model that will offer a novel way to deliver services and open doors to greater value generation, which may lead to links between the organizations' value chain participants. IoS according to Xu *et al.* (2020), intends to boost the value of services in a digital medium and utilise the internet in a variety of inventive methods. Additionally, from an information technology (IT) standpoint, the term "service" refers to a technical comprehension of several software capabilities that are promoted as web services.

In addition to the expansion of networking and communication links inside the IoT, which generates a sizable amount of data that can be accessed via the cloud.

3.4.3.2 Augmented reality

Product customisation is one-way manufacturers can increase customer satisfaction. This is possible with additive manufacturing, which gives businesses a variety of innovative solutions to provide end users with more value while saving them money and time. One method by which businesses have begun using additive manufacturing is the use of 3D printing, which is mostly utilized for the creation of unique components as well as prototyping. By using additive printing processes, it will be possible to create specific products with multiple design and usability benefits.

3.4.3.3 Big data analytics

To uncover the crucial patterns and trends needed to make intelligent decisions, big data analytics involves analyzing complex and enormous volumes of data. It also offers more precise future event prediction for construction projects (Niu *et al.* 2021). Institutions and businesses cannot disregard the concept of data since it is crucial to every step of the building and manufacturing process. Big data refers to datasets that are so large that they cannot be stored, maintained, executed, or analyzed using well-known database software tools. Big data varies from typical data in three major areas: volume, velocity, and variety. Variety refers to the many data kinds that were acquired, Volume to the size of the information, and Velocity to the rate at which the data was gathered. Big data analytics and related technologies make it possible to quickly gather data from numerous sources and analyze it thoroughly, which can lead to the production of high-quality items, better decisions, production flexibility, and energy efficiency. Typically, big data and big data analytics are supported by the six Cs. Some of these are the relationship between networks and sensors, content

and context, community data sharing and cooperative partnerships among important stakeholders, cyber, which deals with system properties, customisation, and the translation of data into results.

3.4.3.4 Additive manufacturing

One strategy used by companies to increase client satisfaction is product personalisation. This is possible with additive manufacturing, which gives businesses various variety of innovative solutions to provide end users with more value while saving them money and time. One method by which businesses have begun using additive manufacturing is the use of 3D printing, which is mostly utilized for the creation of unique components as well as prototyping. By using additive printing processes, it will be possible to create specific products with multiple design and usability benefits.

3.4.3.5 Cloud computing

Using cloud computing to successfully complete construction projects has also been noticed. Computing resources can now be shared among various users thanks to this technology. Another way to define cloud computing is as a platform that enables broad, on-demand network access to a linked pool of computing resources, including servers, services, and networks. By facilitating the networking and connectivity of data, goods, services, and people over the internet in the manufacturing industry, cloud manufacturing promotes a smart system. Cloud technology ensures more data sharing across organizational boundaries, enhancing system agility, efficiency, and flexibility while reducing costs. Due to the broad adoption of digital technology, it is inevitable that big data sets will be involved, resulting in an increase in the frequency of data exchange. In addition, cloud technologies have advanced for a variety of production systems thanks to the continued work of developers. Du Plessis (2017) claimed that cloud computing can also be viewed as software as a service (SaaS), with reference to the functions of Google Drive, but there is space

for a storage service as well as other services like Google Docs, Sheets, and Slides in the case of Google Drive, which is a synchronization service.

3.4.3.6 Internet of Things (IoT)

The Internet of Things (IoT) has been demonstrated to enhance communication among project participants by establishing internet-based connections between devices using predefined protocols that incorporate information sensors (Ammar, Russello and Crispo 2018). The significance of cyber-physical systems to the effective and efficient delivery of building activities was also mentioned by (Anumba *et al.* 2021). A group of technology concepts that are based on linking real-world things to the internet collectively go by the name "IoT." Since the internet's creation, computer systems have been more interconnected, and as technology has developed over time, it has enabled the internet to advance and give rise to sentient objects. As a result, the smart object is a byproduct of the Internet of Things (IoT), which is characterized by the interaction and connectivity of intelligent items with one another and their environment. To create a smart environment or a smart industry that achieves particular goals, the Internet of Things (IoT) can be regarded as the interconnection of things (machines and robots), people, systems, and objects (smartphones, tablets, and laptops) over the internet.

CHAPTER FOUR

INTERNATIONAL CONTEXT OF VM

4.1 INTRODUCTION

This chapter review VM studies in several international contexts. The chapter also reviewed the background of the construction industry in the developed countries as it examined the challenges of policies for, and hindrances to VM in construction in developed countries. Furthermore, a comparative VM analysis was conducted in the selected countries. Finally, this chapter also revises several international research studies conducted on VM performance required for the successful delivery of construction project.

4.2 A COMPARATIVE ANALYSIS OF VM PRACTICES IN HONG KONG AND AUSTRALIA

4.2.1 VM practice in Hong Kong Construction Industry

This section evaluated VM practices in Hong Kong construction industry. This study utilizes a bibliometric review methodology backed by the comprehensive literature study. According to Santos, Costa and Grilo (2017), bibliometric analysis offers the chance to discover a crucial area in a specific topic, the most-cited authors and their works together with their affiliations. Therefore, a bibliometric analysis was used in this study to determine the most often cited researchers, the important subfields for VM in the construction industry, and the Hong Kong nation with the greatest number of publications. A thorough assessment of the literature was also conducted on the author and papers that received the most citations. To compensate for the bibliometric method's limitations, the study conducts a thorough assessment of the literature. Issues results from a lack of proper analysis of the publications' content.

The benefit of the bibliometric method is that it allows for the analysis of a vast amount of data from a database of studies (Hu et al. 2010). For analysing the data pulled from the sizable database, this study used VOSviewer. The database was compiled using Elsevier, Google Scholar, Emerald, and Web of Science as back-up sources. The study utilized keywords such as “construction VM”, “VM in construction”, “collaboration in VM”, and “VM integration” for searching the database. The Web of Science database was filtered to remove publications from outside Hong Kong because the purpose of this part is to evaluate VM practice, including existing VM frameworks and models in Hong Kong. The initial search of the Web of Science database turned up 430 articles (journals, conference proceedings, book chapters, theses) pertaining to Hong Kong construction value chain. However, additional noteworthy papers were found using search results from the databases of Google Scholar, Emerald, and Elsevier, and these were then added to the Scopus database, bringing the total number of articles to 521.

To ensure their veracity, the items were further screened and sanitized. Although it was found that several research had not been carried out in Hong Kong, the authors were connected to a Hong Kong-based institution. As a result, the study omitted these papers. Additionally, papers that primarily focused on logistics, suppliers, value chains, the nature of construction in Hong Kong, or the delivery of sustainable construction were disregarded from the study. As a result, the number of articles used for the study was reduced to seventy-seven (77) articles in total. The papers, along with the author's name, affiliation, title, keywords, and abstract, were then obtained from Web of Science and imported into the VOS viewer software. The bibliometric study of the publications' citations and co-citations was determined using the VOSviewer software. According to Zhang *et al.* (2020), citation analysis helps identify significant authors and articles in a given field of research. As a result, the study used citation analysis to identify a key piece of literature in Hong

Kong construction VM practices. A content analysis of the literature review was also performed on the significant publications. The awareness of the external impact of citations on a topic matter is provided by co-citation. This research incorporated author's co-citation because it believes that authors that are co-cited in literature are reviewing materials in related fields of study.

4.2.2 Authors and their related articles for VM practice in Hong Kong

This section introduces the important authors regarding VM practices in Hong Kong. The authors were extracted using VOSviewer software. Moed (2006) asserted that authors with more than 40 citations are regarded as significant. As a result, the authors chosen for this study were those who had received more than 40 citations as shown in Table 4.1. The table shows that there are four columns, including the column for authors. The second column (documents) indicates the number of articles each author has published regarding VM practice in Hong Kong. The table shows that all the authors have published a minimum of two articles in Hong Kong. The third column shows the total number of citations for each author. Table 4.1 shows that authors such as Li, Ameyaw, Chan, Lam, and Chan have over 100 citations. The authors' citations were calculated by multiplying the citation of each article with their total number of articles. This means that "Pan" has a citation of 5 for each of his articles that was published relating to construction VM in Hong Kong.

Table 4.1: VM Authors and their Articles in Hong Kong

Author	Articles	Citations	Total strength link
Pan, W	4	53	5
Cao, D	2	42	3
Wang, G	2	42	3
Li, H	4	117	2
Ameyaw, E. E	2	132	1

Chan, A.P.C	8	333	1
Chan, D.W.M	4	169	1
Saka, A.B.	2	15	1
Shen, G. Q	3	29	1
Wuni, I.Y.	2	26	1
Cheung, S.O.	3	23	0
Gao, R	2	38	0
Ho, C.M.	2	14	0
Lam, P.T.I.	3	140	0
Leung, M.	2	11	0
Oladinrin, O.T.	2	14	0
Skitmore, M.	2	73	0
Zahoor, H	2	50	0

Source: Researcher's analysis from VOSviewer

Table 4.1 also shows the total strength link of the authors' articles. According to Al-Ashmori, Othman and Rahmawati (2020), the overall strength links serve as a standard for weighing an attribute. The amount of significance attached to an item is also indicated by its weight. As a result, the author with the greatest number of linkages of total strength stands in for the author with the greatest significance in Hong Kong. Table 4.1 shows that authors with high strength links in order of hierarchy are Pan, Cao, Wang, and Li with a strength link of above 2. However, this study perceives strength link as the number of links of an author with other authors. Therefore, from Table 4.1, it can be deduced that Pan has the higher strength link with other authors concerning VM. This analysis found that simply disclosing the significant authors would not be enough to interpret VM practice in Hong Kong. The study of significant papers about VM practices in Hong Kong is presented in Table 4.2.

Table 4.2: Analysis of significant VM-related articles

Author and Year	Title of research	Design/Methodology/Approach	Findings	Citations
Shen and Chung (2003)	A group support system for improving VM studies in construction.	Systematic literature review using GSS framework	The paper attributed problems of implementing VM to lack of information, lack of participation and interaction, and difficulties in conducting evaluation and analysis and then introducing a GSS framework for VM studies and a specific GSS prototype to illustrate how this framework can support discussion, information, collaboration, and decision analysis to overcome the common problems in VM studies.	38
Yuan <i>et al.</i> (2016)	Experimental study on virtual VM workshop in Hong Kong	Qualitative and quantitative approach was used	The study's conclusions suggested a structure for a virtual VM workshop to allow remote involvement and virtual collaboration among members.	5
Yuan <i>et al.</i> (2013)	A Study of Virtual VM Workshop: Identifying Risks of Its Implementation	To establish the CSFs and the challenges, a review of the literature, an experimental investigation, and a follow-up questionnaire survey were carried out.	In organising virtual VM workshops for building projects, this article highlighted significant concerns. By determining the critical success factors (CSFs). The study identified seven major risks of virtual VM workshop.	1
Yu (2007)	A VM Framework for Systematic Identification and Precise	A qualitative strategy was used with the assistance of	The study revealed that clear and efficient communication was the most crucial success criterion for briefings. The research further supports the claim that VM is a way to increase briefing efficiency	38

	Representation of Client Requirements in the Briefing Process	quantitative strategies.	because it can promote stakeholder and client engagement.	
Fan and Shen (2011)	The Effect of Using Group Decision Support Systems in VM Studies: An Experimental Study in Hong Kong	By adopting a competitive value method, a comparative experimental study is conducted to determine the extent to which the usage of IVMS can enhance the performance of VM workshops (CVA).	The effectiveness of a conventional VM workshop and an IVMS-supported VM workshop is compared in this study in three areas: process measures, outcome measures, and participant satisfaction. The outcome measures demonstrate that IVMS-supported parties perform better in brainstorming sessions, and the results also suggest that IVMS is useful in enhancing decision and involvement mechanisms' effectiveness, information dependability, and supportability.	31
Yu <i>et al.</i> (2018)	Integrating VM into sustainable construction projects in Hong Kong	Extensive literature review, questionnaire survey based on semi-structured interview	The research examined at the SWOT analysis of incorporating sustainability into the VM process in Hong Kong and discovered that the strength of VM is its capacity to give interdisciplinary practitioners and stakeholders possibilities to focus on issues pertaining to society and the environment, while its main integration drawback is the dearth of well-trained employees and low levels of VM expertise in connection to achieving sustainability.	23
Lin and Shen (2007)	Measuring the	A comprehensive review,	For VM studies, the study established a model in a computer-	6

	performance of VM studies in construction	interviews, survey questionnaires, theoretical analysis, case studies, and focus group sessions were the research techniques employed.	aided toolbox that was combined with collaboration tools and allow for the measurement of its efficiency during the course of the VM procedure.	
Luo (2010)	A knowledge-based electronic meeting system for implementing VM in construction briefing	Experimental study	According to the study, VM implementation challenges include a lack of knowledge, a dearth of engagement and communication, and challenges with carrying out precise evaluation and analysis. Secondly, there is an increasing desire to use information and communication technologies (ICT) to boost briefing effectiveness. The case-based reasoning (CBR) components of the EMS are referred to as "knowledge-based" characteristics in this study.	4

Source: Researcher's review of literature

Table 4.2 indicates that there has been much research published about construction VM in Hong Kong. Additionally, most studies rely on case studies and interviews with varied results. In Hong Kong, the main techniques of ensuring effective VM practices are integration and collaboration. Also, most professionals choose collaborative working exclusively because it allows for risk sharing, access to new ideas, and quick market responses. However, the collaborative effort has hampered the contractors' manner of procurement and the culture of the workplace, while integration is hampered by the complex work environment, and the availability of construction professionals. The examined studies also demonstrated that VM practices will be successful when

they include provisions for mutual goals, trust, a decrease in a blame culture, joint effort, improved communication, and information flow.

4.2.3 School of thoughts supporting VM practice in Hong Kong

There are various school of thoughts with relation to the practice of and motives for applying VM practice in Hong Kong built environment. Shen and Chung (2003) and Yu *et al.* (2018) mentioned that the reason for adopting VM for construction activities in Hong Kong is to eliminate unnecessary costs and ineffective delivery of construction project that are mainly caused by factors such as a lack of information, communication and coordination, and difficulty in conducting evaluation and analysis, are bound to exist in construction projects. According to the author, VM can be utilized to eliminate these expenses that result in subpar value and should, therefore, be recognized. In addition, Yu *et al.* (2018) noted that different companies, backgrounds, and disciplines are represented on VM study teams. Due to their social anxiety, these individuals may be reluctant to speak at the beginning of meetings. Additionally, due to competing goals or interests, a small number of engaged participants may dominate the conversation during the analytical and creative phases. Other members would not be able to participate as a result, and members' contributions would be uneven (Shen and Chung 2003). It is determined that these issues are the natural boundaries of face-to-face communication and that they greatly reduced the efficacy of several activities in VM experiments.(Fan and Shen 2011). The author believed that to enhance the implementation of VM in Hong Kong, discussion support, information support, collaboration support, and decision analysis support should be incorporated. It can be inferred from the authors cited in this paragraph that they are of the school of thought that collaboration, corporate culture, and integration affect the performance of VM. To ascertain the schools of thought, the study employed a systematic literature review for the various VM schools of thought in Hong Kong.

With the use of content analysis, the analysis screened the article keywords and abstract to extract three different schools of thought on VM practice in Hong Kong.

The first school of thought contains articles published by Fong (2002), Fong and Shen (2000). The authors in this school of thought describes VM as a cost-cutting tool used for adding value to an organisation and guaranteeing clients/customers satisfaction. This school of thought believes that creating value belongs primarily to the client that is recognized as the main suppliers of capital. Emphasis is placed majorly on the financial result/cost-cutting. Consequently, all the managerial decisions are aimed at achieving this goal.

The second school of thought contains articles published by Shen and Chung (2003), Lin and Shen (2007), Luo (2010), Yu *et al.* (2018), and Yuan *et al.* (2016). A review of this studies indicated that this school of thought believed that the practice of effective VM practices requires the ability of construction professionals to efficiently manage the relationships and collaborate during the VM workshop. This school of thought embraces the mechanism of creating value in the system of achieving a “balance of interest” of all the stakeholders in the value chain process. This school of thought perceives VM as a technique to maximize value for money while preserving functionality and fostering teamwork through enhancing relationships among team members. This approach supports the cooperation, integration, and information sharing. The authors also perceived that VM are applied in the construction industry to address the business strategy issue of whether the construction project represents the best manner or function in which to meet the organisation needs and never be seen as a quick fix or cost-cutting exercise for projects in trouble or jeopardizing the value and function of the project. Additionally, it was noted in the analysis of these publications that the level of cooperation, interaction, collaborative effort, institutionalized thinking, integration, cultural dimensions, and technology aids used during VM workshops have a

significant influence on maximizing creativity among project team members. The studies discovered that the practice of VM is not widely practiced in Hong Kong as sustainability has not been fully incorporated into the VM process. The research found that the absence of well-trained people and poor standards of VM expertise in regard to sustainable construction challenges are the key weaknesses of incorporation. Shen and Chung (2003) further identified lack of information, lack of participation, and difficulty in conducting evaluation and analysis as major problems affecting the collaboration of value members and the implementation of VM practices. The subsequent study of Yuan *et al.* (2016) and Lin and Shen (2007) developed a framework that encourages debate, information sharing, teamwork, and decision-making to address frequent issues in VM studies. This study revealed that the main driver of effective VM practices is the collaboration of value members who will enhance integration with collaboration tools thereby improving its performance throughout the entire VM process.

The third school of thought was authored by Shen and Chung (2003), Yu (2007), Lin and Shen (2007), and Yuan *et al.* (2016). A review of the articles in this category revealed that they all indicated that for effective practice of VM, a model or framework needs to be established.

Table 4.3: Existing framework and models supporting VM in Hong Kong

	Title of research	Method for validation of model	Findings	Variables for creating model/framework
Yu (2007)	A VM Framework for Systematic Identification and Precise Representation of Client Requirements in	Qualitative and quantitative approaches in the form of literature review, questionnaire survey, focus group meetings, experimental study, and desktop case studies were used.	The framework investigates whether a practical framework utilising the VM (VM) approach can lead to a systematic identification and clarification of	Projects, Stakeholder Management, Teams and Team Dynamics, Client Representation, Change Management', 'Knowledge Management, Risk and Conflict Management, Post-Occupancy

	the Briefing Process		client requirements, and the precise and explicit representation of these requirements in the briefing process	Evaluation, and Post-Project Evaluation, Communication, Organisational theory, and Culture and Ethics.
Fan and Shen (2011)	The effect of using group decision support systems in VM studies: An experimental study in Hong Kong.	Experimental type of research	This paper investigated the performance of using IVMS in a VM workshop in three aspects through a comparative study: process measures, outcome measures, and participants' satisfaction.	Information exchange, Interaction, Integration, Active participation in VM workshops, Participants' satisfaction
Lin and Shen (2007)	Measuring the performance of VM studies in construction	Qualitative and quantitative approach in the form of critical review, interviews, questionnaire surveys, theoretical analysis, case studies, and focus group meeting	A framework in a computer-aided toolkit that will be integrated with collaboration tools for VM studies, so that the measurement and improvement	Collaboration, Integration, Communication
Shen and Chung (2003)	A group support system to improve VM workshops in Hong Kong	Literature review	The paper introduces a conceptual 4-S GSS framework to illustrate how the discussion, information, collaboration, and decision analysis support of this	Collaboration, Communication, Decision Analysis support,

			framework can be applied to overcome the problems in VM studies.	
Yuan <i>et al.</i> (2016)	Experimental Study on Virtual VM Workshop in Hong Kong	Qualitative and quantitative analysis was used.	This paper proposes a framework of virtual VM workshop to enable participants' remote participation and virtual collaboration and found that VM study can be virtually delivered to a satisfactory level, using the support of VVMS (virtual VM system)	Collaboration, Integration, Communication
Zou, Zhang and Wang (2008)	The Contribution of VM to developing collaborative working relationships	Review of literature	A robust framework for the initiation of collaborative and even eventual alliancing relationships.	Collaboration

Table 4.3 presents the existing framework and model related to VM in Hong Kong. The articles were extracted from the Web of Science database utilising the same search criteria as explained above.

4.2.4 Lessons learnt from VM practices in Hong Kong

1. The publications underwent a thorough review, which emphasized the importance of encouraging teamwork among the development team. These findings suggested that construction professionals in Hong Kong believed that collaboration communication, integration, and organisational culture are essential elements for enhancing performance of VM in the construction industry.
2. Although previous assessments have been made on the essence of collaboration and integration among construction stakeholders, the review noted that the Hong Kong construction industry still has poor collaborative practices. Similarly, Yu *et al.* (2018), affirmed that the Egan and Latham Report acknowledged the necessity for an interconnected working mechanism that can help recognize value creation through multidisciplinary working processes at varying phases. However, challenges and difficulties experienced within the construction industry such as complex working environment, health and safety issues, and many others have not been fully resolved.
3. There are three school of thoughts concerning VM practice in Hong Kong which includes, cost-cutting, collaboration with effective organizational culture, communication, and integration.
4. Also, majority of the models developed for managing VM in Hong Kong construction industry are built around collaboration.

4.2.5 VM in Australia

Australia is one of the biggest countries in the world but of the smallest continent on earth, bedding the Indian and the Pacific Ocean situated in the Southern Hemisphere. The capital is Canberra, located between larger and more essential economic and cultural centres of Sydney and Melbourne

in the southeast. The form of government-operated is that of a federal parliamentary state with two legislative houses.

In construction practice in Australia, the Institute of VM (2000) stated that through the practice of VM, competitiveness has been greatly enhanced and growth by optimizing the use of resources and improved decision-making. This has been of advantage to the industry (Martin, 1997). The practice of VM in Australia has grown enormously, and as such, the Australian State, and Federal Government has shown support, and VM has become a criterion in the Construction practice in the country.

4.2.6 Application of VM in Australia

VM found its way into Australia 54 years ago. It started as a concept that is now developed to process that is well known and widely accepted (IVM, 2002). It is used to manage cost, quality and time and function in a construction project. It entails design management, construction management, risk management, lifecycle costing, and human resource management. It entails getting value for money right from client brief to design stage to meeting with various professionals involved in the project to execution stage until it gets to the final stage. Kelly, Male and Graham (2004) defined VM as a system that creates the rate at which a project functions by supervising the concept from brief stage to use stage through evaluation of justifies decisions actions taken against the value idea proposed by the client. It could also be expressed as the systematic enhancement in terms of the quality expected from the project rendered through comparing specifications alternated in the material used in building or engineering services.

It is a concept aimed at eliminating unnecessary costs from collecting client briefs to transforming them to reality to have functional value for money that might be more than the initial money

proposed or lower to the proposed cost. VM is a proactive, creative, and interrelated approach in disciplines adopted to attend to client's needs by using functional analysis to evaluate the correlation among time, cost, and quality with tactical decisions taken towards the project development and life (Hughes, Williams and Ren). VM was formally incorporated as Institute of Value Engineering before transforming it to Institute of VM in Australia on 8 November 1977 (IVMA, 2002). In 1985, the Department of Public Works and Services (DPWS) in Australia mandated that VM process must be used in big construction projects, be it the public sector or the private sector, whose contract sum is high (McGeorge and Palmer, 1997).

In 1991 and 2013, Australia encountered the longest streak of economic boom, more than any country with average capita per income, 25% higher than residents of the United States, and 50% more than people living in the European Union (Garnaut, 2013). This stable economy and increment in GDP resulted in an influx of people from parts of the world of Australia. Barton (2012) laid claims to some projections of major Australian cities to grow from 4.7 million to 8.4 million in Sydney while Melbourne will grow from 4.2 million to 8.6 million inhabitants. These projections span from 2013 to 2060. These population growths have spurred the need for more buildings, condominiums, and public infrastructure to be constructed either financed by the government or public, private partnership. VM in the Australian construction industry has received a boost from the Australian government in project assessment since the early 1990s. This is due to deficiencies that may occur, such as the inability to apply VM in construction deliverables in the Australian construction industry, which causes deficient brief, and poor value of money and inefficient asset (Queensland Department of Housing and Works, 1996). These deficiencies are caused by ineffective or wrong decisions taken to manage the project from inception to completion and maintenance. It has constantly been established that VM helps to make better and informed

decisions in managerial decisions of an organisation, firm, and construction projects (Howard and Lennon, 2006).

The adoption of VM has increased Australia's competitiveness in World construction ranking, facilitating better and justified decisions on projects (Institute of VM, 2000). This decision makes opportunities abound from project inception to completion. It allows VM to be considered in project analysis early at a brief stage, thereby bringing sustainability, functionality, and value (Kinnan and Martins, 1997). With the high rise in the need for infrastructure, construction project designs are getting more complex to execute with increasing population and environmental development, which necessitate the need for VM tools to be applied. VM tools are the pre-conceived techniques targeted towards some level of communication and decision-making (Garnaut, 2013). In Australia today, there is a medium usage level of VM applications, especially in the public sector. There is a medium adoption level in the country, as discussed by various journals on VM applications in Australia. Nonetheless, there is an urgent need to improve the efficacy and general output in terms of the efficiency of public infrastructure in Australia. This is essential when designing and executing public projects, it must be widely accepted to widen its use, bringing value for money for the Australian government and desired satisfaction to the community.

Few practical examples of application in Australia are the Olympic Games 2000 in the Sydney bus transportation system and port harbor construction. At the Sydney Olympic Games in the year 2000, it was recorded that VM detailed project was used in the transportation of people and sports personnel to the stadium. Road networks to be used during the Olympics are itemized and analysed according to the estimated number of users and the sub-ways to be created to remove transport delays on every major road. This approach was later adopted by the transport system of Sydney

(Barton, 2012). This in-house crew of Leighton contractors has done the design of the port harbour. The Managing director of Leighton Contractors Limited that the government awarded the contract organized workshop meetings for executive workers of the Darling Harbour Authority, Architects, Quantity Surveyors, and other consultants on the project. In the meetings, they discussed the geographical site planning aspects, which are building orientation, the filling pattern, the design of the surrounding harbour area, materials to be used for construction, the benefits and function of alternatives and the need to cater for every inflow of water across the site land (Gough, 2000).

Australian Institute of VM claimed that without a structured approach or right methodology of undertaking VM along with right attitude of clients, professionals, and VM facilitator, it would fail. Many believed that VM should not be used for projects lesser than AU\$500, 000 because the cost saved from inception to completion versus the workshop cost for VM is minimal. According to Adam (1993), there is a small but reasonable ratio of cost saved in the project's actual construction to organising VM workshops. Australian government mandated VM for specific projects that cost more than AU\$500, 000. Such projects must have advanced technology components or small projects to get an expected value for their culture, use available funds to achieve the best functional and operational workings of the project, and get value for money (Bordass, 2000). In achieving value for money, some decisions taken resulted in additional costs on the project where the alternatives to be used are expensive but perform better and improve the usage of the product (Daddow, 2002).

4.2.7 Benefits of Construction VM in Australia

Oke, Stephen and Aigbavboa (2022a) mentioned that the benefits of VM in construction industry in Australia includes;

- **Better insight into Project:** It provides a better insight into a particular project's major function by diving deeply into every detail concerned with the project. This provides the channel for thorough utilization of labour and materials allocated for the construction.
- **Quality and Performance improvement:** The quality and performance of the project's entirety improve through the implementation of VM and other relevant studies. With the construction sections analysed, the professionals involved could carry out identified operations on the construction with little or hitch-free execution.
- **Cost optimization:** Through the effective use of VM study, unnecessary costs in construction projects are avoided with proper analysis of techniques and decisions about the entire budget cost of the construction project.
- **Project definition:** VM study provides a better definition to project objectives than what meets the eyes alone. Every section, personnel, and other aspects of the project are annotated extensively. It also confines a project to what purpose it is to serve without diverting from the goal before, during, and after completion.
- **Reduction of wastages:** Wastages come in different manners; labour, material, plant and so on. The alternatives to inputs to be used in the construction would substitute for wastage and avoidable excesses on the project.
- **Enhancement of alternative materials, operations, and techniques efficiency:** Alternative materials, operations and techniques introduced from the VM study will improve efficiency in cutting cost, project duration, and quality of the construction project.
- **Team buildings:** There is an interaction among the facilitator and the value team from different disciplines. This interaction will help improve the relationship among them and the rate at which work would be delivered.

- **Solving problems:** It improves proper understanding of how to solve challenges detected before the project starts. The experience obtained from this study would be helpful to the participants in solving related construction challenges in the future.
- **Enhanced creativity:** The involvement of different construction professionals coming together for a single purpose, the knowledge sharing mechanism during the study sessions will give the participants involved the boost to be better creatively in solving problems within and outside construction.
- **Optimisation of value for money:** A construction project is considered a success when there is an assurance of getting value for the money spent within an acceptable time. Value for money ensured as a priority in VM study.
- **Enhanced stakeholders understanding:** There is an avenue to exchange ideas and thoughts about current threads in construction locally and internationally.
- **Discovery of project constraints and risks:** VM discovers project issues, restraints and risks involved. Through analysed conceptual methodologies, constraints particular to the highlighted project is discovered, and solutions are proffered.
- **Client's involvement:** The participation of the client is not only limited to the early involvement with the Architect or the designer in charge, but rather part of the practical details of the whole construction project. The client feels much closer to the project and the ideas chosen for the execution.

4.2.8 Challenges affecting the Practice of Construction VM in Australia

Oke, Stephen and Aigbavboa (2022a) mentioned that the challenges affecting the practice of VM in construction industry in Australia includes;

- **Poor communication:** Erratic distribution of project information to every construction personnel involved in the construction project to carry out specifics effectively will hinder this effect by limiting the construction personnel to the knowledge available with no or little consideration on the specifications about the project. If there is no proper dissemination of information among the VM team, the decision to be made at the end of the practice will not be the best.
- **Stiffness by clients in paying for the service rendered:** Like in most countries, most clients see it as no necessary evil to employ the services of a value manager. The clients believe a cost consultant (Quantity surveyor) involved in the project could carry our relative function.
- **Lack of interaction:** This is also similar to poor communication in every aspect of the construction. Lack of interaction causes hoarding of important information that could benefit the project and its progress. There is a possibility of rivalry between value managers and cost consultants, with the latter impeding proceedings towards the full implementation of VM practices in construction.
- **Time constraints:** With most VM related workshops slated for 40 hours or days, there is a possibility of time constraint. The client and the project designer might consider utilizing available time in starting the construction rather than making inferences about value.
- **Lack of coordination between the designers:** In a bid to reduce time constraints in setting up VM practice (workshop), the designers might be hasty in preparing for implementing the practice. The resultant effects of the lack of coordination are cost and time specifics that could have been channeled to bringing the project to reality.

- **Lack of Participation:** Despite VM being introduced for a long time, few construction professionals in various construction industries utilize the service involved in the practice. In a situation whereby a VM workshop is organised, few interested participants would be available through the practice sessions.
- **Lack of needed experts:** This is very common in most construction industries, especially in developing countries. The inadequacy in numbers of qualified experts to take care of VM proceedings is too low to increase the awareness and bring to standard the measures embedded in the practice.
- **Lack of needed information:** Some information might not be available when VM practice is scheduled. This might limit the knowledge of the facilitators and participants to the details available at the time of planning early methodologies to be inputted into the construction.
- **Extra work for the existing project team:** In carrying out VM practices, the facilitator and the team spend a lot of time carrying out procedures concerned with the practice. In addition to the services to be rendered during the construction, the construction professionals involved are subjected to fatigue which will affect efficiency.
- **Difficulty in conducting analysis:** The analysis of the information at hand after the practice may be a great deal to decipher when there are contrary opinions regarding the details presented. Apart from putting unnecessary pressure on the team, the team is subjected to numerous analyses rather than establishing a simple fact.

Table 4.4: Studies related to VM Practices in Australia

Author(s)	Title of research	Design/ Methodology	Findings	VM Practices
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Oke, Stephen and Aigbavboa (2022a)	VM Implementation in Construction – A Global View	Literature review	The findings of the study discussed about the history of VM in Australia construction industry, the challenges affecting the practice of VM, benefits of VM, and measures to improve project performance through VM in Australia	Collaboration, communication, integration
Whyte and Cammarano (2012)	VM in Infrastructure Projects in Western Australia: Techniques and Staging	Quantitative study adopting descriptive statistics	Findings from this study show that VM has the potential to increase value and effectiveness at the stages of the project life cycle. Time constraints, a lack of comprehension, and team member engagement have a detrimental impact on the quality of the VM exercise. Level of information, communication, commitment, and initiative of members influence the quality of the final decision.	Integration, Standardisation, and Collaboration
(Ahmed, 2012 #449@@author-year)	Integration of Risk Management and VM – An Australian Case Study	Qualitative case study using semi-structured interview.	The study investigated how risk management and VM approaches may be combined and established the advantages of doing so. The study recommended that, while the procedures are merged during the idea creation stage of the VM study, a clear focus should be maintained on identifying risk and values individually. Gaining the willingness of the clients was classified as an important critical success factor to the implementation of VM process.	Integration, risk management
Ranesh, Zillante and Chileshe (2012)	Towards the Integration of Risk and VM	Qualitative study using semi-	The result from the interview suggests that there are barriers to the integration of risk	Risk management, integration, VM

		structured interview	management and VM and the need to develop a systematic process to integrate risk and VM is of utmost importance. The findings also suggest that the integration of RM and VM will enable cost and time savings to deliver better VM.	
Mohamad and Coffey (2010)	Implementing VM as a Decision-making Tools in the Design Stages of Design and Build Construction Projects: A Methodology for Improved Cost Optimization	Quantitative and qualitative methods focusing on literature survey, semi-structured interviews, case study, focus group sessions, and a VM workshop.	The study clarified the results of using VMM in design and build construction projects and how well the technique tackles problems linked to cost overruns brought on by ineffective teamwork and the neglect of crucial constructability issues.	Collaboration
Spaulding, Bridge and Skitmore (2005)	The Use of Function Analysis as the Basis of VM in the Australian Construction Industry	Quantitative survey utilizing scales of measurement	Function analysis application challenges, a lack of skilled facilitators, Australia's long history of VM use, and the length of VM workshops are all contributing factors.	Integration, standardisation
Gough (2005)	VM – Achieving the Impossible on Time	Systematic literature review	The research concentrates on the use of VM to coordinate a large amount of participants and stakeholders in order to manage a crisis and address a myriad of issues in an improbable amount of time.	Collaboration, integration

Barton and Wilson (1997)	VM – A Vehicle for Project and Team Learning	Systematic literature review	The study concentrated on the importance of organizational learning in creating a learning environment and its impact during the information phase of a VM study.	Integration, Team Learning
Mohamad (2014)	VM in Design Planning: A Systems-based Framework for Multi-disciplinary Team Involvement	Quantitative Analysis	In order to maximize involvement among members of the project team during the full VM workshop procedure, it is observed that the levels of engagement, diversity of visualization aids, specific cultural characteristics, and the system thinking approach all play a key role.	Integration, Collaboration, Cultural Dimensions

4.2.9 Lessons Learnt from Construction VM in Australia

Following a survey of the existing literature on VM practices in Australia, the following conclusions and lessons were drawn:

- In terms of GDP and employment potential, the Australian construction industry significantly contributes to the country's economy.
- In Australia, a significant number of debris is produced by building sectors. About 32.4 million tons of garbage were produced by the industry in 2006, the bulk of which came from the construction and demolition sector.
- The bulk of decisions made in VM are made with a focus towards maximizing financial returns, reducing costs, maximising time, quality, and functionality for the successfully delivery of construction project.

- In Australia, there are various schools of thought about the practice of VM. Cost-cutting tool, value for money, management of activities, and collaborative working are the schools of thought.
- Most of the decisions concerning VM practices in construction are targeted at achieving cutting of cost and value for money while enhancing the working relationships between team members in order to sustain function and encourage collaboration.
- The reviewed literature showed that getting the support and commitment of the client is a major project in VM practices within the Australian construction industry as most clients and project designers might consider utilizing available time in starting the construction rather than making inferences about value.

4.3 CONCLUSION

In this chapter, VM practice in developed countries were discussed with emphasis on Australia. According to the reviewed literature, collaboration, standardisation, and integration are the main parameters for enhancing the performance of VM in Australia. Most of the professionals in both countries encourage teamwork for the primary aim of improved, project performance, risk sharing, and effective project delivery. Integration is hindered by complex project process, teamwork, and the ability for the clients to support VM practices. Additionally, the reviewed research revealed that VM practices will be effective in line with principles such as commitment of participants, early goal definition, availability of resources, dedicated personnel, and constant communication.

CHAPTER FIVE

OVERVIEW OF VM IN DEVELOPING COUNTRIES – AN AFRICAN PERSPECTIVES

5.1 Introduction

This chapter presents the discussion of VM practices in African (developing) countries using Ghana as case studies. The chapter commences by reviewing the background of the construction industry in the country and examines the challenges, and hindrance to VM practices in the country. This chapter also appraises the construction industry in Ghana, the structure of the industry and the practice of VM in Ghana. The articles were extracted from databases such as Scopus, Emerald, ResearchGate, Elsevier and many others.

5.2 Ghanaian Construction Industry

According to Lopes, Nunes and Balsa (2011), the Ghanaian built environment is a crucial industry for the nation since it helps the nation attain middle-income status. By providing the infrastructure required for the nation's development, the sector supports economic growth (Owusu-Manu *et al.* 2019). Ofori (2012) and Owusu-Manu *et al.* (2019) indicated that there is a positive relationship between the Ghanaian construction industry and its economic development due to the physical infrastructure provided by the industry. The relationship stems from the contribution of the industry to the GDP. Boadu, Wang and Sunindijo (2020) revealed that between 10 and 15 percent of the GDP of Ghana is contributed by the country's building industry. According to Ofori (2012) the construction sector in Ghana employs 10% of the total labor force. So, it makes sense to say that the Ghanaian building industry is essential to the development of the nation.

Despite the construction industry's enormous economic significance to Ghana, it is characterized by unethical practice (Kissi *et al.* 2017a). Famiyeh *et al.* (2017) provided other shortcomings of

the industry and revealed the sector is complicated because of bad planning and an inability to satisfy customer expectations. Offei, Kissi and Nani (2019) opined that project delays caused by construction contractors' untimely payments are a defining feature of the sector. Kwofie, Adinyira and Botchway (2011) submitted that the necessity to provide housing for the nation's ever-growing population is the biggest problem facing Ghana's building industry. This suggests that the Ghanaian built environment is faced with numerous challenges and constraints.

Sustainability in construction is concerned with reducing the negative impact of construction activities on the environment (Muhwezi *et al.* 2012; Awang and Iranmanesh 2017). Leyzerova, Sharovarova and Alekhin (2016) believed that sustainability in construction is concerned with ensuring buildings that use less energy and decent housing for people. A body was established in Ghana in response to the aforementioned viewpoints regarding the necessity of sustainable construction. Darko *et al.* (2017) affirmed that the body is called the Ghana Green Building Council (GHGBC) concerned with ensuring the sustainability of construction activities. Likewise, Ofori (2015) and Darko *et al.* (2017) contended that Ghana's construction industry uses a lot of energy, degrades the soil, and pollutes the water. This shows that the Ghanaian building industry must improve its use of sustainable construction methods.

The idea of collaborative working was made popular from the work of (Elmualim and Gilder 2014) in the UK after the Egan and Latham reports. However, different scholars have worked on collaborative working such as Hughes, Williams and Ren (2012), Nawi *et al.* (2014), Bishop *et al.* (2009), and Mesa, Molenaar and Alarcón (2016). The importance of collaboration is to lessen the harm caused by fragmentation in the building sector. According to Boadu, Wang and Sunindijo (2020) and Ofori-Kuragu, Owusu-Manu and Ayarkwa (2016), the Ghanaian built environment is very fragmented owing to the many small construction industry within the industry. Asare *et al.*

(2022) indicated that, apart from fragmentation, the built environment of Ghana is renowned for its fragmented operations and poor interprofessional coordination. To ensure that construction employees cooperate, a concept like VM must be adopted.

Assibey-Mensah (2009) provided some sound advice on how to improve the efficiency of locally owned-construction companies in Ghana. The author suggested that the government support inter-firm collaboration and strategic partnerships between indigenous building companies. Xue, Shen and Ren (2010) opined that an informal or formal agreement between two or more construction companies that have the same goals is referred to as a strategic alliance. However, Kissi, Boateng and Adjei-Kumi (2015a) suggested that the adoption of VM practice such as integration, collaboration, standardization, and the use of digital innovations would assist in improving the performance of construction firms. Therefore, the subsequent sections examine VM practice in Ghana.

5.2.4 VM Practices in Ghana

In this section, VM practices in Ghana is explored. Tillmann *et al.* (2013) asserted that the desire to improve the value of construction projects has led to the adoption of numerous practices. Chileshe and Kikwasi (2014) stated that the measures taken by an organization to enhance management of construction value is crucial to the performance of the organisation. Ojo, Ogunsemi and Ogunsina (2021) described VM practices as tangible activities that guarantee effective teamwork among construction professionals. In this study, VM practices were identified as the measures taken by construction firms to guarantee the success of construction projects. As a result, this section presents the steps taken to ensure the best possible performance of VM practices in the Ghanaian construction sector. VM practices in Ghana construction firms was examined by reviewing articles related to construction value chain. The articles were sourced from

Scopus, Web of Science, Google Scholar, and many others. The search words used include, “VM”, “value in construction”. Since this part exclusively concerns Ghana, the items returned by the search were filtered to remove any from other nations. The articles were taken out of the databases and underwent a content analysis, the results of which are shown in Table 5.1.

Table 5.1: Content analysis of articles supporting VM practices in Ghana.

Authors	Title of research	Methodology approach	Findings
Kissi, Boateng and Adjei-Kumi (2015b)	Strategies for implementing VM in the construction industry in Ghana	The study adopted a quantitative approach using questionnaire survey.	The findings showed that improving client attitudes of VM, developing VM workshops for experts, developing local standards, and gathering data on VM methods are the most important tactics for adopting VM in the Ghanaian construction business.
Kissi <i>et al.</i> (2017b)	Principal component analysis of challenges facing the implementation of value engineering in public projects in developing countries	Using an empirical questionnaire survey, the study identified the obstacles to the successful application of value engineering in public projects among developing nations.	According to the report, the main obstacles to VE implementation in Ghana include team impediments, VE study obstructions, implementation issues, and conceptual issues.

Because there isn't much literature on VM practices in the Ghanaian construction industry, it may be inferred from Table 5.1 that little has been done in this area. This explains why there is a need for greater VM research in poor nations.

5.2.5 Lesson learnt in Ghana.

The following are the conclusions and lessons discovered after examining the research on the Ghanaian construction sector and VM practice.

The Ghanaian construction industry is an important sector for the country as it contributes to making the country's a middle-income country. The findings from the literature showed that there is a positive relationship between the Ghanaian construction industry and its economic development due to the physical infrastructure provided by the industry.

- The construction industry in Ghana is confronted with some sustainable issues such as excessive land degradation, water pollution and high energy usage.
- Due to the large number of small construction companies operating in Ghana, the construction sector is highly fragmented.
- The fragmentation of the construction sector was caused by the large number of companies in the lowest tier.
- It can be deduced that not much has been done regarding VM practice in Ghana construction industry since there isn't a lot of articles on the subject.

5.3 CONCLUSION

This chapter examined the VM practices in African countries using Ghana as case studies. It commenced by reviewing literature related to the construction industry in developing countries. It found that the industry is the major backbone for the development of infrastructure in African

countries. Unfortunately, the construction industry in Ghana is not performing at the same level as their international counterparts (Hong Kong and Australia). The construction industry in Ghana is known for numerous project delays, low client satisfaction, and poor performance. The practice of VM in the country was examined using content analysis of articles related to the construction VM. The findings from the content analysis shows that there are no model showing the operation of VM in Ghana, and there is limited evidence supporting the practice of Ghana construction industry.

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CHAPTER SIX

VM PRACTICE: THE NIGERIAN PERSPECTIVE

6.1 INTRODUCTION

The aim of this chapter is to offer a glimpse into the implementation of Value Management (VM) in the Nigerian construction sector. It begins by examining Nigeria's context and providing an overview of the construction industry in the country. Additionally, the chapter delves into the construction industry's contribution to the national economy, its key stakeholders, and the prevalent challenges. It also explores the industry's structure and evaluates significant construction projects strategically. Furthermore, this chapter covers various research studies pertaining to VM practices in the Nigerian construction industry.

6.2 THE NIGERIA CONSTRUCTION INDUSTRY

Around the globe, the construction industry plays a pivotal role in a nation's economy due to its far-reaching influence across various aspects of human life (Alaloul *et al.* 2021). In Nigeria, the construction sector is similarly significant and serves as one of the country's key sectors (Oladinrin, Ogunsemi and Aje 2012a). Etuk, Etuk and Michael (2014) asserted that the Nigerian construction industry acts as a backbone and contributes significantly to the nation's economy in multiple ways. One of these contributions is the creation of employment opportunities for the country's workforce (Ajakaiye *et al.* 2015). In addition to job creation, Oyedele (2012) affirmed that the Nigerian construction industry plays a crucial role in developing and maintaining essential infrastructure projects such as roads, bridges, and both residential and commercial buildings. This infrastructural provision by the construction industry has made a substantial contribution to the country's Gross Domestic Product (GDP) (Ogun 2010). According to Nnadi, Enebe and Ugwu (2018), the Nigerian

construction industry contributes approximately 16% to the country's GDP. However, it's worth noting that this contribution to GDP is lower compared to developed nations like the UK, Australia, and others, which typically contribute more than 20% to their GDP (Ogbu 2018). This discrepancy suggests that the Nigerian construction industry's contribution to the GDP is relatively modest in comparison to that of developed countries.

Despite expansion within Nigeria's building sector, According to Tanko, Abdullah and Ramly (2017), the industry is experiencing various difficulties that are impeding its performance. According to Kalu (2015), the Nigerian construction industry faces financial difficulties because the government primarily finances most of its construction processes. Government-funded building projects experience bureaucratic obstacles, according to (Wang *et al.* 2019). The government's initiatives frequently change, which causes obstacles. These disruptions finally result in the delay of construction projects and the underpayment of local contractors (Omopariola *et al.* 2022). According to Ugochukwu and Onyekwena (2014), government financial bureaucratic delays have the greatest impact on small and medium-sized construction enterprises. Likewise, small businesses in the Nigerian construction industry are unable to acquire financing due to a shortage of money (Osotimehin *et al.* 2012).

In order to manage how the Nigerian construction industry manages its building activities, VM has been suggested by academics and professionals (Oke and Ogunsemi 2011). It is anticipated that using VM concepts to manage construction projects in Nigeria will enhance integration among professionals (Oke, Aghimien and Olatunji 2015; Othman *et al.* 2020). VM practices is essential for the development of Nigeria's construction sector (Oke, Stephen and Aigbavboa 2022c). This is because it helps project stakeholders establish positive relationships that will lead to higher project performance. As a result, the chapter's next section examines research that focused on VM in the

Nigerian construction sector. Analyzing earlier research helps to reveal insights into the industry's current VM procedures as well as potential areas for improvement.

6.3 ORGANIZATIONS THAT CONTROL ACTIVITIES IN NIGERIAN CONSTRUCTION FIRMS.

6.3.1 Trade Unions

According to Ngwama (2016), trade unions in the Nigeria construction sector are in charge of safeguarding the interest of both employers and employees. The Nigerian Labour Congress (NLC), which defends the rights of the nation's workers, oversees the trade unions. However, the NLC oversees and controls many trade unions for a certain area of the nation. The National Union of Civil Engineering, Construction, Furniture and Woodworkers, the Steel and Engineering Workers Union of Nigeria (SEWUN), and the Nigeria Welder's Association are some of the trade unions associated with the construction industry.

6.3.2 Federation of Construction Industry in Nigeria (FOCI)

The Federation of Building and Civil Engineering Contractors (FOBACEC) was the previous name of the Federation of Construction Industry in Nigeria (FOCI) (Oladimeji and Aina 2018). To unify and oversee the operations of building businesses, the organisation was founded in the colonial era in 1954. Because the nation was under pressure to overthrow the colonial administration, control of construction businesses' operations was crucial throughout the colonial period. Following the colonial era, the group expanded from seven members to over 200 as the nation's infrastructure improved. The necessity for the organization to grow stronger within the sector may also be tied to the increase in membership. According to FOCI (2018), the organisation's members manage 60% of the capital investment in Nigeria's construction sector.

6.3.3 Council of Registered Builders of Nigeria (CORBON)

The Council of Registered Builders of Nigeria (CORBON) is a regulatory body established by the Builders Registration Act Cap No. 40 (formerly known as Decree No. 45 of 1989), and now established by Builders Registration ACT CAP. B13LFN 2004. It is responsible for the regulation and registration of builders in Nigeria. CORBON'S primary objective is to ensure professionalism and competence in the construction industry by setting standards and guidelines for builders and promoting adherence to ethical and professional conduct. The council strives to enhance the quality of construction projects, protect the interests of clients, and maintain the integrity of the building profession. CORBON registers qualified individuals as professional builders and grants them licenses to practice in Nigeria.

6.3.4 Council for the Regulation of Engineering in Nigeria (COREN)

The building industry's use of engineering practices is governed by the Council for the Regulation of Engineering in Nigeria (COREN 2019). According to Tanko, Ilesanmi and Balla (2013), the Council oversees and ensures the registration of engineers and companies that engage in engineering practice. COREN ensures that engineering work is up to industry standards, hence their importance to the construction sector cannot be understated (COREN 2019). Also, despite COREN's advantages for the Nigerian built environment, according to Hassan (2013), its administration presents certain difficulties. According to Falade (2011) and Oloyede, Ajimotokan and Faruk (2017), COREN lacks the resources necessary to fully educate aspiring engineers in the field.

6.4 THE NIGERIAN NATIONAL BUILDING CODE

Since the Building Code establishes the minimum requirements for all construction projects in the nation, its advantages for the construction sector cannot be overemphasized (Dahiru, Abdulazeez and Abubakar 2012). Building codes, according to Hu and Qiu (2018), are intended to protect the health and wellbeing of building users as well as those connected to the structures. According to Fakunle *et al.* (2020), building codes are developed globally to avoid mediocre construction and guarantee conformity among industry experts. Ihuah and Benebo (2014) argued that the bad conditions in the built environment are due to the unplanned development of construction projects. Oboirien and Windapo (2020) noted that the Nigerian built environment was characterized by deteriorating, uncompleted, abandoned, and obsolete buildings in addition to the unfavorable environmental situations. According to Wahab (2013), building collapses, fire breakouts, and pipeline development for crude oil and electricity are only a few of the issues that the built environment in Nigeria is dealing with which renders the ecosystem unsustainable.

The Nigerian construction sector was an open playing field without regulation or oversight prior to the existence of the NBC (Inuwa, Napoleon Daniel Usman and Dantong 2015). According to Fakunle *et al.* (2020), the NBC made sure that building projects were handled by experts and built with certified materials. The NBC offers the chance to get rid of unethical behaviour, including corruption and professional negligence in the construction sector (Inuwa, Napoleon Daniel Usman and Dantong 2015). Abisuga and Okuntade (2020) asserted that the NBC offers Nigerian local construction companies the chance to expand. The NBC, according to Dahiru, Abdulazeez and Abubakar (2012) serves as a blueprint for controlling construction operations by offering rules and penalties. Hence, it can be concluded that NBC's implementation has had a significant positive impact on the development of the Nigerian construction sector.

6.5 VM PRACTICE IN THE NIGERIAN CONSTRUCTION INDUSTRY

Mudi, Bioku and Kolawole (2015) mentioned that when compared to other sectors of the economy, the Nigerian construction industry does poorly. According to Adebisi, Ojo and Alao (2018), the industry's complexity, which is to blame for the dispersion of tasks and operations, is related to its lack of performance. Due to inadequate administration and lack of information sharing among construction parties, the industry is characterized by significant fragmentation. Saidu and Shakantu (2017) stated that the industry's decentralization causes delays, reduced productivity, budget overruns, and schedule overrun. On the other hand, Oladinrin, Ogunsemi and Aje (2012a) found that the firm's heterogeneity is what leads to disagreements amongst project professionals and the main contractor's reliance on suppliers and subcontractors. Due to this circumstance, the professionals in the built environment must work together to improve the efficiency of the sector.

Without the implementation of VM concept, according to Saka and Mudi (2007), Nigeria's building participants may not be able to collaborate. According to Oke and Ogunsemi (2011), successful VM practices benefits the Nigerian construction industry by improving project planning, reducing fragmentation, and preventing time and cost overruns. Oke and Aigbavboa (2017c). Olawumi, Akinrata and Arijeloye (2016) mentioned that VM practices in Nigeria is immature in terms of adopting the ecofriendly idea and sustainable growth. Empirical studies on the topic have been carried out to enhance VM practices within the construction sector, as indicated in Table 6.1.

Table 6.1: Literature review of VM in Nigeria

	Title of research	Design/Methodology	Findings	Practice
Aghimien and Oke (2015)	Application of VM to Selected Construction Projects in Nigeria	Case study approach was employed in which group of professionals carried out hypothetical VM analysis of selected projects using 40-hour workshop plan.	The study revealed that VM has numerous benefits if fully implemented for construction projects thereby enhancing value for money for project clients, owners, or sponsors	Decreased expenses while preserving functionality by identifying and eliminating superfluous materials, processes, and labor hours.
Aghimien, Oke and Aigbavboa (2018)	Barriers to the adoption of VM in developing countries	Quantitative analysis and factor analysis	The study found that there is a moderate level of familiarity with Value Management (VM) and classified the obstacles into four categories: barriers stemming from stakeholders, hindrances related to training and education, obstacles from clients, and barriers originating from top management or government.	Integration, Readiness to adopt
Olawumi, Akinrata and Arijeloye (2016)	VM- Creating Functional Value for Construction Project – An Exploratory Study	The study adopted a qualitative research methodology	The study determined the benefits – clearer brief, improved communication; barriers – inadequate training and education, lack of regulatory framework, unwillingness to entertain new ideas; and drivers – establishment of regulatory framework, client’s awareness, establishment of group support system of VM approach	Integration, standardisation

Oke, Aghimien and Olatunji (2015)	Implementation of VM as an Economic Sustainability Tool for Building Construction in Nigeria	A case study approach was employed.	The study revealed that VM has a role to play in delivering economic sustainability in construction since both VM and economic sustainability have a common goal in achieving value for money. The benefits of VM in providing economic sustainability were also attributed to; reduction of overall cost while maintaining function through identification and removal of unnecessary materials and use of local materials to save cost.	Integration, sustainability
Tanko <i>et al.</i> (2018)t	An Implementation framework of VM in the Nigerian construction industry	The study adopted quantitative analysis using structural equation modelling for both descriptive and inferential analyses	A framework required for the successful implementation of VM construction practices was provided	Collaboration, integration, and standardisation
Vitalis <i>et al.</i> (2019)	VM and Organisational Performance: A Case of Selected Manufacturing Firms in South-East, Nigeria	A survey research design was utilized using Pearson product moment connection coefficient and simple linear regression statistical tools.	The findings indicated that there was a significant relationship between VM and product quality in the selected manufacturing firms in south-east Nigeria and concluded that VM offers a method for stakeholders to achieve organisational performance	Integration, Collaboration, Value culture
Bola-efe, Ajayi and Ordu	VM for Sustainable Development in Nigeria	Quantitative research approach was adopted and analysed using descriptive statistics	The study examined the concept of VM and identified the benefits of VM and established the relevance of VM to promoting sustainable	Sustainability

	Construction Industry		development in the Nigerian construction industry.	
Olaleye, Baba and Nazif	An Appraisal of VM Practice in Construction Projects Delivery in Nigeria	A Survey research design using descriptive and inferential statistics.	Cost management practice and business case management were found to be the benefits of VM in the construction industry while fear of incurring additional cost due to VM study was attributed as the barrier	
DANJUMA (2021a)	Framework for VM Implementation in Abuja Construction Companies, Nigeria	Quantitative survey approach using descriptive statistics and factor analysis was employed	A framework which consists of the benefits, and factors hindering the implementation of VM was established.	
Ojo and Ogunsemi (2019)	Critical drivers of VM adoption in the Nigerian construction industry: A Delphi study	A two round Delphi survey and analysed using descriptive statistics, Kendall's coefficient of concordance test, Chi-square test, interrater agreement analysis and significant level analysis.	The study attributed the critical drivers of VM adoption to adequate understanding of the benefits of VM, educational programmes that teaches VM technique, professional's previous experience with VM, collaboration among construction professional bodies and VM training.	Collaboration, Standardisation, and Integration.

Source: Researcher's review of literature

6.6 LESSONS LEARNT

The Nigerian built environment plays a pivotal role in the nation's economy, employing over 30% of the workforce and contributing approximately 16% to the country's GDP. However, the sector faces challenges, including a slow adoption of sustainable building practices, leading to increased

risks in construction projects. The reliance on government funding raises financial concerns for the Nigerian construction industry.

The demand for expertise in managing complex building projects results in extensive subcontracting, contributing to project complexities and, in some cases, abandonment. The decentralization of firms in the construction sector has led to delays, poor performance, reduced productivity, budget overruns, and disputes.

Recognizing the need for a fundamental shift in project management, it has been proposed that Value Management (VM) is a crucial tool for controlling construction activities. Despite its potential benefits, VM is still in its early stages of implementation within Nigeria's construction business. As the industry grapples with these challenges, there is a growing realization of the necessity for a more streamlined and efficient approach to project management to ensure the success and sustainability of construction endeavors in the Nigerian built environment.

6.7 CONCLUSION

This chapter looked at VM strategy used in the Nigerian construction sector. The section begins off by looking at Nigeria's history, including the population and the various ethnic and religious groups that make up the nation. The result of the literature review revealed that Nigeria's population increase makes the building industry viable due to the large number of international investors. Buildings became necessary because of the population's fast development, particularly in metropolitan areas. This promoted growth within the construction industry's housing sector. Even though the construction sector significantly positively impacts the economy, the results of the literature analysis indicate that the sector suffers from increasing levels of heterogeneity,

minimal quality of the project, and delayed project delivery. Academics and construction experts have proposed VM concept as a means of enhancing the Nigerian construction sector. This section reviewed literatures pertaining to the application of VM within the construction sector. Despite starting in 2007, VM is still in its early stages in the Nigerian construction sector, according to the findings. In the Nigerian construction industry, the main application of VM focuses on realizing efficient building projects that are economically feasible, socially useful, and do not harm the environment.

CHAPTER SEVEN

RESEARCH METHODOLOGY

7.1 INTRODUCTION

This chapter describes in detail the different steps and approaches undertaken in determining the stated and peculiar objectives, aims and goals of this research. As highlighted in the introduction, this research aims to determine the possible outcomes of improved VM performance for effective delivery of construction projects in the Nigerian construction industry. Hence, this research aims to develop a VM model to improve the performance of VM in the construction industry. The variables considered were integration, collaboration, and standardisation. While these variables have been measures in previous models and studies, this study identified corporate culture and the use of digital technologies requirements as the new variables that are required for VM model to be validated. Moreover, none of the latter variables have been considered in previous existing models of enhancing VM performance.

This chapter presents an in-depth and robust overview of the methodological research framework guiding this research study. The section provides the research methodology that highlights the various research procedures and justification of choices of research methods. For this study, mixed method (quantitative and qualitative) was adopted by means of a Delphi technique and a questionnaire survey (field study). The adoption of a mixed-method approach is also explained in detail and fully justified in this chapter.

7.2 QUALITATIVE AND QUANTITATIVE RESEARCH

This chapter is dedicated to the exploration of the various methodological options that were employed to achieve the aims and objectives of this research (Whitehead, Dilworth and Higgins

2007). Usually, the research aim, and objectives dictate the tone for the appropriate research methodology to be used as well as the type of data to be collected (Johnson, Onwuegbuzie and Turner 2007). Therefore, researchers must choose which methodology options to embrace and, in most instances, these fall into two main (quantitative and qualitative) approaches. However, in some cases, a researcher may adopt either one of the methodologies or a combination of both (quantitative and qualitative), provided they adequately answer the stated research questions in that specific study. Johnson, Onwuegbuzie and Turner (2007) indicated that despite the research questions, the choice of research methodology is often dependent on the research paradigms. The research paradigm is a combination of beliefs that are often adopted by researchers to make sense of the world (McCusker and Gunaydin 2015). It can also be deduced that the paradigm inspires the researcher in designing the conceptual framework. asserted that the research paradigm is crucial because it provides the guidelines for Gunasekare (2015), the researcher in choosing the research method, inquiry and the purpose of the research. Thus, the paradigm adopted by a researcher influences the research method and perceptions regarding the research process.

Dieronitou (2014) provided another factor that influences the research method, namely philosophical considerations (ontological and epistemological) underlying the research process. This suggests that the choice of research methodology depends on the epistemological assumptions concerning the nature of knowledge and the pattern of abstracting the knowledge. Wright and Sweeney (2016) affirmed that the ontological assumptions also determine the research methodology adopted by the researcher. The ontological assumptions refer to the nature of the problem or phenomena being investigated. This study adopted the pragmatism philosophical considerations for explaining and understanding the problem statement identified in this study.

The justification for choosing the philosophical considerations is explained in the subsequent section.

7.3 PHILOSOPHICAL CONSIDERATIONS IN RESEARCH METHODOLOGY

The previous section indicated that the form of research methodology is usually determined by the assumptions underlying the problem statement and the philosophical considerations. According to Kumar (2018), the research methodology adopted by a researcher needs to be based upon the statement of assumptions that are introduced into the research process and reflected in the methodology. There are different assumptions which are often classified into philosophical ontology and epistemology. The description of the two philosophical considerations is described in the subsequent sections.

7.3.1 Ontological Consideration

This philosophical school of thought ultimately deals with reality and how it unfolds with focuses on questions such as ‘what is’ (Tuli 2010; Dieronitou 2014). It further describes the effort to explain the concept of reality and to understand the reason why things are occurring in that exact way. This implies that the ontological assumption examines what reality is and the reason in which the reality occurs. According to Selinger and Mix (2004), reality in terms of research methodology can be divided into objectivity (positivism) and subjectivity (interpretivism). This study adopted pragmatism ontological considerations which consist of positivism and interpretivism. Pragmatism believes that there are many ways a researcher can perceive what reality is. The researcher can either perceive reality from a positivistic or interpretivist point of view. The pragmatism philosophy is suitable for this study because it assumed that the model for VM in the construction

industry cannot be developed from one perspective. Thus, two ontological considerations, namely positivism and interpretivism, were used in undertaking this research study.

According to Giddings (2006), positivism supports the assumption that reality is not a function of human opinion. According to Taylor and Medina (2011), positivism researchers believe that there are some variables or phenomena that have not been discovered in the world. Also they submitted that the scientific method can be used to discover the phenomena existing in the world. Rehman and Alharthi (2016) described scientific methods as those methods that are used to discover or unravel a phenomenon without the interference of an individual. Therefore, using the scientific method ensures the production of a result that is scientifically verified and prevents bias from the researcher. The adoption of a scientific method provides results that can serve as theories used in explaining social behaviour. This is exactly what the current research aims to achieve in the sense that the model to be developed is expected to provide constructs that will be used to explain the effective VM in Nigeria. Therefore, the positivism ontological consideration was adopted in some sections of the research.

However, the use of positivism has its drawbacks regarding the assumption of an independent reality without human intervention. Following the drawback of positivism. Mayer (2015) opined that the idea of reality existing outside human intervention is illogical because reality is made up of human activities. Also, individuals do not perform as passive spectator; instead, they are actively involved in the creation of meaning in their environment. Therefore, Saunders, Lewis and Thornhill (2007) contended that positivism is not sustainable because it is not possible to separate the subject of knowledge from the observer.

7.3.2 Epistemological Consideration

Antwi and Hamza (2015) indicated that epistemology is concerned with answering the question of how knowledge is established. In conducting research, epistemology provides the guide in determining the form of knowledge that is regarded as appropriate and suitable for the research. In further support of the affirmation, Rahi (2017) and Kumar (2018) stipulated that epistemology and research methodology are intertwined because research methodology is applied epistemology. This implies that a researcher is expected to clarify and explain the choice of epistemology that supports his or her choice of research methodology. Wahyuni (2012) stated that the form of epistemology adopted by a researcher is a function of the ontological considerations in a field of specialization. Likewise, Goertz and Mahoney (2012) confirmed that the dimensions of ontology (/pragmatism) perform a vital role in the choice of epistemology and the methodology. Therefore, since pragmatism ontological considerations were chosen it is logical to adopt pragmatism for the epistemological considerations. As mentioned earlier, the epistemological considerations determine the form of research methodology to be implemented; therefore, the mixed method of methodology was adopted to suit the pragmatism philosophy.

7.3.3 Pragmatism Epistemology

The pragmatism epistemology which is made up of positivism and interpretivism philosophy supports using quantitative and qualitative methodology for a section in this study. In this study, qualitative methodology was used in extracting the constructs for developing the VM model in the Nigerian construction industry, whereas the quantitative methodology was used for validating the model developed in this study. The subsequent sections (6.3.4 and 6.3.5) explained further how the epistemology considerations determine the form of research methodology adopted in this study.

7.3.3.1 Positivism Epistemology

Positivism epistemology which is a category of pragmatism was explained in this section and its impact on determining the research methodology. Mayer (2015) believed that the positivism researchers perceives reality has an independent human intervention. Hiller (2016) informed that a positivism researcher is interested in examining the relationship between the variables that supports reality. Some principles provide the foundation for a positivist researcher in the search of reality. The principles include the following:

1. Knowledge can only be validated using a situation that can be observed.
2. Systematic observation of the reality or verified facts can be used in generating scientific knowledge.
3. The relationship between the verified facts should be described using scientific theory to establish a causal connection.
4. In determining the relationship between the verified facts, the judgment should be free from the researcher's opinion.

This implies that the positivist epistemology ensures the adoption of research methodology that supports scientific inquiry into the variables that represent reality. This present research also supports the scientific inquiry into the variables that ensure effective VM performance. Aliyu *et al.* (2014) asserted that the accomplishment of positivist research relies on data collection that can be measured using a mathematical formula which was also used in this present research.

Also, Antwi and Hamza (2015) opined that researchers that believe in the positivist opinion encourage the adoption of quantitative methodology to examine the relationships between

variables. Taylor and Medina (2011) affirmed that the under-positivist research the findings must be reported scientifically using an informal procedure. This implies that a positivist researcher will adopt statistical tools such as reliability tests, validity, regression, and many others. The adoption of these statistical tools ensures that the research process is free from bias and free from the judgment of the researcher. It can also be implied that quantitative method support the use of statistical tools. Creswell and Creswell (2017) affirmed that a researcher adopting quantitative methodology should ensure that apart from using statistical tools, some guidelines are followed. This includes coming up with a research problem, deciding on the expectations based on reality, creating variables, collecting data, analysing data, reporting the data analysis, and comparing the findings to the existing theory.

Creswell and Creswell (2017) declared that quantitative methodology is not suitable for some social phenomena that cannot be quantified. The failure in using this method for a phenomenon that cannot be quantified accounts for the shortcoming in this method. However, the shortcomings can be overcome by converting the social phenomenon into meaningful quantitative results to follow the norms of quantitative methodology. Mackenzie and Knipe (2006) provided another shortcoming of the quantitative research methodology. The scholars indicated that the methodology allows the detachment of the researcher from the research process. This suggests that the methodology allows the adoption of tools that do not have a mind of their own, thereby seeing the respondents as research objects. Unfortunately, it is difficult to detach the researchers from the process because their expectations and interpretations are part of the research process.

Despite the shortcomings of quantitative research methodology, it is suitable for scientific research that is focused on following formal procedures. McCusker and Gunaydin (2015) confirmed that

the shortcomings of the quantitative research methodology can be overcome through supporting it with a qualitative method. Thus, this study used a qualitative method to reduce the shortcomings of the quantitative research methodology. The qualitative methodology is described in the subsequent section of this chapter, including the epistemology supporting its adoption.

7.3.3.2 Interpretivism Epistemology

Antwi and Hamza (2015) opined that the interpretivism view of reality upholds the idea that humans should be involved with the creation and forming of facts. Interpretivism focuses on constructing meaning that is related to the respondent's (human being) opinion using interpretation. Wahyuni (2012) stated that the procedure in which a fact is sourced using interpretation is also known as interpretivism. Interpretivism implies that the researcher is concerned with obtaining information that relates to people's view and their interpretation of the world (Ormston *et al.* 2014). The definition of interpretivism makes it suitable for this study as the opinions of some experts in the construction industry were sought. These opinions were sought using qualitative methodology owing to the numerous advantages of the methodology.

According to Antwi and Hamza (2015), qualitative research methodology is appropriate for research that investigates the relationship between humans and their environment. This is because humans are part of the environment and are therefore able to attribute meaning to their environment. Creswell and Creswell (2017) affirmed that qualitative research is suitable for learning about human beings as it allows the researcher to gain knowledge about the phenomenon through the experience of the researched (human beings). Mayer (2015) indicated that studying a phenomenon through the experience of the respondent makes constructing the fact regarding a social world easy.

Despite the advantage of qualitative methodology for this study, it also has its shortcomings. Rahi (2017) asserted that qualitative research cannot study the relationship between variables at a specific degree of accuracy. Creswell and Creswell (2017) provided another shortcoming of qualitative research, namely that the researcher is the alpha and omega and can decide on what to concentrate upon. This situation sometimes leads to bias on the part of the researcher. Saunders, Lewis and Thornhill (2007) contended that using this method sometimes causes misconceptions because what is observed by one researcher may be different from another researcher. This implies that the findings generated from the qualitative methodology are sometimes not accurate. Taylor *et al.* (2015) related the poor accuracy in the findings of qualitative methodology to the small sample size associated with the use of the qualitative method. This is because the sample size may not be an actual representation of the whole population being studied. Robinson (2014) opined that the choice of sample size during the use of qualitative methodology is not a function of the research population. Rather, it is a function of the subject under investigation. This implies that the sample size is selected based on the subjectivity of the researcher which may pose some disadvantages to the research.

Sutrisna (2009) provided another disadvantage of adopting qualitative research. The scholars believed that it is not easy to subject the findings of a qualitative study to a reliability and validity test. Robinson (2014) affirmed that the validity test is concerned with the quantification of the object for enquiry. Thus, it makes the validity test difficult in the qualitative study because the aim is not to measure but generate ideas. On the other hand, qualitative researchers such as Jordan *et al.* (2011) and Rahman (2020) stipulated that the use of a validity test is not necessary for qualitative research because it is backed by scientific theory and positive paradigms similar to the quantitative study.

7.3.3.3 Justification for using pragmatism epistemology.

The aim of this study (developing a model of VM for the construction industry) cannot be achieved without requesting experts in the construction to provide constructs that support the practice of VM in the construction industry. Also, the constructs provided by the experts should be validated using a scientific method. The validation and extraction of the constructs from the experts require a pragmatism epistemology that supports the use of mixed philosophies and research methodologies in the form of both quantitative and qualitative methods.

Bleiker *et al.* (2019) advocated that a thesis can adopt quantitative and qualitative research methodologies depending on the objectives and aim of the study. This is because some research is based on four major objectives, namely exploration, explanation, description, and prediction. A qualitative methodology would be suitable for research the objective of which is concerned with exploration and explanation. This is possible owing to the capability of qualitative research methodology to explain a previously unknown phenomenon. However, a quantitative methodology is appropriate for research in which the main objective is predictive and descriptive. This is because quantitative research supports the use of the statistical method. It can be deduced from the use of either method should not depend on the preference of a method over the other. Rather, it should depend on the aims and objectives of the research, including the problem to be solved and the expected findings. The aims and objective of this study support the use of both methods which is also called mixed method or pragmatism. The mixed method of research is described extensively in the next section.

7.3.4 Mixed Method

The use of both quantitative and qualitative methods has been encouraged in numerous sources of literature such as that of (Castro *et al.* 2010; Tuli 2010; Lee and Smith 2012; Antwi and Hamza

2015; Queirós, Faria and Almeida 2017; Rahman 2020). The findings from these sources revealed that the use of both methods allows them to complement each other. Similarly, Almalki (2016) and Choy (2014) asserted that the use of both qualitative and quantitative methods simultaneously allows the covering of the weakness inherent in each method. According to Tuli (2010), the use of quantitative and qualitative methods ensures that research is richer in findings and details that a single method would be able to provide. Choy (2014) opined that combining both methods provide the advantage of gaining better insight into the research problem and ensuring an effective analysis of the data. The advantages of mixed methods (quantitative and qualitative) provide the basis for its adoption in this study.

According to Hanson *et al.* (2005), there are six designs used for the mixed method. However, this study adopted the following sequential exploratory mixed-method research approach. This method is summarised in figure 7.1 as adopted from literature such as that of Tashakkori and Creswell (2008) and Creswell and Creswell (2017). The chart shows that the main driver for this study is the quantitative research method supported by the qualitative method. Both methods are independent of each other with the quantitative and qualitative findings reported in separate chapters supported by their underpinning philosophies.

Gunasekare (2015) asserted that mixed-methods research is made up of philosophical assumptions and methods of inquiry. The philosophical assumption provides direction regarding the description of the problem statement and the statement of aims and objectives in the thesis. The method is focused on the data collection and analysis, including the presentation of the qualitative and quantitative report in this thesis. The main idea behind the mixed method is that using quantitative and qualitative methodology ensures a better insight into the research problem than using a single methodology (Strijker, Bosworth and Bouter 2020). The data for quantitative methodology was

sourced using a close-ended questionnaire. However, quantitative data can sometimes be sourced through documents such as census and attendance records. The qualitative data is often collected through open-ended questionnaires that the researcher uses in gathering the opinions and the experiences of the respondents. The use of an open-ended questionnaire for the qualitative study provides the advantage for the respondents to provide their response in their terms. According to Hignett and McDermott (2015), qualitative data can also be sourced from audio-visual information, artefacts and studying a respondent's behaviour. The response acquired can therefore be converted into qualitative data using thematic or content analysis. Nowell *et al.* (2017) described the thematic analysis as a method of proving/providing meanings (themes) to qualitative data.

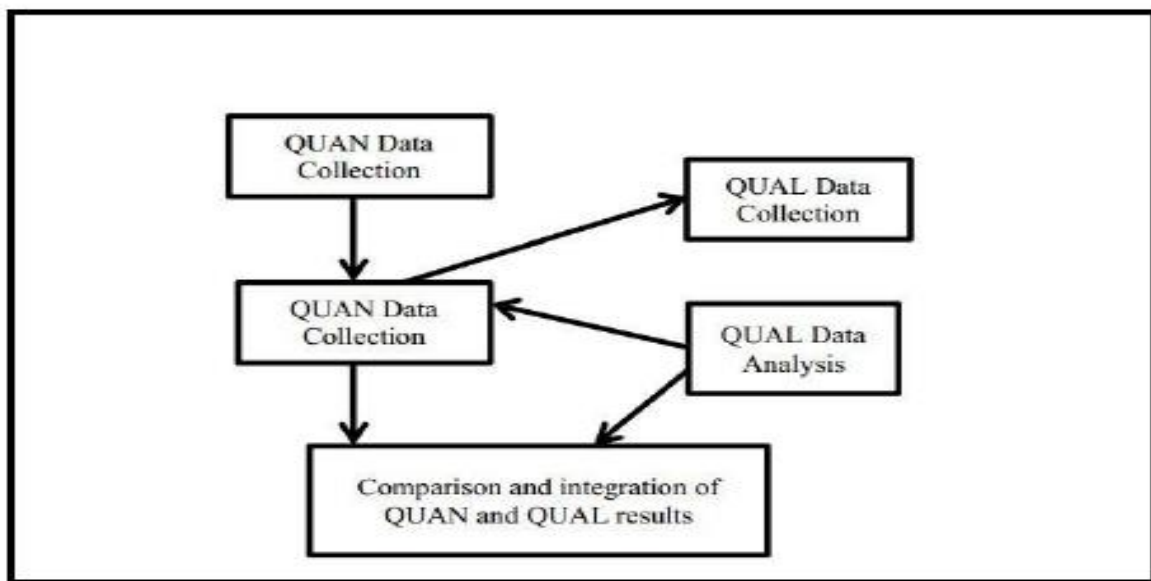


Figure 7.1: Mixed-method design
Source: Tashakkori and Teddlie (2003)

Figure 7.1 shows that a mixed method is achieved from the integration of quantitative and qualitative data. Tashakkori and Teddlie (2003) provided another characteristic of mixed-method

research methodology to include the ability to reveal that one construct or factor will have a predictive relationship against another. The second characteristic is the ability of the method to show the constructs or factors related to each other. Thus, this present study adopted a combination of the quantitative and qualitative method to determine some variables associated with VM. The mixed method was also used to identify the statistical significance of the variables in determining the management of construction VM.

This study adopted mixed methodology to explore how the variables identified by the qualitative study (Delphi technique) and literature review affect the performance of VM in Nigeria. For instance, it examined the perceived impact of integration, collaboration, corporate culture, and other variables on the expected outcome of VM performance. Thus, adopting only the quantitative methodology would not be sufficient to meet the objectives of this research. Therefore, a qualitative method was adopted to explore and obtain a better understanding of how the carefully chosen variables would impact VM in the construction industry. The responses from the qualitative study were sourced from experts in the Nigerian construction industry. The response from the expert was verified using a quantitative survey that was distributed to the construction firms within the study area.

Delphi technique was used in sourcing the qualitative data. The Delphi technique is described extensively in the subsequent sections of this chapter. The findings from the Delphi technique assisted in refining the questionnaire adopted for this study in validating the framework. The Delphi technique was also used in predicting the possible likelihood of certain trends related to the fourth industrial revolution (4IR) occurring within the construction industry. Also, the Delphi study was used to reveal the expected years in which the trends will occur within the construction industry. The data for the quantitative method was collected using a survey method adopting a

structured questionnaire. The quantitative data was analysed using structural equation modelling (SEM) through the assistance of SmartPLS software.

7.3.5 Justification for the Use of Mixed Method Methodology

The use of a mixed method (quantitative and qualitative) was adopted to compensate for the strength and weakness in each method. Scholars such as Tashakkori and Teddlie (2003) and Tashakkori and Creswell (2008) revealed that the quantitative method is criticised for its failure in incorporating contextual realism. Kumar (2018) indicated that when providing answers to research questions related to ‘why things occur’, qualitative methods are suitable. On the other hand, when providing answers to questions concerning ‘What things occur’ in a phenomenon, quantitative methods are appropriate (Creswell and Creswell 2017). Therefore, in this study that is focused on predicting the variables that ensure effective VM in the construction industry, the use of a single method would not have been sufficient. This is because some other factors or variables need to be explored from experts in the construction industry. This was achieved using a Delphi technique (qualitative survey). For these reasons the use of a mixed method was deemed suitable for this study.

The adoption of a mixed method (qualitative and quantitative) in this study offers the benefit of providing robust findings to the problems identified relating to VM. The use of mixed method also allowed the researcher to validate the model developed in this study which would have been impossible using only a qualitative method. This is because the qualitative method provides the variables needed for the generation of hypotheses and frameworks through the involvement of people. The framework needed to be validated using a questionnaire survey and some statistical tools. In this study, structural equation modelling (SEM) was the statistical method adopted in

validating the model developed from this study. Thus, it can be implied that the use of mixed methods provided the advantage of validating and generating the model developed in this study.

The mixed method also provides the advantage of answering the research questions that could not be answered using either a qualitative or quantitative approach alone. Also, the method strengthens the ability of the research findings to be generalised to other studies related to VM in Africa. This is because the use of mixed methods ensures a stronger conclusion due to the conjunction and confirmation of findings. The mixed method also allows the discovery of clear knowledge that can inform theory and shape the practice of VM in Nigeria. Creswell and Creswell (2017) revealed that individuals tend to solve problems using numbers and words which supports inductive thinking. This implies that it is natural that this study adopts the use of a mixed method that encourages the usage of words and numbers to solve the problem identified in this research. In support of the aforementioned, Kumar (2018) opined that words and numbers collaborate in solving a problem. This is because words are used to make numbers more meaningful and numbers are used for adding precision, measuring, and validating words. Hence, this study combined the use of a survey method with the Delphi technique for the development of a model for VM in Nigeria.

7.4 RESEARCH DESIGN

Marczyk, DeMatteo and Festinger (2010) and Turner, Cardinal and Burton (2017) affirmed that a research design can be perceived as the outline for carrying out research, which ensures that the research is carried out successfully by the researchers. Lee and Smith (2012) indicated that a research design can also be used as a tool for justifying the decision taken in the research process. They are two factors that determine the choice of research design Rahi (2017). They are the form

of methodology (quantitative or qualitative) adopted in a study and the philosophical considerations (ontology and epistemology). Tuli (2010) asserted that a researcher that supports the objectivist ontology will be interested in a more positivist epistemology, which emphasises the adoption of a quantitative method in the research process. On the other hand, a researcher that favours the objectivist ontology will tend towards the stipulations of objectivism, which accentuates the use of the scientific method for collecting data. Likewise, Antwi and Hamza (2015) declared that the research design determines the form of instrument for collecting data in the implementation of the research process as shown in Figure 7.2.

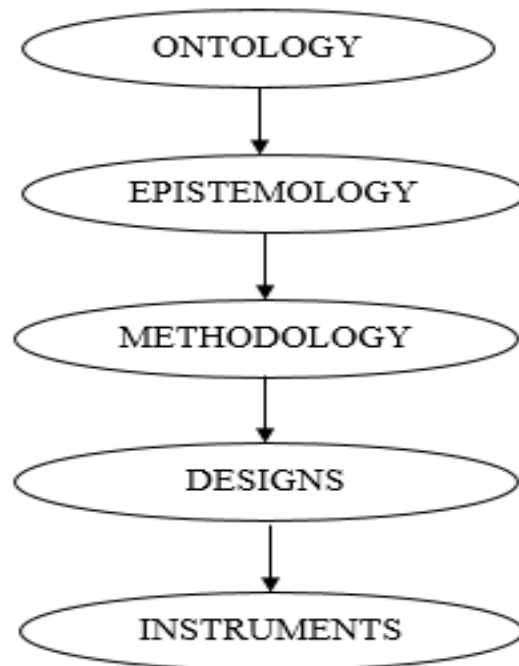


Figure 7.2: Steps in Research Design

Source: Adapted from Opoku, Ahmed and Akotia (2016)

According to Opoku, Ahmed and Akotia (2016), research design assists in ensuring that the five crucial components of research are interconnected. The components are the purpose of the

research, research question, theoretical framework, research methods and sampling strategies. Thus, the choice of research method in this thesis was determined by the research aim, questions, and objectives. The choice of research method to answer the questions and meet the objectives was based on three considerations. Firstly, the variables supporting VM should be identified by the research method. The next consideration is that the research method must be capable of reflecting the relationship between the variables and how they can predict effective VM performance. Lastly, the research method should ensure that sufficient information is collected and analysed to reflect how experts in the industry perceive the identified variables as crucial in determining VM performance.

1. The first objective which was to establish VM key performance indicators in the construction industry. For this objective, an extensive literature review was conducted regarding the expected outcomes of adopting VM in the construction industry. The study sought information from published articles in journals, conferences and book chapters related to VM. Also, publications relating to the growth of the construction industry in Nigeria and other developing and developed nations were reviewed. The findings from the reviewed literature informed the researcher about the global and local expected outcomes for adopting VM in the construction industry.
2. The next objective of the study was to evaluate the main existing variables that support VM practices and its application in the construction industry. A rigorous and extensive literature review was conducted to achieve this objective. The review was conducted across a wide database using Scopus, Web of Science and Google Scholar with a focus on reputable published journals, conferences, and book chapters. A special concentration focused on theories supporting VM. The findings from this literature were expected to

provide constructs that were used to develop the VM variables. The findings from the literature review also revealed variables or constructs that have not been used before in developing the model for VM. This was also known as the gap in the study that formed the third objective, which is identifying the gap in the existing VM models.

3. The third objective of the research was to investigate the gaps in the existing VM models needed for consideration in the Nigerian construction industry. This objective was achieved by conducting a review of the literature that is related to VM in the construction industry. The literature was targeted at examining the models that have been developed for VM in the construction and manufacturing sector. Also, the search of literature focused on the theories that have been used in examining the practice of VM in the construction industry. The review of the literature shows that VM in the construction industry has been supported by theories such as collaboration theory and goal-setting theory. These theories support integration, collaboration, and standardisation. However, it was believed that VM in the construction industry has not been studied with an all-inclusive theory and construct or variable, thereby creating a gap.
4. The fourth objective was to determine the impact of the established variables on the performance of VM in the construction industry. This objective was achieved using a Delphi method which was deemed fit for this objective. It was deemed fit because the method entails seeking experts experience on the factors that ensures improved performance of VM. This type of objective can only be achieved using methods such as a focus group or Delphi technique, apart from experimental procedures that are not practicable for this thesis. The focus group was not used because it would have been difficult to bring all the expert together in a room and to decide on the issues related to VM

in the construction industry. The focus group was also deemed expensive because it would have entailed catering for the experts for two days for a minimum of two hours. The focus group could also lead to biasness because the experts would know each other's responses with someone possibly going for the most popular response. The element of bias was eliminated using the Delphi study as the experts did not know each other and were selected anonymously. An extensive description of Delphi technique is described in the subsequent section, including how the technique was conducted. The anticipated outcome from the Delphi study was to reveal the extent to which the variables that were extracted from the literature in the previous objectives determine VM in the study area. Also, a consensus was measured using the Delphi study to provide an expected output regarding factors that determine the management of the construction value chain. The factors or variables extracted from the Delphi study were used to conceptualise a model for VM in Nigeria.

5. The fifth objective was attained from concluding the literature review and the results of the Delphi study and validating the conceptualised integrated VM model developed for this study. In meeting this objective, a quantitative methodology was adopted using a structured questionnaire that was administered to construction professionals within the study area. The questionnaire was designed to measure the relationship between the variables that determine VM and establish the relationship produced amongst them. It was also used to determine which variables have the greatest impact on the performance of VM within the study area. The method was deemed suitable for this objective because the agenda was to establish and measure the major determinants of VM in the study area. An extensive description of the quantitative method including the population, sampling procedure is

given to the subsequent section. The expected outcome from this objective was to validate the model suitable for VM in the Nigeria construction industry.

A summary of the research methods adopted to achieve the objectives of this research is presented in Table 7.1.

Table 7.1: Research Procedure

Stage	Research objective	Data collection	Data Analysis method	Output
Review of literature	RO1: Establish VM performance indicators in the construction industry	Literature review	Content Analysis	The expected outcome and benefits of adopting VM
	RO2: Investigate variables that support the performance of VM in the construction industry	Literature review	Content Analysis	Information regarding constructs that determine VM performance in the construction industry
	RO3: Investigate the gaps in the existing VM model needed for consideration in the Nigerian construction industry	Literature review	Content Analysis	The gap identified in this study are corporate culture and use of digital technologies
Delphi Technique	RO4: Determine the sub-constructs that have a significant impact on the performance of VM in the Nigerian construction industry	Delphi Technique	Descriptive statistics	A consensus or agreement was reached on the main and sub-attributes that determine the performance of VM
Questionnaire survey	RO5: Develop and validate a model for VM in Nigeria	Desk study Questionnaire survey Delphi Technique	Structural equation modelling (SEM) SmartPLS	An integrated and validated best fit model for VM

7.4.1 Methods

The methods shown in Table 7.3 used for this research are described in this section. As shown from the table, the methods include literature review, Delphi technique and Questionnaire Survey. This section assisted in explaining how the study was carried out.

7.4.2 Literature review

Nowell *et al.* (2017) opined that the literature review is one of the most crucial aspects of developing a study or thesis. This is because it reveals what has been studied in the past about the topic, the methodologies that were used previously and the reason for using these. Vaismoradi, Turunen and Bondas (2013) asserted that the review of literature contributes to the discovery of findings, solutions or trends that were discovered in the past about the topic under research. This study adopted a literature review in identifying the gap in the existing models supporting VM. Thus, it can be deduced that the literature review can be perceived as the foundation of this thesis. Apart from forming the foundation of this thesis, the literature review also assisted in contributing to the discovery of variables that support the performance of VM. It also aided in providing a framework that was used in comparing this study to other previous studies. The literature review was the next step of action in Stage 1 as shown in Figure 7.3. Figure 7.3 shows that the findings from the literature review were also inputted into the Delphi study of this thesis as shown in Figure 7.3.

A rigorous and thorough literature review was conducted to ensure integrity and sophistication in this study. The literature reviewed was consistent with a focus on articles published in reputable journals and conference proceedings. Also, unpublished materials such as thesis and books from the library were consulted. The review of the literature was also conducted on other developed nations such as Hong Kong and Australia. The literature review adopted VOSviewer software to

reveal the trends in the research related to the topic. The VOSviewer software was also used to establish publication history as it revealed the leading author and their contributions to the subject matter.

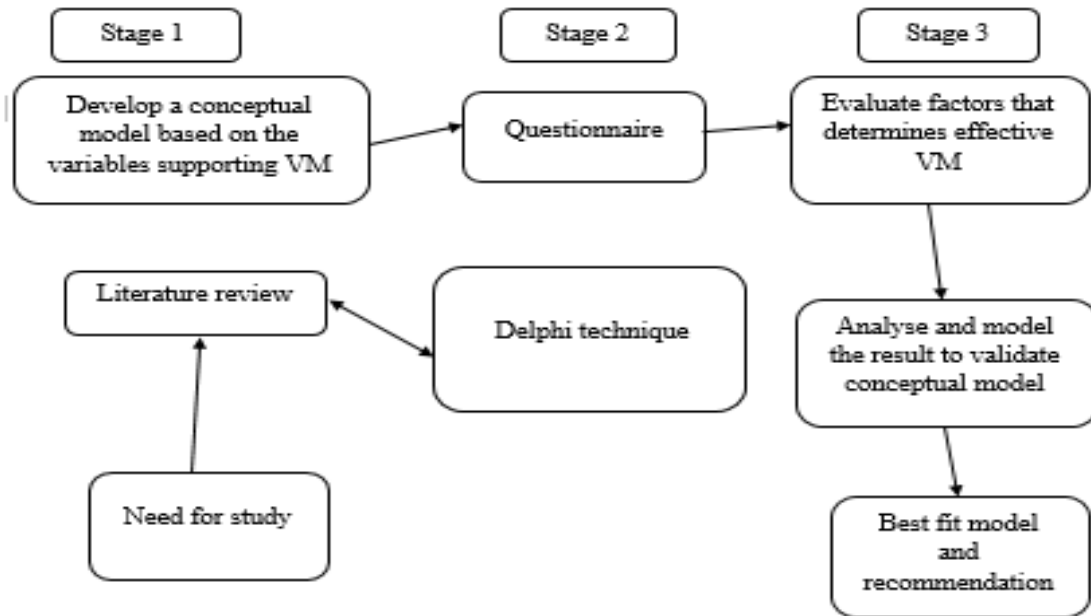


Figure 7.3: Research design outline

The findings from the literature review show that there are numerous factors that could determine effective VM. The literature also assisted in grouping the factors into main and sub-variables of factors. It was also discovered that there are other factors (a gap) which should be considered as important in determining effective VM performance which were excluded in past models. The literature review assisted in revealing theories that support the identified gaps in existing models. To test whether there is a relationship and influence of the identified gaps in VM, a Delphi method was adopted which is described in the subsequent section.

7.4.3 Delphi Method

In the second stage of this research, a Delphi study was employed to identify the primary variables that contribute to effective Value Management (VM) performance. This Delphi study aimed to investigate whether the variables identified in the literature were consistent with the Nigerian context. Additionally, the Delphi study sought to assess the extent to which the sub-attributes influenced the performance of VM within the study area.

Giannarou and Zervas (2014) emphasized that a key objective of conducting a Delphi study is to establish agreement on various variables. Typically, this consensus is reached by administering multiple rounds of surveys to experts anonymously in a structured manner. In a similar vein, Hallowell and Gambatese (2010) pointed out that utilizing structured surveys over several rounds allows the Delphi method to yield both quantitative and qualitative results. Likewise, Ojo and Ogunsemi (2019) characterized a Delphi study as a process involving three or more rounds, with the initial and second rounds serving as a basis for feedback. Consequently, the expert responses in the third round are influenced by the collective input gathered during the first and second rounds.

Hallowell and Gambatese (2010) asserted that the Delphi technique requires the involvement of experts who possess deep knowledge in their respective fields to provide valuable insights to the researcher. The information supplied by these experts is then analyzed to identify central and extreme tendencies. Subsequently, the researcher presents the analyzed findings back to the experts for their agreement or potential modifications. This iterative process continues until a consensus is achieved.

The Delphi method was selected for this study as an alternative to a focus group, primarily to mitigate potential biases that can arise when professionals convene in the same physical location.

Utilizing the Delphi method allows for the establishment of anonymity among experts, preventing them from becoming acquainted with each other. This is achieved because the Delphi method involves the distribution of questionnaires to experts anonymously by the researcher, with the aim of reaching a consensus. Following each round of the survey, a comprehensive analysis was conducted, including calculations of medians, percentages, and interquartile deviation scores. These analyses were performed to assess the level of agreement or disagreement among expert opinions. The questionnaire served as a crucial medium of interaction throughout the decision-making process when employing the Delphi technique.

Moreover, there is a noticeable gap in the existing literature when it comes to utilizing the Delphi technique to make decisions related to Value Management (VM) within the Nigerian construction industry. The choice of the Delphi technique for this study was favored over other survey methods due to the nature of the question being addressed. Unlike straightforward "What is" questions, the inquiry in this study leaned more towards "What if" scenarios. As highlighted by Aghimien, Aigbavboa and Oke (2020b) and Kauko and Palmroos (2014), the Delphi method is particularly well-suited for analyzing "What if" questions. Furthermore, conducting experiments was deemed inadequate for this study, given the financial constraints associated with experimentation. The Delphi method was also selected because of its robustness in accommodating multiple rounds involving experts. These rounds provided valuable opportunities for feedback to be circulated among the experts, enabling further scrutiny and validation of their responses. As suggested by Chedi (2017) and Alaloul, Liew and Zawawi (2015), the Delphi method is the most suitable approach for predicting the future trends in certain domains. In this particular study, the objective was to assess the future trajectory of VM within the Nigerian construction industry, making the Delphi method a fitting choice for the research.

7.4.4 Epistemological approach towards the Delphi technique

The epistemological approach chosen for the Delphi technique is based on the definition of Delphi method, the criticisms and aim of the Delphi method. The aim was determined from numerous sources of literature related to the Delphi technique. This is because the robustness of a framework for the Delphi design is crucial in understanding the overall objective of the study. The main objective of the Delphi research was to assist in the development of a VM model for the Nigerian construction industry and to extend its application to other developing countries. The aim was to ensure a consensus on the variables supporting the adoption of VM in the construction industry given the absence of a generally agreed-upon variables for VM model within the Nigerian construction industry.

This implies that the foremost objective of the Delphi study is to obtain a consistent consensus on the variables supporting VM in the Nigerian construction industry. Ameyaw *et al.* (2016) indicated that the Delphi technique is often used in sourcing opinions from experts to determine the future occurrence of a phenomenon. It is useful for predicting the future occurrence of phenomenon, especially in situations where the past data or reports regarding such a phenomenon are not available to extract from. The review of literature related to the present research revealed that there are few studies that have been conducted in the past to show variables that support the adoption of VM in the construction industry. This justifies that the Delphi method is one of the most effective methods to examine the aim and objectives of this research.

7.4.5 Research Situations Suitable for Delphi Technique

The Delphi method is suitable for adoption in research situations that appraise continuing research problems as in this present study. This is possible due to the ability of the Delphi technique in revealing trends that will be useful in the future. Therefore, the adoption of this method (Perneger

et al.) in combination with another survey method in modelling VM will give a rich outcome. Krijtenburg-Lewerissa *et al.* (2019) asserted that the Delphi technique can be used in research situations that involve the investigation of a prediction about an event. Also, it is used in situations that are difficult in terms of bringing all the experts under one roof. Rossouw, Hacker and de Vries (2011) affirmed that it is useful in situations that are focused on discovering the rational of a group of experts towards a situation. The authors adopted the Delphi technique for designing a curriculum in engineering and technology education in high schools.

Sanatigar, Peikani and Gholamzadeh (2017) indicated that one of the strengths of Delphi technique is the ability to reveal the wisdom and experience of experts in the industry. Ameyaw *et al.* (2016) also confirmed that the Delphi technique's components (round) provide the opportunity for reducing the subjective nature of the experts' experience. It can be inferred from the situations supporting the use of the Delphi technique that one of the components of Delphi technique is the ability to ensure anonymity among the experts.

7.4.6 Components of the Delphi Technique

A typical Delphi technique consists of five major components according to Ameyaw *et al.* (2016), Alaloul, Liew and Zawawi (2015), Barnes and Mattsson (2016), Ojo and Ogunsemi (2019), and Krijtenburg-Lewerissa *et al.* (2019). These five characteristics are adopted in this present study.

- i. A well-selected panel of experts who are well informed on the specific topic or subject in question should be considered for the study.
- ii. The panel of experts should remain anonymous throughout the study.
- iii. During the Delphi process, it is expected that the researcher designs a structured questionnaire and feedback report for the panel of experts.

- iv. An iterative process that involves multiple rounds to determine when consensus is reached by the panel of experts. and
- v. The designing of a research report which reflects the results of the Delphi study which provides forecasts, action plans, and recommendations.

In support of the components of the Delphi technique, Green (2014) provided some guidelines for its use. The scholars opined that the following should be followed when conducting a Delphi survey:

1. Identifying the research problem: According to Turoff (1970), the Delphi technique is considered when an informed perspective on a subject matter is required from a broad range of disciplines, hence the use of experts. According to McKenna (1994), engaging experts to share their knowledge in a subject matter is appropriate, especially if previous studies have not adopted a similar technique. This current VM study goes one step better in utilising the Delphi technique as a tool of investigation. This technique also examines the validity of the cross-disciplinary nature of the subject matter or issue in question.
2. Proper understanding of the Delphi process – One of the merits of the Delphi technique is generating consensus after a multistage process of collecting and analysing opinions from the experts (McKenna, 1994).
3. Experts' selection – This is the process of shortlisting and selecting the panel members who are interested in the topic, knowledgeable, committed to responding to multiple rounds of questions and impartial. Depending on the scope of the study, some researchers can accept more than 100 experts or as few as 10. An elaborate explanation on how the experts were chosen for this study will be presented in this chapter of the research.

4. Communication with experts – This deal with the process of explaining key information to the experts. This includes the amount of time required, instructions before filling, the objectives of the study and how the information will be utilised for the research study.
5. Data collection and analysis – This deal with collecting and recording expert opinions. The Delphi technique can go through several rounds, although two or three rounds are preferable with at least an 80 per cent consensus rate (stability or acceptance of data) as the minimum target (Green et al., 1999). Analytical software was employed to examine the diverse responses gathered during the various rounds of the study, enabling the provision of feedback to experts. This feedback encompassed essential statistical measures such as central tendencies, including the median (M), and the interquartile range (IQD). Additionally, the software facilitated the assessment of dispersion levels through the calculation of standard deviation; and
6. Presenting and interpreting results - This deal with the presentation of data from the Delphi study. Notably, two methods are prominent, namely graphical, and statistical. Both methods were adopted in the realisation of this study.
7. Formulating the second round of the Delphi questionnaire - The responses obtained from the first round of the Delphi questionnaire form the basis for the second round. The second round focuses mostly on the opinions of experts during the first round; and
8. Analysing the second round of the Delphi questionnaire – This involves distributing the Round Two questionnaires to selected experts who complete and return them to the researcher who analyses them. In this round, the experts are given the opportunity to verify their initial responses, retain their initial opinions (choices) or to change their initial opinions since the results of other experts are shared in the latest round. Again, constant, and careful verification

by the researcher is required to improve the consistency and reliability of the results (Skulmoski et al., 2007)

Thus, based on the components and guidelines for conducting a Delphi survey, it was believed that the technique was suitable for collecting reliable information from experts in the industry, academia, and government. The information collected was used in developing the model for VM in the Nigerian construction industry. The subsequent section reveals how the technique was conducted in this study.

7.4.7 Conducting Delphi Technique in this Study.

In cases where consensus is not reached after the first two rounds, a third round of the Delphi questionnaire is required.

The procedure was extracted after reviewing past literature relating to the adoption of the Delphi method in other fields. The procedure was broken down into four stages as follows.

- i Development of Delphi questionnaire
- ii The experts' size determination for the Delphi
- iii Selection of experts for the Delphi
- iv Carrying out Delphi iterations

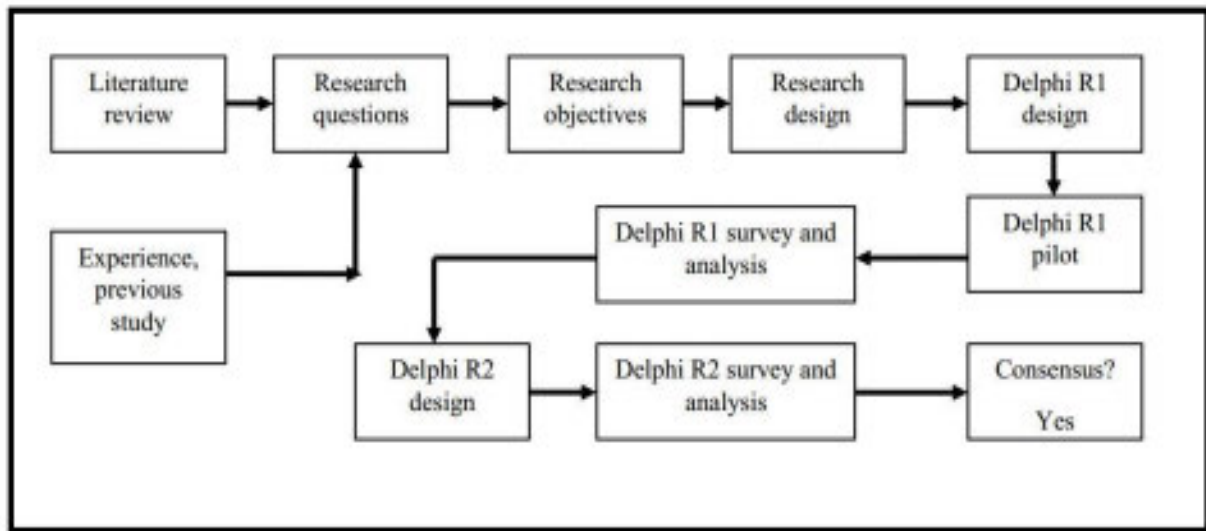


Figure 7.4: Delphi design for this study

7.4.7.1 Stage 1: Development of Delphi Questionnaire

The questionnaire was developed using variables extracted from the review of literatures. At this stage the researcher had to ensure that the respondents (experts) understood all the variables supporting VM. This is critical because the literature (Barratt 2004; Vázquez *et al.* 2016) has shown that the concept of VM connotes different things to different people. The questions were developed according to some guidelines as shown in Table 7.2.

Table 7.2: The formulation of Delphi questions

Main Delphi question	The rationale for phrasing this question
Kindly provide the reason for your interest in this study.	This study was developed because VM in Nigeria is still adopted haphazardly without a specific framework to provide the guidelines for adopting this phenomenon.
Is there any new information regarding the phenomenon being studied?	Although there are numerous variables that could support the practice of VM in the construction industry, these variables have not been put together to develop a model that could be used to generate policies or practice for VM.
Will the result from the Delphi technique have an impact on VM in the study area?	The outcome from the Delphi supports the development of a conceptual framework for VM within the study area.

Source: Author's compilation

In formulating the Delphi-specific questions, a rigorous literature review was conducted to develop a robust understanding of the subject area and to determine gaps in the research field. The questions developed were closed and open-ended in nature. Although the Delphi questionnaire identified factors relating to enhanced VM, the panel of experts were also required to provide variables which

in their opinion contribute to improved VM performance. The following Delphi specific objectives (DS0) were formulated for this research study:

DS01 - To identify the impact of VM attributes for enhancing the performance of VM in the Nigerian construction industry.

DS02 - To determine the impact of collaboration on the performance of VM in the Nigerian construction industry.

DS03 - To evaluate the impact of integration on the performance of VM in the Nigerian construction industry.

DS04 - To examine the impact of standardisation on the performance of VM in the Nigerian construction industry.

DS05 - To appraise the impact of corporate culture on the performance of VM in the Nigerian construction industry.

DS06 - To determine the impact of digital technologies on the performance of VM in the Nigerian construction industry.

7.4.7.2 Stage 2: Selection of Delphi experts

The successful execution of the Delphi interview process is largely dependent on the quality and the knowledgeability of experts providing responses and opinions (Giannarou and Zervas 2014). For this current research, an expert or group of experts refer to a panel of knowledgeable individuals who were selected based on criterion sampling (Habibi, Sarafrazi and Izadyar 2014). It is also germane that the experts were willing to participate in the process to ensure a high commitment response rate. Over the years, researchers have exercised flexibility in establishing criteria in deciding who should be called an expert. According to Gurung and Choi (2019), an expert should possess at least one of the following: a robust understanding of the subject matter

under focus; authorship of peer-reviewed publications related to the subject or discipline in question; and regular participation in conferences and workshops related to the subject or discipline in question. The flexibility of these guidelines may lead to many individuals who qualify as experts; hence the quality of the research results may be compromised.

In the same vein, Ameyaw *et al.* (2016) recommended four key requirements for Delphi experts. According to them, they must be knowledgeable and experienced in the subject matter under focus; willing to participate in the study; possess ample time to participate in the study and partake in several rounds if required; and be good communicators to express their suggestions and opinions with minimal issues and clarity. Rowe and Wright (2011) suggested that in a typical Delphi study, experts must satisfy at least two of the following requirements. These include authoring a peer-reviewed publication; presentation at a conference; chaired or is a member of a committee; practicing (employed) with at least five (5) years of relevant experience; and employed as a staff member with an accredited institution of higher education. In addition, Hallowell and Gambatese (2010) recommended that experts must satisfy at least four of the following: authorship of several peer-reviewed articles relating to the subject matter; presentation at a conference; chair or member of a committee; at least five (5) years of relevant experience in the construction industry; faculty member at an accredited institution of higher education; advanced academic qualification in a related discipline; and registered with a professional body. As observed, researchers have the autonomy to design criteria as they deem fit to suit the purpose of their study.

In selecting the panel of experts for this current research study, the recommendations of Hallowell and Gambatese (2010) and Aghimien, Aigbavboa and Oke (2020a) were considered.

1. Possess at least a bachelor's degree in a discipline within the built environment.

2. Currently employed with a registered and recognised tertiary institution in Nigeria or professional in the construction industry.
3. At least five (5) years as a staff member with any registered and recognised tertiary institution in Nigeria or at least five (5) years of working experience in the construction industry.
4. Affiliated with recognised professional bodies so that their opinions, suggestions, and recommendations may be applicable and transferable to the wider population; and
5. Author or co-author of a peer-reviewed publication in any of the disciplines within the built environment and have presented at conferences and workshops.

Table 7.3: Assessment of Delphi expert qualifications

S/N	Eligibility criteria for experts	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14
1.	Possess at least a bachelor's degree.	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2.	Currently employed with a tertiary institution or professional in the construction industry.	X	X	X	X	X	X	X			X	X	X	X	X
3.	At least 5 years of working experience with a tertiary institution or construction industry.	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4.	Affiliated with professional bodies	X	X	X	X		X	X	X	X		X	X	X	
5.	Author or co-author of a peer-reviewed publication	X		X		X	X	X	X	X	X	X			X
	Total	5	4	5	4	4	5	5	4	4	4	5	4	4	4

Source: Author's compilation

As seen in Table 7.3, the experts selected for this study all satisfied three or more of the listed criteria. Experts were recruited via an e-mail and other social media platforms which described the objectives of this research study with 20 invitations sent out initially. Subsequently, 16 responded and agreed to the initial invitation. These 16 respondents were sent a comprehensive description of what the Delphi study entails as shown in Appendix C of this study. The potential experts were asked to send their curriculum vitae (CV) to ascertain their study field, area of expertise and to verify whether they met the study's qualification standards. After this verification and confirmation process, the selected experts received the First-round questionnaire survey as shown in Appendix D of this study. The first-round survey consisted of both open-ended and closed questions with the experts required to mark and state their opinions. Sixteen experts successfully completed the first round of the questionnaire survey. However, two (2) members dropped out despite several reminders, allowing 14 members to successfully complete the survey rounds. The two members who failed to respond could have withdrawn owing to the rigorous nature and time-consuming tendencies of the Delphi method. Based on previous recommendations from different scholars, the number of active experts (14) who completed the survey rounds was deemed adequate.

This was echoed by Giannarou and Zervas (2014) who confirm that 10 to 15 experts are adequate if the backgrounds of the panel members are similar, something which this study achieved. In addition, Rowe and Wright (2011) suggested that in peer-reviewed studies, the Delphi panel size can range from three (3) members to 80 members, hence the number adopted by this study is suitable. According to Skulmoski, Hartman and Krahn (2007), the Delphi panel size can range between 10 to 18 members while Hallowell and Gambatese (2010) insisted a minimum of eight (8) is appropriate. Hence the number of experts (14) adopted for the Delphi process in this current

research study is suitable since the Delphi process is based on arriving at a consensus and not statistical influence or power. Furthermore, the Delphi panel size should be based on several factors such as the choice of geographical location, the capacity of the researcher, characteristics of the study in focus and the number of willing and available experts (Hallowell and Gambatese 2010). A drop of only two (2) members from the first round with 14 completing the Delphi process further showed how the issue of VM is both engaging and critical in Nigeria.

7.4.7.3 Stage 3: Panel size determination

Since the Delphi technique tends towards a qualitative approach rather than a quantitative one, fewer experts are required to participate in the study when compared to normal quantitative surveys. However, establishing the minimum number of experts for Delphi studies has been debated over the years and various researchers have suggested various sample sizes. Chan *et al.* (2001) asserted that a typical Delphi panel should constitute between eight (8) to 12 experts. This is similar to the study of Rowe and Wright (2011) who recommends between seven (7) and twelve (12) experts. In cases where the group of experts is homogeneous (belonging to similar backgrounds and share similar views and characteristics), then 10 to 15 participants are recommended (Skulmoski, Hartman and Krahn 2007). On the other hand, if the group of experts are of different opinions and characteristics (an international study), then a larger sample is required to maintain balance (Skulmoski, Hartman and Krahn 2007). It is also necessary to state that larger samples present issues with data collection and analysis as well as challenges in reaching consensus (Skulmoski, Hartman and Krahn 2007). Another significant factor is the availability of experts to participate. In cases where experts are limited, a smaller sample is expected (Sourani and Sohail 2015). For this current research study, owing to time constraints and varying schedules of experts, a relatively small sample was adopted and subsequently follow-up

research was conducted through a questionnaire survey. Hence, a sample size of 14 experts was adopted based on certain criteria that were discussed earlier. Owing to the nature of the subject area, experts were expected to represent a broad spectrum of backgrounds (fairly split between academics and industry) to provide knowledgeable perspectives to the study.

7.4.7.4 Stage 4: Design iterations

Another significant aspect of the Delphi process is the number of iterations (series of rounds) before reaching consensus (Hallowell and Gambatese 2010). Also, Critcher and Gladstone (1998) suggest between two (2) and five (5) rounds. Also, studies such as those of Kauko and Palmroos (2014) and Ilic *et al.* (2017) that used the Delphi technique adopted three rounds in achieving consensus. For most studies, two (2) or three (3) iterations are satisfactory (Skulmoski, Hartman and Krahn 2007). In cases where the sample is heterogeneous, three (3) or more iterations are recommended. For this current research, the expert panel was homogenous because they all possessed a background in the built environment (both academia and industry). Hence, the consensus was achieved after two (2) rounds of iteration with each round taking an average of a month to complete.

Each round within this study was conducted for approximately two (2) weeks to a month before collating the responses from the experts. Each round was developed based on the responses from the previous rounds to ensure consensus from the experts. The first round was designed to come up with variables that determine effective VM performance in the Nigerian construction industry. At this stage, an open and close-ended questionnaire was used. The responses from the first round were analysed and inputted to form the second round adopted for this study. At this stage frequencies and median were adopted in calculating the level of consensus reached by the experts. Content analysis was utilised for the open-ended questionnaire and inputted into the second round.

The second round was aimed at allowing the experts to review and comment on their initial responses in the first round. At this round, only close-ended questionnaire was adopted to reveal the participants' level of agreement or disagreement with the overall response on the variables ensuring effective VM performance in the Nigerian construction industry. Also, frequencies were adopted at this stage to support the interquartile deviation (IQD) to determine the consensus and input into the third round. The third round was aimed at informing the experts on the outcome from the second round. It was also aimed at obtaining their last confirmation of the variables that did not achieve consensus. The round three was designed using the responses from the open and close-ended questions in rounds one and two.

In the third round consensus was achieved for most of the variables supporting the development of a model ensuring the effective VM practices in the Nigerian construction industry. The findings from the third round were used in forming the conceptual framework adopted for this study. This was achieved using a ten-point Likert scale of 'no impact', 'low impact', 'medium impact', 'high impact' and 'very high impact', while 'no impact' was assigned the lowest weighting (1 and 2), 'very high impact' had the highest weighting (9 and 10). The degree of consensus reached amongst experts regarding the outlined dimensions that contribute to improved VM performance were measured by the frequencies obtained. Based on analyses of the second round, the dimensions that contribute to improved VM performance were prepared, which conceptualises the model for the broader study.

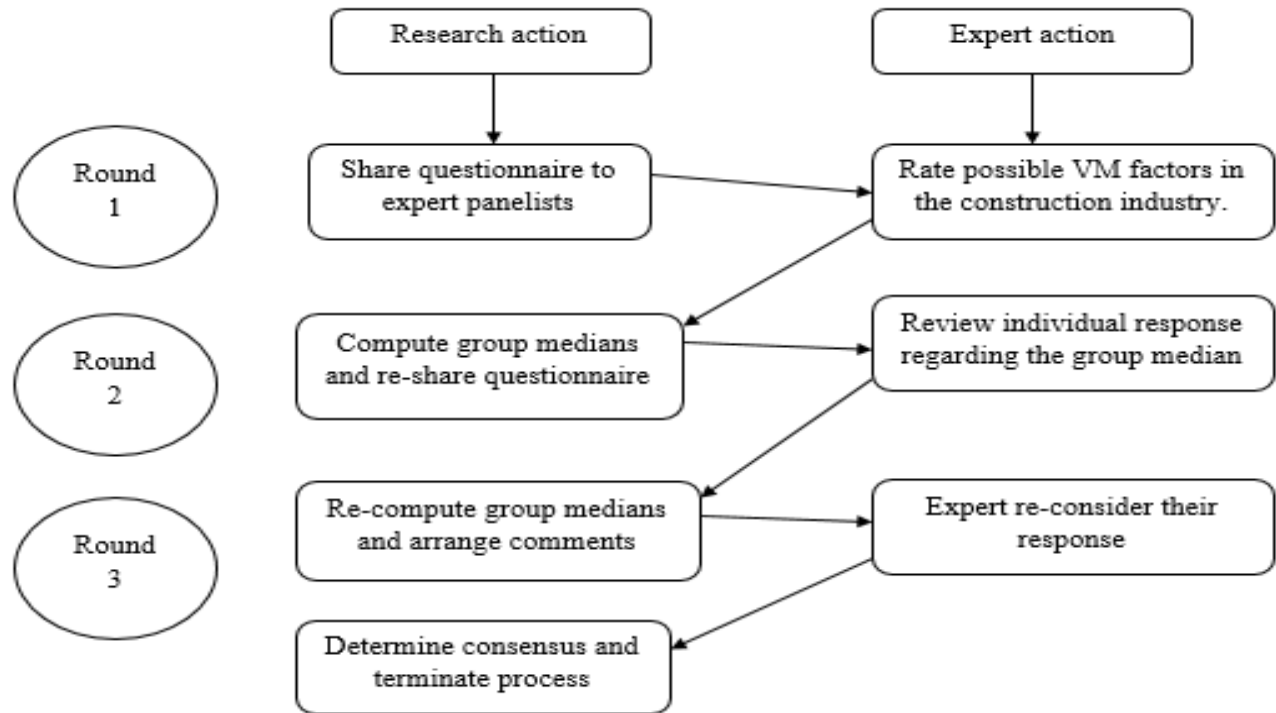


Figure 7.5: Delphi Process
 Source: Researcher's review of literature

7.4.7.5 Mode of communication

For this research study, the mode of communication was well thought out and considered the possible issues surrounding the anonymity of experts and the choice of analysis. There are two key forms of interaction, namely a paper-based mode and an electronic medium (Kock 2005). Unlike the paper-based mode, the electronic medium (e-mails) offers timely and swift communication channels (real-time messaging). This immediate response system provided by e-mails makes this mode of communication more convenient than the paper-based mode as it sustains the interest of the experts. Hence, the Delphi survey for this research was successfully carried out via email and follow-up thread messages were used to remind experts and provide immediate clarification where necessary.

7.4.7.6 Invitation to the panel of experts

Some studies suggest that the invitation of experts is a fundamental section of round one. However, this research study sent out 20 invitations initially and 16 responded and agreed to the invitations. However, 14 experts completed the survey. The letter of invitation explained the main objective of the research which is to develop a VM model for the built environment in Nigeria. The letter also informed experts on the number of rounds and the approximate time required to complete the survey. Based on previous studies, the number of experts (14) who completed the survey rounds was deemed adequate (Hallowell and Gambatese 2010).

7.4.7.7 Evaluation criteria

At the end of each round, the study established some criteria to analyse responses from the experts. For this study, each round required a minimum of three weeks to afford experts ample time to respond to the questions. Since the first round was mainly an exploratory round, experts (based on their knowledge and experience) were instructed to indicate the significance of certain factors across various degrees of measurement (extent) and to provide extra factors where necessary. For the second round, experts were instructed to either accept the group median, maintain original opinions, or record a new response. After this second round, consensus was reached. Before the Delphi survey commenced, the questions were approved by the researcher's supervisor and piloted with different experts to ascertain whether the objectives of the research could be realised with the structured questionnaire. The pilot study also improved the overall comprehension of the questions. The pilot team constituted six (6) experts (2 from academia and 4 from the industry).

7.4.7.8 Computing data from the Delphi study

As stated earlier, experts' responses and opinions were presented and analysed on Microsoft Excel spreadsheets with columns assigned for the median, mean, standard deviation and interquartile

values. Each question element and factor contributing to improved VM performance in Nigeria and other related issues was presented. For every round, the respective group median value and interquartile deviation (IQD) were computed as a measure of the central tendencies to determine consensus. Owing to its tendency to minimise the influence of potentially biased persons, the median value was adopted as a measure of central tendency as opposed to the mean and IQD. On the other hand, the respective IQD scores helped to summarise data variability and hence identified the appropriate measures that influenced VM performance. By eliminating outlying values, the IQD also offers general coherence and clarity of the overall dataset. The inter-quartile range, which is closely related to the median, indicates the extent to which the central 50% of values within the presented dataset are dispersed. Delphi results are explained in detail in the next chapter. After the second round of the Delphi, the below equation was adopted to calculate the absolute deviations (D_i) of the group medians ($m(X)$) of each rating or ranking for the respective questions:

$$D_i = [x_i - (X)] \dots \dots \dots \text{Equation 1}$$

D_i represents absolute deviation.

x_i represent panel ratings.

$m(X)$ represents the measure of central tendency.

7.4.7.9 Determining consensus from the Delphi study.

After the first two rounds, the group median and the IQD were computed for all responses and consensus was reached on all questions. In addition, the respective deviations for all responses were calculated using the absolute median as shown in Equation 7.0. In determining consensus, several researchers have adopted numerous parameters and judgements as benchmarks. Heiko

(2012) mentioned that consensus refers to an agreement of opinions and can be determined by the following parameters:

1. The summative judgments and opinions made by experts.
2. Opinions from experts shifting towards central tendency; and
3. By checking the consistency and steadiness of experts' responses between subsequent rounds of the Delphi study.

According to Giannarou and Zervas (2014), consensus can be reached by considering both the mean values and standard deviations values where a decrease in the latter between subsequent rounds shows high agreement levels. Aigbavboa (2015) further suggested the adoption of the IQD in determining the consensus, a parameter adopted by this study Agumba and Musonda (2013) further recommended another criterion to achieve the stability of results. They state that the IQD should equal one (1), meaning over 60% of the experts provided responses that were generally positive or generally negative regarding the subject matter. In the same vein, factors with an IQD value of less than one (1) suggest that responses that were generally positive or generally negative fell between 40% and 60% which signified consensus. This study by Agumba and Musonda (2013) resonates with that of Heiko (2012) who maintains that an IQD value of one (1) or less can be construed as an indicator of consensus. Furthermore, Holey *et al.* (2007) provide several parameters to confirm whether consensus has been reached:

1. A significant increase in percentage agreements.
2. When importance rankings achieve convergence.
3. A significant increase in Kappa values
4. Reduced or no comments and responses from experts as rounds progress.

5. Significant reduction of standard deviation values.

Based on the foregoing parameters, consensus can be reached when there is a convergence of ideas and opinions from the experts. For this current study, consensus was achieved when the following were observed:

1. When over 60% of responses for each question were ranked generally positive or generally negative.
2. When the average of the absolute deviation as calculated from Equation 1 was not more than 1 unit; and
3. When the IQD had a value that was less than 1, meaning factors with $IQD = 0.00$ were considered to have a high agreement and consensus among experts.

Consequently, the consensus scales for this study are shown in Table 7.4.

Table 7.4: Consensus scales for this study

S/N	Consensus strength	Median	Mean	Interquartile deviation (IQD)
1	Strong	9-10	8-10	≤ 1 and $\geq 80\%$ (8-10)
2	Good	7-8.99	6-7.99	$\geq 1.1 \leq 2$ and $\geq 60\% \leq 79\%$ (6-7.99)
3	Weak	≤ 6.99	≤ 5.99	$\geq 2.1 \leq 3$ and $\leq 59\%$ (5.99).

7.4.7.10 Validity and reliability of the Delphi study

Both validity and reliability are necessary for studies adopting a qualitative approach as they check the consistency of the study's research design and paradigms across various studies (Creswell and Creswell 2017). Reliability deals with the extent to which a well-thought process provides

comparable and identical results under constant conditions at every point in time (Hishinuma, Horiuchi and Yanai 2016). However, this is difficult to accomplish in Delphi-based studies as decisions and findings are based on diverse perspectives of experts based on their knowledge, experience, and perceptions towards ideas. In qualitative studies, validity (internal and external) remains an important consideration, and this current research made a conscientious effort to ensure the accuracy and integrity of the study findings from the researcher's perspective. As a measure towards ensuring credibility, the study also considered the response consistency from experts.

The validity of the research was further boosted by ensuring that experts were completely anonymous from each other to eliminate the 'bandwagon' effect. By establishing several rounds in the Delphi study, experts were given a chance to maintain their opinions or make changes whilst providing explanations for their arguments and differing views. Hence, the iteration process enhanced the internal validity of the study. In addition, the back-and-forth email communication between the researcher and the panel of experts further ensured the internal validity of this study. On the other hand, this study achieved external validity by comparing the findings of the Delphi study with the outcomes of the questionnaire survey that were statistically analysed.

Meanwhile, the reliability of the Delphi study was enhanced through the selection of experts from a homogenous background (possessing built environment orientation). Experts were considered from both academia and industry to improve the balance of opinions (Creswell, 2014). To further improve the reliability and credibility of the research study, there was strict adherence to the qualification criteria across the board. Based on the foregoing discussions, this study fulfilled requirements for both validities (internal and external) and reliability in conformity with standard research ethics.

7.4.7.11 Questionnaire survey and justification

The third phase of this research involves data collection from the field by means of a well-structured questionnaire will be used in validating the findings from the Delphi study. This stage of data collection is a critical aspect of the research design, according to (Queirós, Faria and Almeida 2017). In this research study, a well-structured questionnaire was designed to obtain opinions and responses (quantitative data) from a large group of professionals from within the built environment, including individuals from academia and the construction industry. Through the questionnaire survey, the generalization of results to the wider population was made owing to the large sample size considered as opposed to the smaller sample size obtained during the Delphi study. Moreover, data collection can take on various forms such as personal administering and emails (Baltar and Brunet 2012). The field survey aims at achieving the research objectives of assessing the critical success factors that contribute to enhanced VM performance in the built environment. Additionally, the data obtained from the field survey were used in validating the VM performance model postulated after the Delphi survey. The theorized model (described in Chapter 8) postulates that improved VM performance is a multidimensional structure that is determined by integration, collaboration, standardization, corporate culture, and use of digital technologies. The literature review showed that three of the constructs have been used previously to develop a VM model and this study added two as a contribution to knowledge. The two new constructs are digital technologies, and corporate culture. Hence, in validating the findings from the study, some specific objectives of the questionnaire survey are highlighted below.

1. To identify the constructs with the highest impact on the performance of VM in the Nigerian construction industry.

2. To establish the individual influence of the constructs on the performance of VM in the Nigerian construction industry.
3. To evaluate the most significant factor responsible for the performance of VM in Nigerian construction industry.
4. To determine the goodness-of-fit of the hypothesised integrated VM performance model for the Nigerian construction industry.

Based on the conceptual model in Figure 10.1, the following interrelationships were observed:

1. Integration has an impact on VM performance and influences its determination.
2. Collaboration has an impact on VM performance and influences its determination.
3. Standardisation has an impact on VM performance and influences its determination.
4. Corporate culture has an impact on VM performance and influences its determination.
5. The use of digital technologies has an impact on VM performance and influences its determination.
6. The VM performance model describes the determinant (variables) which results in improved VM practices.

Based on these objectives, a questionnaire survey was deemed most suitable for collecting data from professionals within the built environment (academia and construction industry). This research adopted the above-stated modes of data collection by administering them personally as well as through emails and other digital forms. The questionnaire was designed into Google Forms and links were emailed to professionals. Through personal administering, several questionnaires were completed within a short period. The survey method (questionnaire) was also selected for this study based on several factors such as population type, sampling technique, manner of

questions, cost and duration of data collection. Furthermore, this study adopted the questionnaire survey for the following reasons:

1. As seen in (Section 7.3.3) of this study, this research is underpinned by the positivist theory (positivist epistemology). Researchers in the positivist paradigm adopt a quantitative methodology to understand the possible connections and potential correlations between research variables, hence the use of questionnaires to collect data.
2. Through the adoption of a positivist philosophy, data interpretation and presentation are logical, sequential, and easy to understand, hence the use of questionnaires.
3. Based on the literature review and the Delphi study, an alternative method (different approach) was required to validate the findings, hence the use of questionnaire for data collection.
4. Within a stipulated timeframe, a structured questionnaire allows a relatively large number of research questions to be answered by respondents.
5. Generalisations can easily be drawn when questionnaires are used for data collection (Rowley 2014).
6. Questionnaires are relatively cheap to design.
7. Using questionnaires, specific information about perspectives, perceptions, and attitudes can be measured easily as opposed to when observational techniques are adopted.
8. Data obtained through questionnaires are easy to code and analyse using computer software applications and packages.

7.4.8 Field Survey Instrument

The field instrument that was used for this study is the questionnaire. Dieronitou (2014) described a questionnaire as a means or method for gathering information related to the views of many

people. Kumar (2018) stipulated that for a questionnaire to be effective and formalised, it should expose all the respondents to the same set of questions. This study considered the overall design of the questionnaire by checking the grammatical structure (wording) of the questions, ensuring the right measurement scales were used and informing participants of the purpose of the study (Creswell and Creswell 2017). All questions designed in this study's questionnaire were the same for all the respondents.

This research study was designed to obtain objective facts; hence an ordinal and categorical scale was adopted. Simple sentences were formulated throughout the questionnaire while complex terminologies were avoided. The questionnaire avoided double-barreled questions and adopted questions that were close-ended in nature. This provided the opportunity for participants to rank the level of importance of factors contributing to improved VM performance based on their knowledge and experience. Participants were also asked to provide personal information regarding their level of education, professional qualification, and years of experience. Participants' age and names were not required as this information had no bearing on the outcome of this study. The questionnaire for this study also considered measurement scales. The Likert scale was adopted over other scales owing to its high-reliability coefficients and a high likelihood of responses that adequately reflect opinions under focus (Hall, Hume and Tazzyman 2016). Likert scales were also adopted in this research owing to their tendency to increase the variance of responses which ensures stronger measures of association (Hall, Hume and Tazzyman 2016). Over time, five to seven-point scales have been used by researchers to capture opinions (Chan *et al.* 2001; Agumba and Musonda 2013; Ameyaw *et al.* 2016; Jiang, Kleer and Piller 2017; Krijtenburg-Lewerissa *et al.* 2019). Hence a five-point Likert scale of 'no impact', 'low impact', 'moderate impact', 'high impact' and 'very high impact' were adopted for this questionnaire.

The questionnaire consists of three sections (A, B and C). Section A consisted of 5 (five) questions which obtained the background information and demographics of the participants. Section B had five (5) questions and was used to establish the level of impact of each of the identified constructs on improved VM performance as related to integration, collaboration, standardisation, corporate culture, and use of digital technologies. Lastly, Section C was used to measure the outcomes of improved VM performance. Throughout the questionnaire, instructions and questions were kept simple and direct, with no technical words used.

7.4.9 Variables for the Field Study

The research instrument was designed to assess the impact of the exogenous variable on the endogenous variable. The exogenous variables for this study include integration (IN) with fifteen (15) variables, standardization (ST) with twelve (12) variables, and collaboration (COL) with 14 variables. The two additional constructs are the identified gaps from the past models which are corporate culture (CC) with twenty-two (22) variables, and use of digital technologies (DT) with thirteen (13) variables. The endogenous variable is the outcome of VM performance (VMoutput) with nineteen (19) variables as presented in Table 7.5.

Table 7.5: Conceptual Model Indicator Constructs

Constructs	Measurement variables
Integration (IN)	Knowledge about VM
	Regular workshop meetings
	Commitment of participants
	Early goal definition
	Clear objectives of workshop
	Experienced VM facilitator
	Availability of resources
	Accelerated decision making
	Efficient ideas and alternatives gathered in early stage
	Enough time to conduct VM studies

	Open information system
	Workshop preparation checklist
	Prompt response among professionals during VM meetings
	Equal contribution of participants
	Constant communication
Standardisation (ST)	Input of government and its agencies
	Mandatory VM training certification for all construction professionals
	Presence of VM guidelines and legal framework
	Government commitment to implement VM
	Inclusion of VM clause in procurement Act
	Attendance of policymakers on constant basis
	Regulation of VM activities
	Collaboration of government officials and professional bodies
	Customising VM for the Nigerian construction industry
	Active client's support and participation
	VM action plan for implementation
	Clients' capacity to convey demands to the design team
Collaboration (COL)	Sharing of information
	Sharing of resources
	Partnership
	Decision alignment
	Teamwork
	Knowledge sharing
	Shared orientation
	Coordination
	Interaction among participants in each phase
	Dispute resolution techniques
	Client's support and participation
	Group goal setting
	Risk sharing
	Cooperation
Corporate culture (CC)	Interpersonal relationship
	Teamwork
	Management commitment
	Cooperation among stakeholders

	Motivation
	Education and Training
	Skill development and acquisition
	Risk management
	Reward and incentive system
	Creativity orientation
	Innovativeness
	Updated technology system
	High degree of flexibility
	Regulation of VM activities
	Assertion of policy within the value chain
	Control of other construction professionals`
	Smooth operation of VM activities
	Meeting targets with adherence to schedule
	Result oriented
	Client satisfaction
	Goal accomplishment
	Ensures large market size
Digital Innovations (DI)	Internet of things (IoT)
	Building information modelling (BIM)
	Augmented reality technologies (smart phones, video games, etc.)
	Mobile devices
	Digital twin
	Administrative tools (Microsoft suites, Primavera)
	Virtual reality (sophisticated headsets, LCD displays, etc.)
	Cloud computing
	Block-chain technology
	Electronic meeting tools (zoom, Microsoft teams, etc.)
	Knowledge of cyber-security
	Advanced Big data analytics
	Engineering design (Computer-aided design)
Outcome of VM (VMoutput)	Cost-saving practice
	Material management
	Time Management
	Risk management
	Whole life asset management

	Conflict management
	Long-term planning
	Quality management system
	Waste reduction
	Improved project management
	Elimination of delay
	Effective project delivery
	Better quality system and performance
	Innovative designs
	Optimisation of value
	Increased efficiency in achieving tasks
	Better collaboration among professionals
	Enhanced project functionality
	Sustainability

Source: Author's compilation

7.4.10 Target Population

For this research, the population refers to the entire group of individuals that were relevant to this study (Taherdoost 2016). According to Creswell and Creswell (2017), it is necessary for a research study to state the size and the means of identifying who makes up the population. Creswell and Creswell (2017), stipulated that the population of a study be made up of a group of people or organisations with characteristics that relate to the research objectives. Tuli (2010) maintained that the population of a study refers to the object, phenomena, events, or case that a researcher wishes to research. Thus, it can be deduced that the population of a study is made of an institution that relates to the aims and objective of this study. Therefore, this study made use of registered construction firms in Lagos and Abuja as the population of this study.

Abuja, which is the Federal Capital Territory (FCT) of Nigeria, is located in the North Central region of the country while Lagos State is located in the south-western part of Nigeria and was formerly the federal capital territory of the country. The two states were chosen because they are

the most industrialised cities in the country, representing the seat of power in their various geopolitical regions. The industrialization within the states attracts numerous construction activities that in return enhance the establishment of construction and consulting firms. Also, owing to the industrialisation of the state, it attracts complex construction activities that in return require tight management of construction activities. The list of construction firms within the two

Table 7.6: List of some major construction firms in Nigeria

Construction firms	Nature of ownership	Year of establishment in Nigeria	Area of specialization
Firm 1	Foreign	1955	Buildings and road construction
Firm 2	Foreign	1932	Offices and residential buildings
Firm 3	Foreign and Indigenous	1948	Commercial and residential buildings
Firm 4	Foreign	1982	Commercial and residential buildings
Firm 5	Indigenous	1970	Infrastructure and residential/commercial buildings
Firm 6	Indigenous	1969	Building and civil engineering works
Firm 7	Foreign	1956	Engineering projects
Firm 8	Indigenous	1974	Infrastructure projects and supplier of concrete and asphalt
Firm 9	Indigenous	1976	Roads, buildings for private and public buildings
Firm 10	Foreign	1982	Commercial and residential buildings
Firm 11	Foreign and Indigenous	1948	Commercial and residential buildings
Firm 12	Indigenous	1997	Roads and bridges, industrial estates, urban settings
Firm 13	Indigenous	1977	Roads and bridges
Firm 14	Foreign	1979	Railway construction
Firm 15	Indigenous	1976	Infrastructure projects like roads and bridges

Source: Author's review of construction firms in Nigeria

Table 7.6 briefly shows the characteristics of the construction firms that serve as the population of the study. The table shows that the construction firms embark on different forms of construction activities, thereby making them suitable for the study. Generally, only one questionnaire was distributed to each firm within the study area. Construction firms were chosen because VM practices in the construction industry is not an individual function but a collective effort of the firm. Also, one of the gaps (corporate culture) highlighted in this study is a function of an organisation and not individual based.

7.4.11 Sample Frame of the study

According to Creswell and Creswell (2017), the sample refers to the subsection (individuals or institutions) of the population that is relevant to the study and is considered for data collection. A sampling frame is also referred to as the ‘working population’. Since a study cannot conveniently consider the entire population, a sample is often adopted, as in the case of this research. Nonetheless, the outcome of the research study is generalised to represent the population. However, the general population can be studied if a bigger sample is considered. Kumar (2018) reported that the arrangement of those within a population that can be sampled which may include individuals, households or an institution is known as a sample frame. This current study adopted all registered construction firms that make up professionals and VM experts within the Nigerian construction industry. To establish the sample frame, a list of registered construction firms was obtained from the Federation of the Construction Industry in Nigeria (FOCI). The list contains a comprehensive profile of the construction firms, detailing their staff strength, area of specialisation and year of establishment. Owing to the large population size, the selection of the construction firms was based on a probability sampling technique as discussed in the next section. The selection

of the respondents was based on a probability sampling technique as described in the subsequent section.

7.4.12 Method of Sampling

Kumar (2018) affirmed that a subset of an item a researcher selects from a certain population is known as a sample. The process of picking a sample containing people, firms or organisations for a population related to the study is known as sampling (Uprichard 2013). There are two basic sampling methods, namely probability and non-probability (Wiśniowski *et al.* 2020). The non-probability sample is similar to a non-random sample in which samples are selected without using probability techniques whereas the probability sampling technique allows each member of the population to be chosen adopting probability techniques (Clow and James 2014)..

In conducting probability sampling, the first step is compiling a sample frame of all eligible respondents from which the sample is selected (Malhotra 2015).. Although the probability sampling has its shortcomings regarding time consumption and expense in comparison to non-probability sampling, there are more advantages in using probability sampling than the non-probability technique (Emmel 2013). For instance, the probability technique allows the selection of all eligible individuals to participate in the study. Also, probability sampling allows the estimation of sampling error and provides the opportunity for selecting respondents that will provide vital information to the study. The use of probability sampling also provides the opportunity to generalise the findings from this study.

The numerous advantages of probability sampling motivated the adoption of the same for this study. Uprichard (2013) and Clow and James (2014) submitted that probability sampling is achieved using various techniques such as simple random sampling, stratified random sampling,

systematic and cluster sampling. The simple random sampling permits members of the population to be chosen using a simple random selection. The simple random sampling is performed through given each respondent in a population a number and then adopting a table of random numbers in deciding the respondents to include in the study (Uprichard 2013). For instance, in this study with a population size of 202, all the respondents were assigned a number from 0 to the highest numbers. A group of three digits from the random number table was adopted to pick the respondents (sample) from the population.

The simple random sampling provides the opportunity for calculating the sampling error and therefore reduces the selection bias. Another advantage of using simple random sampling is the straightforwardness and ease it brings to the research. However, the major disadvantage of this method is that there is a high probability of selecting sufficient individuals with characteristics that does not interest the researcher. For instance, the population of this study comprises respondents from Lagos and Abuja and using simple random sampling alone may result in selecting respondents from one state only.

Therefore, this study complements the shortcomings of the simple random sampling by selecting the cluster random sampling method. The cluster sampling functions by dividing an expansive area into small units and components. For example, a continent used as a population could be divided into countries, states, and cities as clusters. However, the clusters must be similar to one another with each cluster representing a mix of individuals that are randomly selected (Creswell and Creswell 2017). Kumar (2018) submitted that for the cluster sampling to be effective, the clusters must be already defined. This study defines the clusters into Lagos and Abuja using a two-stage cluster. This study commences with using the cluster sampling to divide the respondents into clusters before adopting the random sampling method.

7.4.13 Sample size

The number of individuals, firms, or organisations to be incorporated in a statistical sample is known as sample size. A study to make inferences about a population from a sample needs a sample size (Bujang, Omar and Baharum 2018). The sample size adopted in this study was based on the degree of data collection and the desire to have considerable statistical power to validate the conceptual model. The sample size for the current study was grounded on the entire population of the construction firms that were used for this study.

Perneger *et al.* (2015) asserted that the decision to pick a sample size should be based on the form of data analysis adopted by the researcher and the population characteristics. Similarly, Hau *et al.* (2008) contended that sample size should be based on the financial strength of the researcher, data analysis technique and access to the population. The data analysis technique adopted for this research is structural equation modelling (SEM) using SmartPLS which is sensitive to sample size. A general rule for SmartPLS is small sample size of between 100 to 300 (Hair *et al.* 2012). Thus, this study adopts a sample size of two hundred and two (202) which makes it an approximate of 60% of the population size which is deemed acceptable. Also, a similar sample size was adopted for studies such as those of Molwus, Erdogan and Ogunlana (2017), Hussain *et al.* (2018) and Aldhaferi, Bakchan and Sandhu (2018) that used SmartPLS software for analysing the SEM.

7.4.14 Pilot Survey

This is another critical aspect of the research strategy. A pilot study is a test-run questionnaire survey aimed at obtaining information and responses before the main study to check the data collection instrument's quality, validity, and reliability. A pilot study is usually conducted on a small scale in comparison to the main research study and is aimed at providing information that can be beneficial to improving the quality of the questionnaire. This was also considered for this

study. According to Khanna, Laroiya and Sharma (2010), a pilot study helps to eliminate any flaws and weaknesses of the survey instrument before the main study. However, results from the pilot study were not analysed and integrated into the main research. The pilot study helped to fine-tune the instructions given to respondents and, the overall structure and grammatical patterns of the questionnaire. This study followed the guidelines provided by Yuen (2007) in carrying out a quality pilot study. These procedures include the following.

1. By ensuring that the questionnaire is administered to the pilot respondents in the same manner as it is expected to be administered during the main study.
2. By ensuring the pilot respondents are asked to identify vague questions and ambiguous statements.
3. By ensuring the time for questionnaire completion is recorded to determine the time required for the main study.
4. By ensuring each question can be measured by the measurement scales.
5. By ensuring the pilot respondents can interpret the instructions and information required (Yuen, 2007).

According to Khanna, Laroiya and Sharma (2010), the recommended sample size for piloting a questionnaire is often between 10 and 30 respondents of the relevant population. This research conducted a pilot study on eight (8) respondents from professionals within the built environment to obtain a wide range of views. Five (5) respondents were professionals in the construction industry while three (3) respondents were academicians. The information obtained from this pilot study was not analysed or presented but was used to make corrections and suggestions on how to improve the study. Some of the observations made during the pilot study include rephrasing some skill factors and outcomes, the use of punctuation marks, reframing questions in the background

information section, spelling errors and grammatical amendments. These observations were duly noted, and corrections were effected.

7.4.15 Method of Data Collection

The method adopted for collecting the data (questionnaire) from the sample is examined in this sub-section. The questionnaires were collected electronically over a three-month period from March 2023 to May 2023. Most of the questionnaires were collected electronically using Google forms that were sent via email, LinkedIn, Facebook, Twitter, and other social networks. The adoption of the electronic method was suitable for this study because it was difficult to meet some of the construction professionals and stakeholders in their respective firms. The findings from the pilot study also justified the use of the electronic method as most respondents respond faster this way. Also, the use of an electronic method ensures that the correct respondents meant to respond to the questionnaire are those who responded to the questionnaire. The responses from the questionnaire were collected and inputted into the software used for analysing the data.

7.4.16 Data Analysis

The process of coding the responses from the questionnaires and screening the data for the appropriate analysis strategy is known as data analysis. The coding of questionnaire entails the process of classifying and allocating numbers to the characters that were collected from the questionnaire. In this study, the electronic responses of the questionnaire were downloaded from Google Forms and automatically converted into Excel formats. The next step was to allocate the numbers to the Excel forms as they were in automatic string format from the Google Forms. After assigning the numbers, the next step was to choose the appropriate statistical technique. Towards choosing the appropriate statistical technique, the following research components were taken into consideration, namely the problem statement of the study, the nature of the data collected and the

characteristics of the statistical techniques. Therefore, in providing answers to the problem statement of this study, a descriptive and inferential analysis technique was employed. The descriptive statistics entail the use of a number to provide descriptive characteristics of the respondents using frequencies, tables, chart, and mean scores. The descriptive statistics were used in analysing the first and second sections of this questionnaire. The analysis was done using the Statistical Package for Social Science (SPSS) version 25. The inferential statistics is also known as the process of identifying the effect of relationships between two or more relationship. Since this study was concerned with examining the impact of the constructs responsible for effective VM performance, structural equation modelling (SEM) was used to conduct the inferential statistics for this study. SEM was used in developing the VM model for the Nigerian construction industry as well as validating the model. The decision to use SEM was made after reviewing literature such as that Ojo, Ogunsemi and Ogunsina (2021), Ojo and Ogunsemi (2019) who used SEM for analysing the dynamics of VM. They adopted SEM for modelling VM in their respective fields of study using different software. Oke et al. (2012) supported the use of SEM for solving problems related to the construction industry. The scholars submitted that SEM provides the opportunity for achieving precision in the operationalisation of constructs used in the development of models. Hensler (2012) submitted that SEM provides the abilities for adequate measurement of errors, correction of errors and modelling the latent variables simultaneously.

7.4.16.1 Methods for conducting Structural equation modelling (SEM)

Hussain et al. (2018) reported that SEM is an improved version of multiple regression that allows the testing of the impact of one or more independent variables on one or more dependent variables. It is more advanced than multiple regression because it simultaneously estimates all the latent constructs used to develop the model with the intention of providing the strength of the expected

model. The first method which is the most frequently used is the covariance-based SEM, also known as CB-SEM. A researcher adopting this method tends to use software such as AMOS, EQS, LISREL and MPlus (Wong 2013; Shanmugapriya and Subramanian 2015). The second method is the component-based method, also known as the generalised structure component analysis (GSCA). The third method is referred to as the nonlinear universal structural relational modelling (NEUSREL) adopting NEUSREL's causal analytics software. The last method is the use of partial least square (PLS) that focuses on the analysis of variance, adopting software such as PLS-graph, VisualPLS, SmartPLS and WarpPLS.

Amongst all the methods for conducting SEM, this study adopted the partial least square method owing to the shortcomings of other methods. For instance, the CB-SEM supports the analysis of data for a large sample size, usually over 300 respondents. It also assumes that the data are evenly distributed. The use of CB-SEM for model development supports the idea that the latent variables that make up a construct used for the model are appropriate (Henseler et al. 2009; Wong 2013). Unfortunately, it is difficult to get a construct with accurate latent variables for developing a model (Wong 2013; Lefcheck 2016). Thus, these shortcomings made CB-SEM unsuitable for this study in developing a model for VM. Mentzer et al. (2001) and Stock and Boyer (2009) reported that VM is subjective and difficult when specifying a definition and variables that determine effective VM performance. The subjective nature of VM prevents the adoption of the CB-SEM method for this study.

Furthermore, within the realm of construction, an extensive body of literature has embraced the utilization of the Structural Equation Modeling (SEM) method. Consequently, this study opted for the Partial Least Squares (PLS) method, harnessing the power of SmartPLS, a distinct software tool renowned for its ability to generate SEM models effectively even with relatively small

datasets. As articulated by Sarstedt et al. (2017), the PLS approach assesses and analyzes the constructs used in SEM development by amalgamating principal component analysis with regression-based path analysis. It's noteworthy that SmartPLS stands out due to its reliance on PLS, setting it apart from the covariance-based and component-based SEM techniques. Moreover, Hussain et al. (2018) have emphasized that SmartPLS is widely recognized for its competence in handling smaller sample sizes, typically ranging from 100 to 200. This validation underscores the rationale for employing SmartPLS to conduct SEM in this study, given the specific characteristics of the dataset at hand. Other reasons that justify the adoption of the PLS method in this study are highlighted below:

- The ability to predict the accuracy of the model: One of the objectives for this study is to predict the role of the VM construct in ensuring the performance of VM in the Nigerian construction industry. For this reason, the partial least square (PLS) method was deemed suitable for this study.
- Small sample size: Hair Jr et al. (2014) affirmed that PLS-based SEM is useful for studies with a sample size like this study which adopted a sample size of two hundred and two (202).
- The PLS-SEM is widely used in research related to the construction industry.
- The software for conducting PLS-SEM like SmartPLS is user friendly and easily available, requiring little technical knowledge about the method.

7.4.16.2 Conducting SEM analysis using SmartPLS

Before conducting the SEM analysis to develop and postulate the model of VM in the Nigerian construction industry, the screening of data was considered essential. The data analysis was

conducted three times to identify the best fit model of VM in the Nigerian construction industry. The models were compared based on the evaluation of the outer measurement and inner structural model as shown in Table 7.8. The findings compared under the outer measurement model include the outer loadings, Cronbach alpha, composite reliability, AVE and VIF. For the inner structural model, the coefficient of determination (R^2), quality of the PLS path model (Q^2), the predictive capacity of the model and the model fit summary (SRMR) were examined.

7.4.16.3 Evaluation of the Outer Structural Model

This stage is concerned with the individual item reliability. According to Rahman et al. (2013), individual item reliability is the degree in which measurement of the constructs variables that were weighted with multiple item scale reflects the original score of the constructs relative to the error. Individual item reliability can therefore be described as the process of determining the effectiveness of sub-variables (latent) that makes up the construct variables. Rahman et al. (2013) described individual item reliability as the correlation of items with their respective variables. The criteria used in examining the outer structural model of this study are presented in Table 7.7.

Table 7.7: Criteria for conducting SEM analysis using SmartPLS

Statistics to check	Reliability measurement	Reasons for accepting
Evaluation of outer measurement model: This includes item reliability, convergent validity, and internal consistency.	Outer loading numbers	A loading of 0.50 or higher is preferred and deemed adequate (Henseler et al. 2009; Aibinu et al. 2011; Rahman et al. 2013)
	AVE numbers	The AVE number should be 0.5 or higher (Fornell and Larcker 1981; Sharif et al. 2019)
	Composite reliability	The composite reliability should be 0.7 or higher. However, 0.6 can also

		be accepted (Hulland 1999; Gye-Soo 2016)
	Cronbach alpha	The Cronbach alpha should be 0.6 or higher (Shanmugapriya and Subramanian 2015)
	Rho_A	Rho coefficient which should be between 0 to 1.00 and a coefficient that is closer to 1.00 are considered desirable (Henseler et al. 2009; Henseler 2016).
	Discriminant validity of the model	This study adopted the cross-loadings and Fornell Larcker criterion for testing the discriminant validity. HTMT between 0.85 and 0.90 is acceptable.
	Multicollinearity test (VIF)	The multicollinearity should be less than or equal to 2.5 (Henseler et al. 2009; Hair et al. 2019)
Evaluation of the inner measurement model	Coefficient of determination (R^2)	The R^2 is beneficial for measuring the overall effect size and variance explained in the endogenous construct. Hair et al. (2019) reported that an R^2 of above 0.7 can be deemed substantial and adequate.
	Quality of the 6PLS path model (Q^2)	The predictive capacity of this model was conducted using the PLS predict function of the software. The predictive power of the model was conducted to improve the practical usefulness of this model. According to Shmueli et al. (2019) and Hair et al. (2019), the predictive power of a model is determined by focusing on the indicators supporting the endogenous construct using the following rules:

		<ul style="list-style-type: none"> • If the RMSE in the PLS predict is more than the LM benchmark for all the variables, then the model has no predictive power. • If majority of the prediction error (RMSE) in the PLS predict is more than the LM benchmark, it means that the model has low predictive power. • If minority of the prediction error (RMSE) in the PLS predict is more than the LM benchmark, it means that the model has medium predictive power
	The goodness-of-fit index (Goffnett)	The GOF must have a value between 0 and 1 where values of 0.10 (Al-Mutairi <i>et al.</i>), 0.25 (medium) and 0.36 are regarded as large (Tenenhaus <i>et al.</i> 2005)
	Standardised root means square residual (SRMR)	The SRMR is the sum of the squared differences between the implied model and the empirical correlation matrix. Henseler (2016) indicated that the only model fit criteria implemented for PLS path modelling are the SRMR. The value of SRMR should be less than or equal to 0.08.
	Path co-efficient analysis	The path coefficient analysis was used to examine the impact of the exogenous variables on the endogenous variables in the model.
	Normed fit index (NFI) (Bentler and Bonnet)	NFI close to 1 is satisfactory.

7.4.16.3.1 Discriminant validity of the model

The discriminant validity assists in showing that the indicators for each construct are different from the indicators of another construct in the path model. Therefore, a model will be described as valid when conducting a discriminant test if the cross-loading value in the latent variable is higher than that in other constructs. This study adopted cross-loading patterns and Fornell Larker from SmartPLS in testing the discriminant validity which was also used in literature (Henseler, Ringle and Sarstedt 2015; Hussain *et al.* 2018; Hair Jr *et al.* 2021).

7.4.16.3.2 Statistical power

One of the major advantages of using PLS-SEM over CB-SEM is the technique's high degree of statistical power (Shmueli *et al.* 2019). According to Sarstedt, Ringle and Hair (2021), "...greater statistical power means that PLS-SEM is more likely to ascertain relationships as significant when they are indeed present in the population" (Sarstedt, Ringle and Hair 2021). Examining the high degree of statistical power is essential for exploratory research that deals with theories that are still in a developmental stage or are in the process of being established. Therefore, the PLS-SEM is suitable for both exploratory and confirmatory research.

7.4.16.3.3 Goodness of fit

This is another critical aspect PLS-SEM as it examines the model fit (theory testing and confirmation) for the research (Henseler and Sarstedt 2013). However, these can be achieved based on the applicability of certain measures which are currently being applied in various research studies with different thresholds. Firstly, these thresholds should be treated as provisional and not absolute. Secondly, the standardized root mean residual (SRMR) which indicates the divergence between the covariance matrices (both estimated and observed) should be interpreted with some level of cautiousness after the overall bootstrap procedure (Hair *et al.* 2019).

7.4.16.3.4 *Indicator reliability*

The first step in examining the results of PLS-SEM is to evaluate the measurement (Strijker, Bosworth and Bouter) model also known as the confirmatory factor analysis (CFA). As stated earlier, the PLS-SEM method can analyse both reflective and formative measurement models efficiently and effectively. However, there are different criteria for both sets of constructs (reflective and formative). Therefore, this study focuses mainly on the reflective constructs as the latent constructs are reflective. The various criteria adopted for evaluating the measurement model are shown in Table 7.7. The foremost step in assessing the outer model is to examine the indicator loadings and variables with outer loading of 0.70 or above are highly recommended. This implies that the construct explains over 50 percent of the indicator's variance and hence, it is considered reliable (Henseler, Ringle and Sinkovics 2009). Moreover, loading values of 0.60 are considered suitable, while 0.50 is satisfactory. However, 0.4 is acceptable, according to Hulland (1999) while Henseler, Ringle and Sinkovics (2009) suggested that loading values between 0.40 and 0.70 should be critically reviewed before deletion.

7.4.16.3.5 *Internal consistency reliability*

The next check is the internal consistency reliability which is determined by the Cronbach's alpha and composite reliability (CR) (which both have similar values). However, owing to its ability to check the standardized loadings of the latent variables, composite reliability is often adopted as a superior measure of internal consistency and is often higher than the Cronbach's alpha (Fornell and Larcker 1981). According to Taber (2018), Cronbach's alpha values of 0.70 and above are considered acceptable. Similarly, Enshassi, Al Swaity and Arain (2016) suggested a value of 0.70 and above as an acceptable composite reliability value. Generally, the higher the values, the higher the reliability levels. Nonetheless, values that exceed 0.95 indicate redundancy and undesirable

response patterns. However, the ρ_A which usually lies between the Cronbach's alpha and CR has been considered as an exact measure of construct reliability (Dijkstra and Henseler 2015). This study adopted all three internal consistency reliabilities during the iterations.

Table 7.8: Acceptable thresholds for the PLS-SEM measurement model

No.	Criterion	Acceptable thresholds	Sources
1.	Indicator reliability	Loading values ≥ 0.70 is acceptable; 0.60 is suitable, while 0.50 is satisfactory. However, between 0.40 and 0.70 can be considered.	Hulland (1999), Henseler, Ringle and Sinkovics (2009), and Hair, Ringle and Sarstedt (2012)
2.	Internal consistency reliability	Cronbach's alpha ≥ 0.70 is acceptable; 0.6 and above can also be considered for exploratory research; Composite Reliability (CR) ≥ 0.70 is acceptable. For both, values between 0.70-0.90 is satisfactory.	Fink and Litwin (1995), Hair, Ringle and Sarstedt (2012), Dijkstra and Henseler (2015)
3.	Convergent validity	AVE value ≥ 0.50 is acceptable	Fornell and Larcker (1981), Hair, Ringle and Sarstedt (2012), Johari, Yahya and Omar (2011)
4.	Discriminant validity	For distinct constructs, a threshold value of < 0.85 is acceptable. For constructs with similar underpinnings, a threshold value of < 0.90	Fornell and Larcker (1981), Henseler, Ringle and Sarstedt (2015), and Hair Jr and Sarstedt (2019)

7.4.16.3.6 Convergent validity

The subsequent phase in evaluating the outer model involves scrutinizing the convergent validity of the different constructs, also referred to as Average Variance Extracted (AVE). Convergent

validity assesses the degree to which a construct effectively consolidates or converges in explaining the variance observed among its constituent items (Fornell and Larcker 1981). According to an AVE value of 0.5 and above is considered satisfactory. Constructs that meet this threshold indicate that it explains at least 50 per cent of the variance of its items.

7.4.16.4 Evaluating the Structural (Inner) Model

After the successful completion of the measurement model, the next step is to assess the structural (inner) model. The assessment of the structural model is based on several checks. First, the R^2 value determines the coefficient of determination of the endogenous variable, the Q^2 value explains the redundancy measure achieved by a blindfolding cross-validated procedure and the β value explains the model's path coefficient and statistical significance. Moreover, a PLSpredict procedure can be conducted to assess the model's out-of-sample predictive power, something which this research study considered (Shmueli *et al.* 2019). The various criteria adopted for evaluating the structural model are shown in Table 7.8.

7.4.16.4.1 Collinearity

According to Hair Jr and Sarstedt (2019), several regression equations need to be developed to determine the relationships between constructs in a structural model. One of the requisite steps to be taken before examining the structural relationships is to check for collinearity issues to ensure there are no problems causing any form of bias to the results of the regression. To check for collinearity issues, the variance inflation factor (VIF) should be 3 or less than 3 (Hair, Ringle and Sarstedt 2012). According to Becker *et al.* (2015), "...high multicollinearity (above 5) can lead to insignificant estimates and unexpected signs of the weights" (Becker *et al.* 2015).

Table 7.9: Acceptable thresholds for the PLS-SEM structural model

No.	Criterion	Acceptable thresholds	Sources
1.	Collinearity	VIF values ≤ 3 are acceptable.	Becker <i>et al.</i> (2015), Hair, Ringle and Sarstedt (2012)
2.	Degree of explained variance	R ² values are between 0 and 1. R ² values of 0.25, 0.50 and 0.75 are relatively sufficient, moderate, and sufficient. R ² values of 0.10 are acceptable depending on study.	Hair <i>et al.</i> (2019), Sarstedt, Ringle and Hair (2021), Akter, D'ambra and Ray (2011)
3.	Model's predictive accuracy	Q ² values > 0 are satisfactory. However, Q ² values of 0.25 and 0.50 represent medium and large predictive accuracy of the PLS path model.	Shmueli <i>et al.</i> (2019) and Hair Jr and Sarstedt (2019)
4.	Relevance of the path coefficient	T-statistic values > 1.96 indicate an acceptable hypothesis. Also, MAE (or the RMSE) values should be compared with the LM values to ascertain the degree of predictive power.	Hair, Ringle and Sarstedt (2012); Hair Jr and Sarstedt (2019)

7.4.16.4.2 Degree of explained variance.

After checking for collinearity issues, the next step is to examine the R² value which determines the coefficient of determination of the endogenous variable. According to Akter, D'ambra and Ray (2011), R² shows the degree of explained variance of the endogenous latent variables. Therefore, the R² (in-sample predictive power) can also be regarded as the model's explanatory power (Hair *et al.* 2019). Generally, the value of R² is between 0 and 1 (Akter, D'ambra and Ray 2011). Therefore, values of 0.75, 0.50 and 0.25 signify appropriate, moderate, and relatively weak explanatory power. However, Raithel *et al.* (2012) stated that low R² values of 0.10 are acceptable

depending on the context of the study and the discipline where the study is executed. This implies that the R^2 of any model should be interpreted within the scope and context of the study.

7.4.16.4.3 Relevance of the path coefficient

The final step is to assess the model's path coefficient (β value) to check which of the exogenous variable has the strongest effect on the endogenous latent variable. In this case, the SmartPLS software conducts a non-parametric bootstrap procedure to test the significance of the various path-coefficients by calculating T-statistics (T-value). This value provides a confidence interval for parameter estimates which helps to generate statistical inferences. In SmartPLS, the bootstrap procedure treats the sample like an actual population by making an estimate of 5000, as chosen for this study. During the bootstrap procedure, SmartPLS also generates the sample mean value, standard deviation, and p-values for each path model coefficient. According to Hair, Ringle and Sarstedt (2011), T-statistic values of 1.96 and above indicate an acceptable hypothesis of the model.

7.4.16.4.4 Model fit analysis

After the successful completion of the iterations and examination of both the measurement and structural model, it was germane to examine the model fit according to several fit indices. This model fit evaluation was carried out to assess how the model fits and this was achieved by adopting 2 fit indices criteria, namely approximate model fit and absolute model fit (Khine 2013). From the PLS-SEM, the indices criteria adopted for absolute fit indices are shown in Table 7.10 and discussed below.

7.4.16.4.5 Approximate model fit

7.4.16.4.5.1 Standardised root mean square residual (SRMR)

According to Hair, Ringle and Sarstedt (2012), SRMR refers to “...the difference between the observed correlation and the model implied correlation matrix which allows the assessment of the average magnitude of the discrepancies between observed and expected correlations as an absolute measure of (model) fit criterion” (Hair Jr *et al.* 2021). In addition, Henseler, Ringle and Sarstedt (2015) described SRMR as a measure of goodness of fit to prevent misspecification of the model. For a model to be considered as a good fit in PLS-SEM, a value of less than 0.08 is acceptable (Hu and Bentler 1998).

Table 7.10: Acceptable thresholds for the PLS-SEM model fit analysis

No.	Criterion	Acceptable thresholds	Sources
1.	Standardised root mean square residual	SRMR values < 0.08 are acceptable	Hu and Bentler (1998), Henseler, Ringle and Sarstedt (2015), Hair <i>et al.</i> (2017), Henseler <i>et al.</i> (2014)
2.	Normed Fit Index	NFI values should range between 0 and 1. Values closer to 1 signify a good fit.	Hair <i>et al.</i> (2017), Dijkstra and Henseler (2015)
	Absolute model fit		
1.	Model’s predictive accuracy	Q ² values > 0 are satisfactory	Hair <i>et al.</i> (2019), Shmueli <i>et al.</i> (2019)
2.	Root mean squared error	Q ² _predict values should be > 0 and have positive values to be considered satisfactory. Also, the RMSE values of both the PLS-SEM analysis and naïve benchmark (linear regression model (LM)) should be crosschecked to	Hair <i>et al.</i> (2019)

		determine the magnitude of predictive power.	
3.	Goodness of fit (Goffnett)	GoF values closer to 1 signify a good fit	Henseler and Sarstedt (2013), Akter, D'ambra and Ray (2011)

7.4.16.4.5.2 Normed fit index (Bentler and Bonett index)

This fit measure as proposed by Bentler and Bonett (1980) determines the model's χ^2 value and compares it with a reasonable threshold. Dijkstra and Henseler (2015) suggested that "...since the χ^2 value of the proposed model in itself does not provide sufficient information to judge model fit, the NFI uses the χ^2 value from the null model, as a yardstick" (Dijkstra and Henseler 2015). Hence, Hair *et al.* (2017) proposed that the NFI is $(1 - \chi^2 / \chi^2)$, where both χ^2 represent the proposed model and the null model respectively. As a rule of thumb, NFI values should range between 0 and 1 and values closer to 1 signify a good fit (Lohmöller, 1989). NFI is also called the Bentler and Bonett index.

7.4.16.4.5.3 Model's predictive accuracy

In further assessing the predictive accuracy of the path model, a blindfolding procedure is required to get the Q^2 value. According to Sarstedt *et al.* (2014), the procedure "...removes single points in the data matrix, imputes the removed points with the mean and estimates the model parameters". This implies that the Q^2 encapsulates certain aspects of both the out of sample prediction and in-sample explanatory power (Sarstedt *et al.* 2014). As reported by Hair *et al.* (2019), the blindfolding procedure "...predicts the data points that were removed for all variables". In this case, high predictive accuracy (Q^2) is achieved when there are considerably small differences between the original values and the predicted values (Hair *et al.* 2019). Hence, for any typical endogenous

variable (construct) to demonstrate the predictive accuracy of that specific structural model, Q^2 values are required to be larger than zero (0). Hence, Q^2 values that are higher than 0 indicate small predictive relevance of the PLS-path model. Similarly, Q^2 values that are higher than 0.25 and 0.50 also indicate medium and large predictive relevance of the PLS-path model. Furthermore, a model's predictive power can be computed using the PLS predict-based assessment to assess the prediction error. According to Hair et al. (2019), the mean absolute error (Attia *et al.*) "...measures the average magnitude of the errors in a set of predictions without considering their direction (over or under). The MAE is thus the average absolute difference between the predictions and the actual observations, with all the individual differences having equal weight" (Hair *et al.* 2019).

7.4.16.4.5.4 Root mean squared error

Another metric adopted to measure the prediction error is the root mean squared error (RMSE) which is the "...square root of the average of the squared differences between the predictions and the actual observations" (Hair *et al.* 2019). In this section, the Q^2 statistic should be examined to determine the prediction values as against the naïve benchmark (Shmueli *et al.* 2019). In checking the prediction statistics, the RMSE should be adopted. However, Shmueli *et al.* (2019) suggested that "...if the prediction error distribution is highly non-symmetric, the MAE is the more appropriate prediction statistic" (Shmueli *et al.* 2019). Therefore, the values of RMSE or MAE need to be cross-checked and compared against naïve benchmark (linear regression model) values which are generated by the PLS predict procedure. Danks and Ray (2018) suggested that the naïve benchmark "...uses a linear regression model (LM) to generate predictions for the manifest variables, by running a linear regression of each of the dependent construct's indicators on the indicators of the exogenous latent variables in the PLS path model" (Danks and Ray 2018).

According to Hair *et al.* (2019), there are several inferences to be made based on RMSE or MAE and LM values.

They include the following:

- 1) The model lacks predictive power if the PLS-SEM analysis values (the RMSE) for all variables possess higher prediction errors as against the LM values.
- 2) The model has a low predictive power if most of the indicators within the PLS-SEM analysis (the RMSE) for all variables possess higher prediction errors as against the naïve LM values.
- 3) The model has a medium predictive power if a minority (or equal number) of the indicators within the PLS-SEM analysis produce higher prediction errors as against the naïve LM values; and
- 4) The model has a high predictive power if none of the indicators in the PLS-SEM analysis has higher RMSE values as against the naïve LM values (Hair *et al.* 2019).

7.4.16.4.5.5 Goodness of fit

Owing to the fact that no distributional assumptions are made for parameter estimation in PLS-SEM, model adequacy and evaluation are therefore achieved by non-parametric and prediction-oriented measures (Hair, Ringle and Sarstedt 2012). While parameters such as comparative fit indices (CFI), root mean square error approximation (RMSEA) and Tucker-Lewis Fit indices (TFI) are absent in PLS-SEM, R^2 is adopted as the main criterion to examine the predictive significance of the model. In evaluating the overall predictive power of the model (including the performance of both outer and inner models), this study adopts a global criterion of goodness of fit to examine the overall model fit (GoF index) as proposed by (Hair, Ringle and Sarstedt 2011). According to Hair, Ringle and Sarstedt (2011), GoF index is described “...as the geometric mean of the average

communality index and the average R^2 value”. According to Akter, D'ambra and Ray (2011), for global validation of PLS model, 0.1 is considered a low GoF value, 0.25 is regarded as a medium value while a threshold value of 0.36 is acceptable for large effect sizes of GoF. Akter, D'ambra and Ray (2011) also proposed the following equation to calculate GoF:

$$GoF = \sqrt{AVE \times \overline{R^2}}$$

7.4.17 Model identification

This aspect of the research (model identification) is one of the critical aspects of the research that must be executed (Hair, Ringle and Sarstedt 2013). The idea behind the model identification is to ascertain whether there is sufficient information for each parameter based in the model and whether those parameters are consistent with the data set (De Carvalho and Chima 2014). For SEM-related techniques, it is important to identify the structural model as it provides the opportunity for the inclusion and exclusion of variables (constructs) to obtain the best fit model which can be further tested (Kline 2015). According to Byrne (2013a), Byrne (2013b), and Hair, Ringle and Sarstedt (2013), a model is identified if the parameters within the model possess a unique solution. Based on these assertions, three categories of model identification exist. First, there is the ‘just identified model where the parameters possess just enough information to be considered. Secondly, there is the ‘under-identified’ model where, owing to insufficiencies in information or theories, one or several parameters cannot be determined. Finally, there is ‘over-identified’ model where the estimation of parameters is made possible based on more than sufficient information (Byrne 2013b). For SEM-based approaches, models are required to fall under the ‘over-identified’ category. This is because it is essential to have more variances and covariance than the parameters in the models. This allows for model rejection and acceptance, and hence it is scientifically

relevant. This study therefore leans towards an ‘over-identified’ model as it possessed a positive degree of freedom as discussed later. The relationship between the five exogenous variables and the endogenous variables indicates an ‘over-identified’ model with the presence of variances and covariance within the model.

7.4.18 Reliability and Validity of the Questionnaire Survey

This study recognised that it is crucial to validate a research work that will have an impact on the public, in particular, on the construction industry. The degree in which the findings of a research are interpreted in a correct way and manner can be referred to as validity (Nowell et al. 2017). On the other hand, Kumar (2018) opined that validity is the degree in which the result of a study can be verified against the objectives. Validity could be examined internally or externally. The internal validation is concerned with identifying whether the input used for the study produced the desired output. For instance, the internal validity of this study is concerned with ensuring that the construct of the VM determines the performance of VM, whereas the external validity refers to the ability of research findings to be generalised to other samples. Reliability refers to the consistency of the results obtained from the research. Hishinuma, Horiuchi and Yanai (2016) affirmed that reliability is attained when the research process is repeated and provides results within the stated limits. This implies that the reliability of a study can be deemed valid if another researcher embarks on the same research and provides similar conclusions. Therefore, it can be deduced that the quality of the data collected performs a significant function in ensuring reliability. Towards ensuring the reliability of this study, the method of data collection (questionnaire) was prepared with rigorousness, ensuring that all the information supporting the study objective was captured. The validity of the questionnaire was ensured by conducting a pilot study as described in section 7.4.14.

The reliability of the questionnaire was further ensured through using a mixed method research methodology and making the lead researcher in charge of quality control.

7.4.19 Ethical consideration

It is important to ensure that appropriate behaviour is maintained in conducting research. Thus, this research has ensured that the interests, opinions, and identity of the respondents are protected. Also, the respondents were not forced or coerced to respond to the questionnaires. This is because the respondents were requested to participate in the study voluntarily and it was explained that they have the right to end their participation at any time. Also, they were briefed about the objective of the study and the reason for which they were chosen. The briefing was conducted to ensure that they are free from any deception or stress in participating in the research. Finally, the respondents' anonymity was guaranteed, and the data collected was analysed in a manner that will not cause any harm or discomfort to the respondents. The research got the required ethical approval from the Institutional Research Ethics Committee (IREC).

7.4.20 Conclusion

The methodology adopted in this study was examined in this chapter. The study adopted a combination of mixed methods in tackling the problem identified in this study. The justification and philosophy supporting a mixed methodology were also provided in this chapter. The variables used in developing the model were also presented in this chapter. The importance of the variables was initially evaluated using a Delphi study and consensus was achieved in the third round. The variables for the model were validated using SEM, adopting the partial least square method. The justification for using PLS-SEM and the procedure for analysis were also presented in this chapter. Finally, chapter concluded with the ethical considerations regarding reliability and validity in the collection of data.

CHAPTER EIGHT

DELPHI STUDY RESULT

8.1 INTRODUCTION

This portion of the research study outlines the Delphi process, which involves the investigation and assessment of expert opinions to identify the various factors, including both primary and secondary dimensions that contribute to enhancing the performance of VM in Nigeria. To achieve a consensus among experts, three rounds of the Delphi process were conducted, during which they discussed and agreed upon the questions posed to them. The outcomes of all three rounds (from the first to the third) of the Delphi process are summarized in this section. The section also provides the calculations for each attribute that can ensure effective VM performance in the Nigerian construction industry. Furthermore, the study examines the sub-attributes related to VM to enhance its effectiveness in the Nigerian construction sector. The initial part of this section introduces the expert panel and offers an overarching view of the Delphi study. Subsequently, it presents the study's conclusions. The chapter concludes with a comprehensive discussion of the findings, aligning them with the objectives of the Delphi study.

8.2 THE DELPHI SURVEY BACKGROUND

It's important to remain focused on the intended objectives when conducting a Delphi study. The goals for conducting the Delphi survey in this study were as follows:

1. DS01 - To identify the impact of VM attributes for enhancing the performance of VM in the Nigerian construction industry.
2. DS02 - To determine the impact of collaboration on the performance of VM in the Nigerian construction industry.

3. DS03 - To evaluate the impact of integration on the performance of VM in the Nigerian construction industry.
4. DS04 - To examine the impact of standardisation on the performance of VM in the Nigerian construction industry.
5. DS05 - To determine the impact of corporate culture on the performance of VM in the Nigerian construction industry.
6. DS06 - To determine the impact of digital technologies on the performance of VM in the Nigerian construction industry.

These objectives were crafted with the aim of identifying the primary factors and variables crucial for enhancing the performance of VM practices in Nigeria and constructing a comprehensive VM model tailored to the Nigerian construction sector. Consequently, the ultimate goal of the Delphi study is to create a VM performance model specifically designed for the construction industry in Nigeria. Initially, an invitation to participate in the Delphi study was extended to twenty (20) experts, and all twenty of them actively completed the first round. To ensure a well-rounded representation of perspectives, the panel of experts for the Delphi process was carefully selected from both academia and industry backgrounds, thus enhancing the diversity of opinion.

Before the Delphi survey commenced, the questions were approved by the researcher's supervisor and piloted with different experts to ascertain whether the objectives of the research could be realised with the structured questionnaire. The pilot study also improved the overall comprehension and grammatical composition of the questions.

The initial round of the questionnaire was sent to the panel of experts via email and was developed through a thorough literature review. Its purpose was to identify the various dimensions, including

both primary and sub-dimensions, that contribute to improving VM performance in the Nigerian construction industry, as detailed in Appendix E. Additionally, the questionnaire aimed to extract the key attributes associated with VM in the construction sector, extending beyond existing VM management models, as identified in the reviewed literature. The first round of the Delphi survey was structured around these variables sourced from the literature and organized systematically. In pursuit of the study's objectives, this initial round sought to generate insights and compile a comprehensive list of empirical variables and sub-variables that define effective VM practices in Nigeria. The questionnaire included a combination of closed-ended and open-ended questions to allow experts to both assess the importance of the identified dimensions and variables and contribute additional variables based on their expertise and experience. Subsequent to the first round, the second and third rounds of the study were built upon the analysis and insights gathered from the initial round.

The primary aim of the second round of the study was to offer experts an opportunity to assess and provide feedback on the key attributes, both primary and sub-attributes that influence VM performance in Nigeria. This round employed closed-ended questions to further explore the insights and comments provided by the experts, including their levels of agreement or disagreement with the variables identified in the initial round. To facilitate this evaluation, experts were presented with the group median for each of the supporting attributes and sub-attributes related to VM. This allowed them to gauge their level of agreement or disagreement with the proposed variables. As a result of the consensus achieved in the second round, there was no necessity for a third round or further iterations. The arrival at a consensus at the second round confirmed the researcher's predictions that only two rounds would be needed to complete the Delphi study. The experts were provided with the results of the median from the previous set of

surveys to ascertain their consensus. A consensus is reached when all the experts concur, and a common consent occurs when there is agreement from two thirds of the experts, according to Ojo and Ogunsemi (2018). Even though a consensus was also acknowledged, the goal of this study was to ensure that there was agreement on each attribute. Quantitative analysis was conducted after each round of questionnaires to statistically assess whether a consensus had been reached for a particular attribute. If there was agreement among the experts on a specific question or attribute, it was not revisited or included in subsequent rounds of the study.

The majority of the primary and sub-attributes that have an impact on VM in the Nigerian construction sector garnered consensus during the second round of the Delphi survey. Based on the outcomes of the analyses conducted during the Delphi rounds, a comprehensive list of variables influencing VM in the Nigerian construction industry was compiled. This list forms the foundation for the conceptual framework. Furthermore, in line with the predefined objectives of the Delphi study, the study also highlighted the barriers to the adoption of digital technologies in VM practices. The results of the Delphi study will now be presented, specifically addressing the objectives set forth earlier in this chapter.

8.3 DELPHI STUDY FINDINGS

DS01 - To identify the impact of VM attributes for enhancing the performance of VM in the Nigerian construction industry.

From the review of existing VM models, frameworks and their corresponding constructs across several contexts, this study identified five key dimensions in ensuring enhanced VM performance. It is upon these dimensions that the conceptual VM performance model for this study was achieved. Some characteristics that are essential for effective VM performance in the construction

sector were identified by the extant review of the literature from the previous chapters. Even though the studied material focused on research from developed nations, its effects on VM in Nigeria were examined. As a fundamental construct for the proposed VM performance model for the construction industry, these five dimensions were included in the first round of Delphi to obtain the opinions of experts. This is shown in Table 8.1. In order to mitigate the potential influence of biased individuals, the study opted to use the median as a measure of central tendency, rather than the mean and interquartile deviation (IQD). This was done by employing a ten-point Likert scale that ranged from "no impact" to "very high impact" to quantify the influence of each attribute. On this ordinal scale, a rating of one indicated "no impact," while a rating of ten indicated "very high impact." Table 8.1 presents the responses of the participants, displaying the median, mean, and IQD for each attribute. To determine the consensus among the attributes, the following criteria were applied:

- Strong consensus: Median values between 9 and 10, mean values between 8 and 10, and IQD of less than or equal to 1.
- Good consensus: Median values between 7 and 8.99, mean values between 6 and 7.99, and IQD between 1.1 and 2.
- Weak consensus: Median values of 6.99 or lower, mean values of 5.99 or lower, and IQD between 2.5 and 3.

Table 8.1: Experts responses to main dimensions

VM Dimensions	Median (M)	Mean (\bar{x})	IQD (σ_X)
Integration	7	6.86	0.00
Standardisation	8	7.10	0.00
Collaboration	9	8.15	0.00

Corporate Culture	10	9.21	0.00
Digital Technologies	9	8.04	0.00

Table 8.1 reveals that there is a strong consensus for all the attributes influencing VM in the construction industry, indicating general agreement among the experts. However, some attributes have a more pronounced impact than others. Notably, corporate culture stands out with a median score of 10, the highest level of consensus, a mean score of 9.21, and an IQD of 0.00, signifying unanimous agreement among experts regarding its significance. Similarly, digital technologies (mean = 8.04) and collaboration (mean = 8.15) also exhibit strong consensus, both with median scores in the 9-10 range and IQD values of 0.00. These attributes are deemed highly influential in VM performance. On the other hand, standardization (mean = 7.10) and integration (mean = 6.86) receive a good consensus, with median scores in the 7-8 range. While they are considered important, they do not attain the same level of impact as corporate culture, collaboration, and digital technologies. It is evident that corporate culture exerts a particularly substantial influence on VM performance, as indicated by its higher mean score compared to the other attributes. Additionally, collaboration and the use of digital technologies are also noteworthy factors contributing significantly to VM performance. In contrast, standardization and integration, while important, have a comparatively lower impact. These results imply that corporate culture, collaboration, and digital technology utilization are key drivers of enhanced VM performance in the construction industry, according to the consensus rule applied in this study.

8.3.1 Sub-dimensions that contributes to improved VM performance.

8.3.1.1 INTEGRATION - To evaluate the impact of integration process on the performance of VM the Nigerian construction industry.

In the initial round of the Delphi survey, a total of 17 integration practices were identified based on the literature review. During this round, experts were asked to assess the significance of integrating construction professionals for achieving effective VM performance in Nigeria. To rate the importance of integration, a 10-point Likert scale was used, ranging from 'no impact' (assigned the lowest weighting of 1 and 2) to 'very high impact' (assigned the highest weighting of 9 and 10). The results of this analysis were presented in Table 8.2, with the aim of addressing the study's objectives and gaining insights into the experts' perspectives on the importance of integration practices for VM performance in Nigeria.

Table 8.2: Impact of Integration Factors on VM Performance

Codes	Integration Practices	Median (M)	Mean (\bar{x})	SD (σ_X)	IQD
INT1	Knowledge about VM	9	8.90	0.83	0.00
1NT2	Regular workshop meetings	9	8.65	1.46	0.00
1NT3	Commitment of participants	9	7.45	1.79	0.50
INT4	Early goal definition	9	7.70	1.30	0.00
INT5	Clear objectives of workshop	8	8.30	0.72	0.50
INT6	Experienced VM facilitator	9	8.40	0.79	0.00
INT7	Efficient project execution	8	7.80	0.67	0.00
INT8	Availability of resources	7	6.94	0.48	0.00
INT9	Involvement of decision makers and other key partners in VM workshop	8	7.15	0.46	0.00
INT10	Accelerated decision making	8	7.90	0.55	0.00

INT11	Efficient ideas and alternatives gathered in early stage	8	8.15	0.81	0.50
INT12	Enough time to conduct VM studies	8	7.64	0.63	0.00
INT13	Open information system	8	7.25	0.65	0.00
INT14	Dedicated personnel	9	8.57	0.93	0.00
INT15	Prompt response among professionals during VM meetings	8	7.10	0.15	0.00
INT16	Constant communication	9	8.35	0.76	0.00
INT17	Adequate skills and training	8	7.56	0.84	0.00

M = Median; \bar{x} = Mean; σX = Standard deviation; IQD = Interquartile deviation

As discussed earlier, a strong consensus is reached when variables have a median value between 9 and 10, a mean value between 8 and 10, and an IQD value = 1 or less than 1. As seen in Table 8.2, *knowledge about VM, regular workshop meetings, commitment of participants, early goal definition, experienced VM facilitator, dedicated personnel, and constant communication* achieved strong consensus. This implies that these seven sets of integration strategies have the greatest impact regarding VM. Apart from these seven integration strategies, the remaining 10 integration strategies were ranked highly with median values of 7 and 8. This implies that these 10 strategies have an equal impact on VM performance. The consensus was further measured by inspecting IQD values as seen in Table 8.2. As previously stated, variables with IQD value less than 1 were considered to have high agreement and consensus among the experts. All 17 satisfies these criteria; hence consensus was fully achieved in the second round.

8.3.1.2 STANDARDISATION - To examine the impact of standardisation on the performance of VM in the Nigerian construction industry.

In the initial round of the Delphi process, a total of 10 standardization variables were identified based on the literature review. Experts were tasked with assessing the impact of each of these variables on VM performance within the Nigerian construction industry. To rate the significance of these variables, a 10-point Likert scale was employed, ranging from 'no impact' (assigned a low weighting of 1 and 2) to 'very high impact' (assigned the highest weighting of 9 and 10). It's noteworthy that no new variables were introduced during the first round, and consensus was ultimately reached after the second round of the Delphi process, as indicated in Table 8.3. This suggests that experts arrived at a collective agreement regarding the importance of these standardization variables in influencing VM performance within the Nigerian construction sector.

Table 8.3: Impact of Standardisation Factors on VM Performance

Codes	Standardisation	Median (M)	Mean (\bar{x})	SD (σ_X)	IQD
ST1	Input of government and its agencies	9	8.85	1.13	0.50
ST2	Mandatory VM training certification for all construction professionals	9	8.10	1.24	0.50
ST3	Presence of VM policies and legal framework	9	8.34	0.78	0.00
ST4	Government commitment to implement VM	8	7.85	1.10	0.50
ST5	VM action plan for implementation	8	8.25	1.48	0.50
ST6	Inclusion of VM clause in procurement Act	8	8.15	0.49	0.50
ST7	Attendance of policymakers on constant basis	8	7.36	0.53	0.00
ST8	Presence of rule that encourage VM application	7	6.35	1.26	0.50

ST9	Collaboration of government officials and professional bodies	7	6.17	1.89	0.50
ST10	Regulation of VM activities	8	7.60	1.56	0.50
ST11	Customizing VM for the Nigerian construction industry	9	8.12	1.75	0.00
ST12	Active client's support and participation	8	8.53	1.34	0.00

M = Median; \bar{x} = Mean; σX = Standard deviation; IQD = Interquartile deviation

As seen in Table 8.3, *Input of government and its agencies, Mandatory VM training certification for all construction professionals, Presence of VM guidelines and legal framework, and Active client's support and participation* all possess a strong median value of 9, indicating very strong consensus. This implies that these variables have a strong impact on VM performance. Aside from this, a total of 4 other variables possessed a strong median value of 8 which also indicates a high impact for VM performance. Consensus was further measured by inspecting IQD values as seen as in Table 8.3. In addition, “collaboration of government officials and professional bodies” and “introduction of VM subject at tertiary institution” and has a good consensus with median value of 7. As previously stated, variables with IQD values less than 1 were considered to have agreement and consensus among experts. All 10 standardisation variables satisfied these criteria; hence consensus was fully achieved after the second round.

8.3.1.3 COLLABORATION - To determine the impact of collaboration on the performance of VM in the Nigerian construction industry.

In the first round of the Delphi process, a total of 14 collaboration factors were identified based on the literature review. Collaboration was recognized as one of the key attributes capable of enhancing VM performance in the Nigerian construction industry. For the purposes of this study, collaboration was defined as a situation where two or more independent construction professionals

work together to plan and execute construction value operations. During this round, experts were asked to assess the impact of collaborative strategies among construction professionals in improving VM performance within the Nigerian construction industry. To rate the significance of these collaborative strategies, a 10-point Likert scale was employed, ranging from 'no impact' (assigned the lowest weighting of 1 and 2) to 'very high impact' (assigned the highest weighting of 9 and 10). This rating scale allowed experts to provide their insights into the importance of collaborative efforts in enhancing VM performance in the Nigerian construction sector. However, one of the experts suggested three additional collaborative strategies, namely “cooperation”, “improved motivation”, and “team building activities”. All the three were included in the second round and experts were requested to rank their level of impact. After the second round, consensus was achieved as shown in Table 8.4.

Table 8.4: Impact of Collaboration Factors on VM Performance

Codes	Collaboration Practices	Median (M)	Mean (\bar{x})	SD (σ_X)	IQD
COL1	Dispute resolution techniques	9	8.15	1.06	0.00
COL2	Partnership	8	7.12	1.83	0.00
COL3	Client’s support and participation	9	8.05	1.43	0.00
COL4	Shared orientation	9	8.75	1.62	0.05
COL5	Information sharing	9	9.21	1.54	0.00
COL6	Equal contribution of participants	8	7.20	1.36	0.00
COL7	Resource sharing	8	7.45	1.91	0.05
COL8	Decision alignment	8	7.54	1.56	0.00
COL9	Teamwork	9	8.75	1.41	0.00
COL10	Knowledge sharing	9	8.05	0.57	0.00

COL11	Interaction among participants in each phase	9	9.35	1.73	0.00
COL12	Group goal setting	9	8.64	0.95	0.00
COL13	Risk sharing	8	7.15	1.90	0.50
COL14	Coordination	9	7.60	1.69	0.00
COL15	Team building activities	9	8.31	0.68	0.00
COL16	Cooperation	9	8.29	1.48	0.00
COL17	Improved motivation	8	7.73	1.55	0.05

M = Median; \bar{x} = Mean; σX = Standard deviation; IQD = Interquartile deviation

As seen in Table 8.4, dispute resolution techniques, client's support and participation, shared orientation, information sharing, teamwork, knowledge sharing, interaction among participants in each phase, improved communication and understanding among stakeholders, group goal setting, human relations among team members, cooperation, and coordination all possess a strong median value of 9, indicating very good consensus. This implies that these factors have the greatest impact on VM performance. Apart from this, a total of 6 other variables possessed a strong median value of 8 which indicates an equal impact on VM performance. Examining IQD values, as shown in Table 8.4, allowed for a further assessment of consensus. As was previously stated, experts were thought to have high agreement and consensus on components with IQD values less than 1. These requirements were met by all 17 of the collaborative variables, hence consensus was entirely reached.

8.3.1.3 DIGITAL TECHNOLOGIES - To determine the level of significance of digital technologies on VM performance in the Nigerian construction industry.

A total of 15 variables were discovered during the first round of the Delphi procedure from the literature research. For professionals to succeed in the Nigerian construction industry, experts must indicate the importance of each element to VM performance. The rating was achieved using a 10-point Likert scale of “no significance, “low significance”, “moderately significance”, “significance” and “very significant”. The lowest weighting (1 and 2) was assigned "no significance," while the greatest weighting was assigned "very significant" (9 and 10). One of the experts, however, proposed the addition of three more elements: Cryptocurrency, Engineering design (Computer-aided design), and Information technology and systems control. The second round contained all three, and experts were asked to rank the significance of each one. Consensus was reached following the second round, as shown in Table 8.5.

Table 8.5: Impact of Digital Technologies on VM Performance

Digital Technologies	Median (M)	Mean (\bar{x})	SD (σ_X)	IQD
Knowledge of artificial intelligence	8	7.60	2.11	0.50
Internet of things (IoT)	9	8.42	1.93	0.00
Building information modelling (BIM)	9	7.95	1.61	0.00
Augmented reality technologies (smart phones, video games, etc.)	8	7.35	1.59	0.00
Mobile devices	8	8.00	1.41	0.00
Digital twin	9	8.20	2.08	0.00
Administrative tools (Microsoft suites, Primavera)	9	8.60	2.11	0.05
Virtual reality (sophisticated headsets, LCD displays, etc.)	8	7.10	1.98	0.00
Knowledge of robotics	8	7.65	1.76	0.00

Knowledge of the use of drones	8	7.45	1.23	0.00
Cloud computing	9	8.65	1.75	0.00
Electronic meeting tools (zoom, Microsoft teams, etc.)	9	8.57	1.56	0.50
Knowledge of cybersecurity	8	7.55	1.64	0.00
Advanced big data analytics	9	7.80	1.67	0.00
Blockchain technology	8	8.15	1.89	0.00
Cryptocurrency	7	7.34	1.19	0.00
Engineering design (Computer-aided design)	9	8.02	1.63	0.00
Information technology and system control	8	7.62	1.55	0.00

M = Median; \bar{x} = Mean; σX = Standard deviation; IQD = Interquartile deviation

As seen in Table 8.5, eight digital technology tools such as Building Information Modelling (BIM), Big Data Analytics, Internet of things (IoT), Additive manufacturing (3D printing), Administrative tools (Microsoft suites, Primavera), Cloud computing, electronic meeting tools (zoom, Microsoft teams, etc.), and Engineering design (Computer-aided design) possesses a strong median value of 9, indicating a very good consensus. This implies that these factors have the greatest significance for VM performance. A strong median value of 8 was also shared by all other criteria, indicating their overall importance for VM performance. Analysis of IQD values, as shown in Table 8.5, allowed for a further assessment of consensus. As was previously mentioned, experts were thought to have high agreement and consensus on components with IQD values less than 1. After the second round, an agreement was totally reached because all 18 digital technologies requirements met these criteria.

8.3.1.4 CORPORATE CULTURE: To determine the impact of corporate culture on the performance of VM in the Nigerian construction industry.

Additionally assessed was the impact of corporate culture variables on VM performance in Nigeria. Literature have acknowledged the problem of corporate culture impacting the performance of VM in construction industries globally. However, there is a dearth of research on how corporate culture affects VM performance, particularly in the context of Nigeria. This survey suggested that the culture of professionals in an organisation has an important role in defining their operations throughout the construction process. Considering the assertion above, it is also true that examining corporate culture can be done on a variety of scales. Given the foregoing, it is necessary to investigate how corporate culture variables affect the performance of VM in Nigeria. According to this study, corporate culture is the common fundamental presumption that a stakeholder in a construction project has learned to use while trying to solve problems and has proven to be effective. Clan, adhocracy, hierarchy, and market culture are the dimensions this study uses to categorise corporate culture. Table 8.6 below shows the impact of corporate culture dimensions on VM performance.

Table 8.6: Impact of Corporate Culture on VM Performance

Corporate Culture	Median (M)	Mean (\bar{x})	SD (σ_X)	IQD
Clan culture				
Interpersonal relationship	9	8.20	1.64	0.00
Teamwork	9	8.25	1.65	0.00
Management commitment	8	7.75	1.77	0.50
Continuous improvement	8	8.75	1.41	0.00
Cooperation among stakeholders	8	7.65	1.56	0.00
Participants satisfaction	5	8.45	1.15	0.05

Motivation	9	8.05	1.61	0.00
Regular communication	9	8.30	1.30	0.00
Education and Training	6	7.60	1.90	0.00
Skill development and acquisition	8	8.05	2.26	0.00
Adhocracy culture				
Risk management	8	8.05	1.70	1.50
Reward and incentive system	8	7.50	2.12	0.00
Entrepreneurial development	7	7.55	1.54	0.00
Creativity orientation	7	7.25	1.59	0.00
Updated technology system	9	8.15	1.76	0.00
Growth and development	8	7.90	1.68	0.50
Availability of new resources	8	7.55	2.28	0.00
High degree of flexibility	8	7.75	1.55	0.00
Hierarchy culture				
Regulation of VM activities	8	7.31	1.84	0.00
Assertion of policy within the value chain	8	7.54	1.61	0.00
Control of other construction professionals`	9	8.57	1.28	0.00
Efficiency among construction professionals	8	7.20	1.69	0.00
Prediction of stakeholder's activity within the organisation	8	7.35	1.81	0.00
Meeting targets with adherence to schedule	8	8.10	1.48	0.00
Smooth operation of VM activities	8	7.65	1.60	0.00
Market culture				
Goal accomplishment	7	7.95	1.32	0.00
Result oriented	9	8.32	0.39	0.00
Client satisfaction	8	7.90	1.86	0.00
Competition among construction stakeholders	6	6.65	0.93	0.50
Ensures large market size	7	7.30	0.56	0.50

Focus on achievement irrespective of another stakeholders' opinion	7	7.75	1.80	0.00
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M = Median; \bar{x} = Mean; σX = Standard deviation; IQD = Interquartile deviation

The experts' comments on the impact of the corporate culture dimension on the effectiveness of VM are analyzed in Table 8.6. The above-described features were taken from the literature research and divided into four categories: clan, adhocracy, hierarchy, and market. Table 8.6 demonstrates that all organisational dimensions were agreed upon. Interpersonal relationship, teamwork, continuous improvement, motivation, and regular communication were the sole element that the experts mentioned had a very high impact on the performance of VM in terms of the clan cultural dimension. The expert also rated management commitment, continuous improvement, cooperation among stakeholders, skill development and acquisition as having a high impact on VM performance whereas participants' satisfaction and education and training were considered to have a medium impact on the performance of VM.

Regarding adhocracy culture, Table 8.6 revealed that updated technology system was considered as having a very high impact on the performance of VM. With an IQD of 0.00 and a median score of 9, the table showed that there was a high consensus among the experts about updated technology system. According to research on adhocracy culture, a stakeholder who adopted it would be motivated to develop a novel strategy and creating an updated technological system for VM. Table 8.6 further demonstrates that variables with a median and mean score between 7 and 8 are considered to have a high impact and this includes, risk management, reward and incentive system, entrepreneurial development, creativity orientation, growth and development, and availability of new resources.

The analysis of hierarchy culture in Table 8.6 showed that all the factors influencing the culture was agreed upon. However, the experts evaluated “control of other construction professionals” as having a very high impact ($M = 9$, $\bar{x} = 8.50$, $\sigma_X = 1.28$) on the performance of VM. This suggests that those involved in the adoption of a hierarchy culture are motivated by a desire to exert control over VM operations. It can also be said that managing VM in the Nigerian built environment requires having a central point of authority and control. Variables like regulation of VM activities, assertion of policy within the value chain, efficiency among construction professionals, prediction, prediction of stakeholder’s activity within the organisation, meeting targets with adherence to schedule, and smooth operation of VM activities were also classified by experts to have a high impact on the performance of VM. However, efficiency among construction professionals has a mean score of 7.20 and median of 7 signifying a good impact on the performance of VM.

The impact of market culture-supporting variables on the effectiveness of VM in Nigeria is shown in Table 8.6. Having previously defined market culture as the culture that is focused with client satisfaction without taking the principles within the industry into account. The experts' consensus that results-oriented and client’s satisfaction had a very high impact on VM performance ($M = 9$, $\bar{x} = 8.32$, $\sigma_X = 0.39$, and $M = 8$, $\bar{x} = 7.90$, $\sigma_X = 0.56$). This suggests that those involved in the adoption of hierarchy culture are motivated by the desire to exert control over VM operations. Additionally, it may be said that effective VM operations will depends on having a central authority figure who will monitor the process of VM practices. Other variables such as goal accomplishment, client satisfaction, ensures large market size, and focus on achievement irrespective of another stakeholders’ opinion were rated as having a high impact on the performance of VM practices. Meanwhile, competition among construction workers was rated to having a medium impact on the performance of VM.

8.4 INFERENCE STATISTICAL ANALYSIS OF FIELD DATA

8.4.1 Partial least squares - Structural equation modelling (PLS-SEM)

PLS-SEM was adopted in this research to test the significance and total effects of collaboration, integration, standardisation, digital technologies, and corporate culture on improved VM performance and consequently, develop a VM performance model (dependent variables). After the conclusion of the descriptive statistics, the coded data was exported to PLS-SEM using the SmartPLS 4 software for inferential analysis. The PLS-SEM method can analyse both reflective and formative measurement models efficiently and effectively. The VM performance model for this study consists of both reflective and formative indicators. The five latent constructs (exogenous variables) of collaboration, integration, standardisation, digital technologies, and corporate culture are all reflective indicators. However, the combination of these exogenous variables forms the model (endogenous variables) which is a formative indicator.

8.4.1.1 First PLS-SEM iteration

After the conclusion of the descriptive statistics, the coded data was exported to the PLS-SEM environment for analysis using the SmartPLS 4 software (Hair *et al.* 2019). After the initial process of arranging the various measurement constructs with their appending latent constructs and dependent construct, a proposed VM performance model from PLS-SEM was produced as shown in Figure 8.1. Subsequently, the first iteration was conducted which produced the outer loadings and the path coefficients as shown in Figure 8.2. The measurement or outer model evaluation was carried in the first iteration to examine the reliabilities, consistencies, and validities of the variables within the model (confirmatory factor analysis). The summary of the CFA (factor loadings, consistencies, and validities) is shown in Table 8.3. The first check is the internal consistency reliability which is determined by the Cronbach's alpha and composite reliability (CR) (which both

have similar values). Cronbach's alpha values of 0.70 and above are considered acceptable. Similarly, Hair, Ringle and Sarstedt (2013) suggested a value of 0.70 and above as an acceptable composite reliability value. Generally, the higher the values, the higher the reliability levels.

However, the ρ_A which usually lies between the Cronbach's alpha and CR has been considered as an exact measure of construct reliability (Dijkstra and Henseler 2015). As shown in Table 8.3, the latent variables all recorded high-reliability levels during the first iteration. Next was the validity checks (both convergent and discriminant). For the convergent validity, the average variance extracted (AVE) values of 0.5 and above are considered satisfactory. After the first iteration, all had AVE values of 0.333, 0.357, 0.251, 0.367, 0.354 and 0.358 respectively which were below the 0.5 threshold as shown in Table 8.3. The next step is to examine the discriminant validity. For distinct constructs, a threshold value of 0.85 and below is acceptable (Henseler, Ringle and Sarstedt 2015).

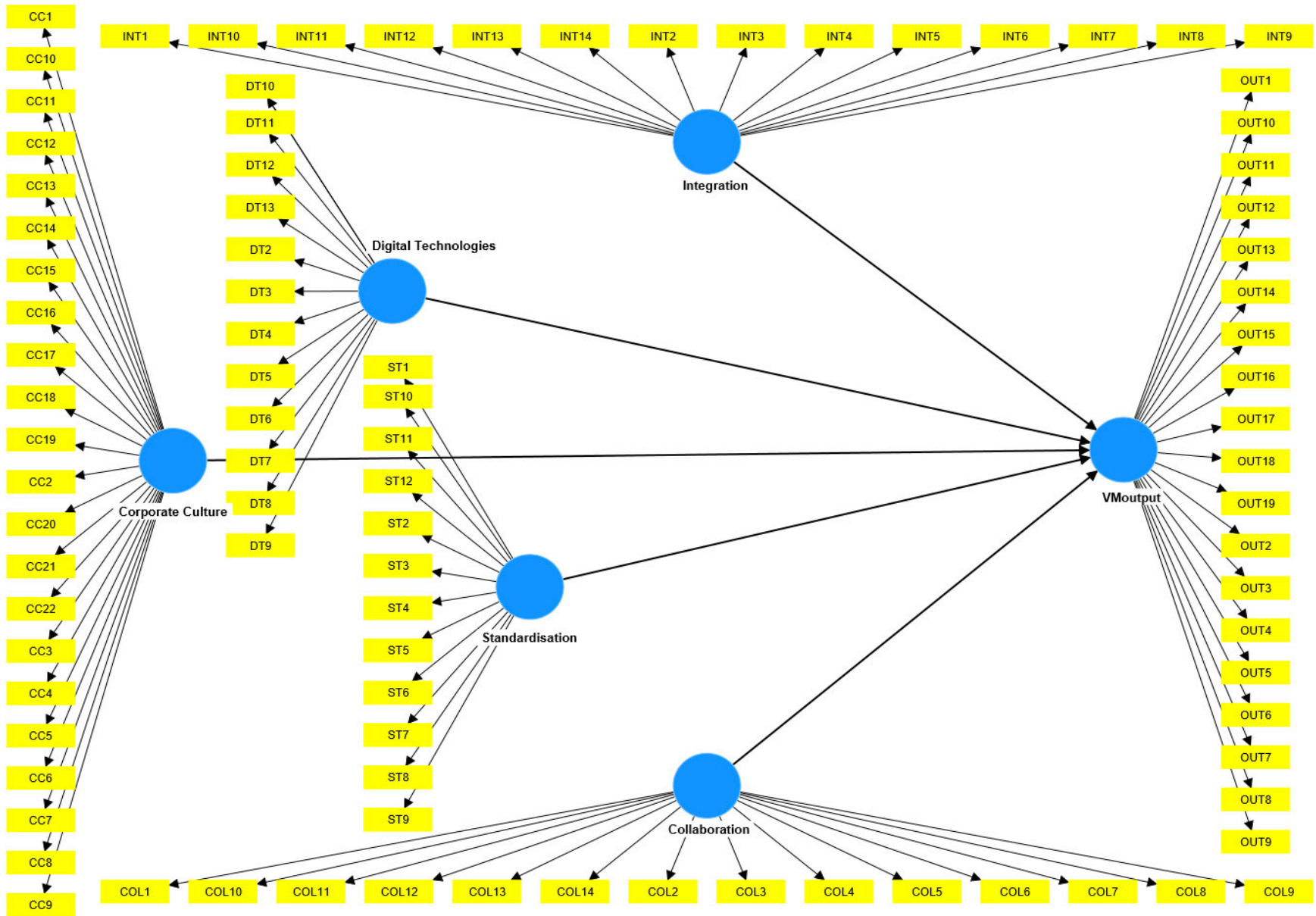


Figure 8.1: Proposed VM performance model from PLS-SEM

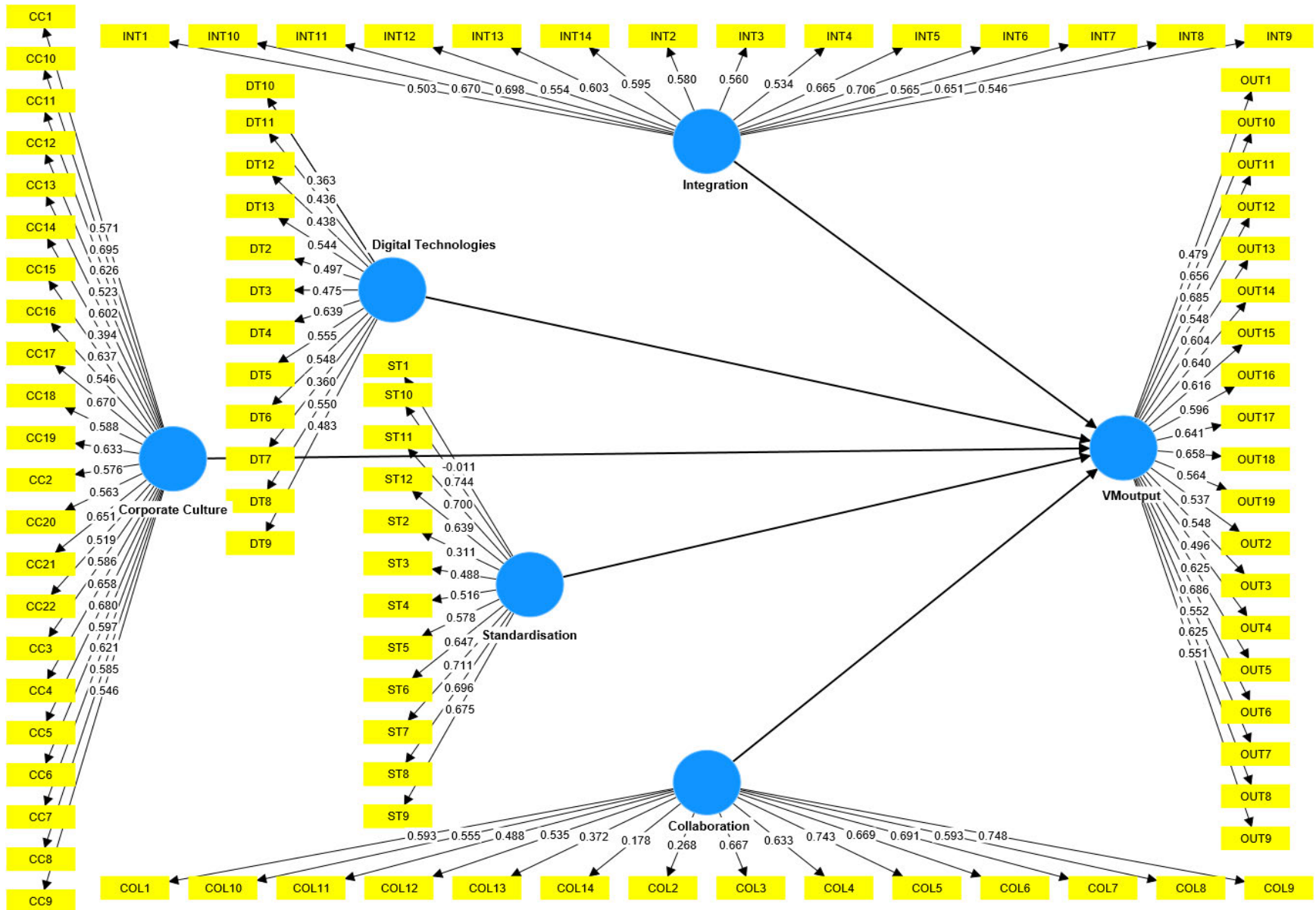


Figure 8.2: PLS-SEM model after first iteration

Table 8.7: First iteration results for the measurement model (CFA)

Latent Variable Constructs	Coding	Measurement Variables	Factor loadings	pA	Cronbach Alpha	Composite reliability	AVE	VIF
Integration	INT1	Knowledge about VM	0.503	0.870	0.865	0.889	0.367	1.363
	INT10	Enough time to conduct VM studies	0.670					1.801
	INT11	Open information system	0.698					1.699
	INT12	Prompt response among professionals during VM meetings	0.554					1.432
	INT13	Equal contribution of participants	0.603					1.460
	INT14	Constant communication	0.595					1.417
	INT2	Regular workshop meetings	0.580					1.464
	INT3	Communication of participants	0.560					1.429
	INT4	Early goal definition	0.534					1.471
	INT5	Clear objectives of workshop	0.665					1.634
	INT6	Experienced VM facilitator	0.706					1.831
	INT7	Availability of resources	0.565					1.464
	INT8	Accelerated decision-making	0.651					1.618
	INT9	Efficient ideas and alternatives gathered in early stage	0.546					1.388
Standardisation	ST1	Input of government and its agencies	-0.011	0.854	0.830	0.852	0.354	1.091
	ST10	Active client's support and participation	0.744					1.672
	ST11	VM action plan for implementation	0.700					1.595
	ST12	Clients' capacity to convey demands to the design team	0.639					1.483

	ST2	Mandatory VM training certification for all construction professionals	0.311					1.336
	ST3	Presence of VM guidelines and legal framework	0.488					1.378
	ST4	Government commitment to implement VM	0.516					1.534
	ST5	Inclusion of VM clause in procurement act	0.578					1.645
	ST6	Attendance of policymakers on constant basis	0.647					1.691
	ST7	Regulation of VM activities	0.711					1.802
	ST8	Collaboration of government officials and professional bodies	0.696					1.784
	ST9	Customising VM for the Nigerian construction industry	0.675					1.711
Collaboration	COL1	Information Sharing	0.593	0.792	0.853	0.865	0.333	1.677
	COL10	Dispute resolution techniques	0.555					1.497
	COL11	Client's support and participation	0.488					1.460
	COL12	Group goal setting	0.535					1.532
	COL13	Risk sharing	0.372					1.327
	COL14	Cooperation	0.178					1.162
	COL2	Resource sharing	0.268					1.495
	COL3	Partnership	0.667					2.151
	COL4	Decision alignment	0.633					1.619
	COL5	Teamwork	0.743					1.820
	COL6	Knowledge sharing	0.669					1.762

	COL7	Shared orientation	0.691					2.247
	COL8	Coordination	0.593					1.923
	COL9	Interaction among participants in each phase	0.748					2.042
Digital Technologies	DT1	Internet of Things (IoT)	0.363	0.741	0.761	0.810	0.251	1.566
	DT10	Electronic meeting tools	0.552					1.701
	DT11	Knowledge of cybersecurity	0.436					1.723
	DT12	Advanced big data analytics	0.438					1.632
	DT13	Engineering design	0.544					1.481
	DT2	Building Information Modelling	0.497					1.457
	DT3	Augmented reality technologies	0.475					1.635
	DT4	Mobile devices	0.639					1.528
	DT5	Digital twin	0.555					1.651
	DT6	Knowledge of administrative tools	0.548					1.658
	DT7	Virtual reality	0.360					1.635
	DT8	Cloud computing	0.550					1.648
	DT9	Blockchain technology	0.483					1.999
Corporate Culture	CC1	Interpersonal relationship	0.571	0.893	0.920	0.924	0.357	1.617
	CC10	Creativity orientation	0.695					1.883
	CC11	Innovativeness	0.626					2.003
	CC12	Updated technological system	0.523					1.914
	CC13	High degree of flexibility	0.602					1.765
	CC14	Regulation of VM activities	0.394					1.654
	CC15	Assertion of policy within the value chain	0.637					2.224

	CC16	Control of other construction professionals	0.546					1.735
	CC17	Smooth operation of VM activities	0.670					2.097
	CC18	Meeting targets with adherence to schedule	0.588					1.800
	CC20	Result oriented	0.563					2.274
	CC2	Teamwork	0.576					1.461
	CC19	Client satisfaction	0.633					1.915
	CC21	Goal accomplishment	0.651					2.029
	CC22	Ensuring large market size	0.519					1.620
	CC3	Management commitment	0.586					1.576
	CC4	Cooperation among stakeholders	0.658					1.885
	CC5	Motivation	0.680					1.817
	CC6	Education and Training	0.597					1.673
	CC7	Skill development and acquisition	0.621					1.700
	CC8	Risk management	0.585					1.825
	CC9	Reward and incentive system	0.546					1.687
VM _{Output}	OUT1	Cost saving practice	0.479	0.902	0.899	0.913	0.358	1.405
	OUT10	Improved project management	0.656					1.869
	OUT11	Elimination of delay	0.685					1.816
	OUT12	Efficient project delivery	0.548					1.463
	OUT13	Better quality system and performance	0.604					1.512
	OUT14	Innovative designs	0.640					1.862
	OUT15	Optimisation of value	0.616					2.050

	OUT16	Increased efficiency in achieving tasks	0.596					1.840
	OUT17	Better collaboration among professionals	0.641					1.833
	OUT18	Enhanced project functionality	0.658					1.884
	OUT19	Sustainability	0.564					1.576
	OUT2	Material management	0.537					1.515
	OUT3	Time management	0.548					1.491
	OUT4	Risk management	0.496					1.498
	OUT5	Whole life asset management	0.625					1.699
	OUT6	Conflict management	0.686					1.888
	OUT7	Long-term planning	0.552					1.484
	OUT8	Quality management system	0.625					1.637
	OUT9	Waste reduction	0.551					1.488

8.4.1.1.1 Evaluation of the inner structural model

The inner structural model is evaluated in this section using the standard assessment criteria as stipulated by Hair *et al.* (2019). The criteria used for evaluating the inner structural model include examining the coefficient determination of R^2 , the goodness-of-fit for the model, and the blindfolding cross-validated redundancy measure (Q^2). Also examined was the predictive power of the model using PLS predict procedure.

Determining the value of R^2

To check for collinearity issues, the variance inflation factor (VIF) should be ≤ 3 or < 3 (Hair, Ringle and Sarstedt 2011). As depicted in Table 10.3, all VIF values are below 3, which indicates no collinearity problems in the constructs. The next check is the R^2 which shows the degree of explained variance of the endogenous latent variables. It has been found that for a good model, the R^2 value of the endogenous variable should be above 0.26 (Raithel *et al.* 2012). For the first iteration, the R^2 value of the endogenous variable is 0.956 as shown in Table 10.7. This implies that the 5 latent variables explain 95.6% of the variance in improved VM performance.

Quality of the PLS model (Q^2)

The next step is to assess the absolute model fit using the model's predictive accuracy Q^2 , root mean squared error (RMSE) and the overall goodness of fit (Goffnett). According to Danks and Ray (2018) and Shmueli *et al.* (2019), for the model's predictive accuracy, Q^2 values > 0 are satisfactory. This was achieved by conducting a blindfolding procedure. High predictive accuracy (Q^2) is achieved when there are considerably small differences between the original values and the predicted values (Hair, Sarstedt and Ringle 2019). For an endogenous construct to demonstrate the predictive accuracy of the structural model, Q^2 values are required to be larger than zero (0). This is shown in Table 8.8.

Table 8.8: Predictive relevance of the PLS path model for the first model

	SSO	SSE	Q² (=1-SSE/SSO)
Integration	3277.000	3277.000	
Collaboration	4180.000	4180.000	
Standardisation	2570.000	2570.000	
Digital Technologies	4261.000	4261.000	
Corporate Culture	3296.000	3296.000	
VM Performance	3160.000	2675.412	0.416

Table 8.8 shows that Q^2 yields a value of 0.416 which is greater than zero. This therefore confirms that the model has predictive power to determine the endogenous variable. According to Hair Jr and Sarstedt (2019), a Q^2 value higher than 0.02, 0.15 and 0.35 reflects small, medium, and large predictive power of the PLS path model respectively. Since the value of Q^2 for this study is 0.416, it is sufficient to affirm that the model has a medium predictive power.

8.4.1.1.2 Standardised root mean square residual (SRMR)

The next step is to assess the model fits, and this was achieved by adopting two fit indices criteria, namely, approximate model fit, and absolute model fit. The approximate model fit was determined by using the standardised root mean square residual (SRMR) and the norm fit index (NFI). For a model to be considered as a good fit in PLS-SEM, an SRMR value < 0.08 is required (Shmueli *et al.* 2019). The findings from the analysis extracted from the SmartPLS program regarding SRMR are presented in Table 8.9. After the first iteration, an SRMR value of 0.101 was recorded which was > 0.08 ; hence not satisfactory, whereas the chi-square was equal to 7517.446. Furthermore, NFI values should range between 0 and 1 and values closer to 1 signify a good fit, while values between 0.6 and 1.0 can also be considered (Hair *et al.* 2017). After the first iteration, an NFI value of 0.324 was attained.

Table 8.9: Model fit for the first model.

	Estimated Model
SRMR	0.101
d_ULS	43.825
d_G	9.568
Chi-square	7517.446
NFI	0.324

The next step is to assess the absolute model fit using the model's predictive accuracy Q^2 , root mean squared error (RMSE) and the overall goodness of fit (Goffnett). For the model's predictive accuracy, Q^2 values > 0 are satisfactory (Shmueli *et al.* 2019). This was achieved by conducting a blindfolding procedure. High predictive accuracy (Q^2) is achieved when there are considerably small differences between the original values and the predicted values (Hair Jr and Sarstedt 2019) which are obtained in Table 8.8. For an endogenous construct to demonstrate the predictive accuracy of the structural model, Q^2 values are required to be larger than zero (0). This is shown in Table 8.10.

Predictive capacity of the model

The SmartPLS predict function was used in assessing the predictive capacity of the model. The predictive capacity was used to verify the usefulness of the model in future after adding a new construct to the model. The technique used in calculating the predictive capacity has been explained sufficiently in the previous section.

Table 8.10: Comparing RMSE values via PLSpredict

	PLS – SEM values	LM values	LM – PLS SEM	
Outcomes	RMSE	RMSE	Difference	Predictive Power
OUT1	1.011	1.305	0.294	High
OUT10	1.046	1.449	0.453	High
OUT11	1.058	1.304	0.246	High
OUT12	0.972	1.374	0.402	High
OUT13	1.080	1.472	0.392	High
OUT14	1.154	1.662	0.508	High
OUT15	1.178	1.658	0.480	High
OUT16	1.118	1.396	0.278	High
OUT17	1.118	1.461	0.343	High
OUT18	1.188	1.585	0.397	High
OUT2	0.963	1.249	0.286	High
OUT3	1.094	1.507	0.413	High
OUT4	1.073	1.380	0.307	High
OUT5	1.017	1.255	0.238	High
OUT6	1.030	1.292	0.262	High
OUT7	1.090	1.418	0.328	High
OUT8	1.061	1.424	0.363	High
OUT9	1.092	1.389	0.297	High

After the first iteration, the hypothesised model has a high predictive power because none of the indicators in the PLS-SEM analysis has higher RMSE values as against the LM values (Hair Jr and Sarstedt 2019). The conditions for the model's predictive power are explained in detail in Chapter 7.

8.4.1.1.3 Goodness of fit index

In evaluating the overall predictive power of the model (including the performance of both outer and inner models), this study adopts a global criterion of GoF to examine the overall model fit (GoF index) as proposed by Henseler and Sarstedt (2013). According to Henseler and Sarstedt (2013), the GoF index is described “...as the geometric mean of the average communality index and the average R² value”. According to Akter, D'ambra and Ray (2011), for global validation of the PLS model, 0.1 is considered a low GoF value, 0.25 is regarded as a medium value while a threshold value of 0.36 is acceptable for large effect sizes of GoF. Akter, D'ambra and Ray (2011) also proposed an equation to calculate GoF. Henseler and Sarstedt (2013) also mentioned that a GOF value must have a value between 0 and 1 where values of 0.10 (Al-Mutairi *et al.*), 0.25 (medium) and 0.36 are regarded as large. The AVE of the various constructs is computed alongside the R² from the endogenous construct as seen in Table 8.11.

$$\text{GOF} = \sqrt{\text{Average AVE} * \text{R}^2}$$

Table 8.11: Goodness of fit index for the first model

Construct	AVE	R²
Integration	0.367	
Collaboration	0.354	
Standardisation	0.333	
Digital technologies	0.251	
Corporate culture	0.357	
VM performance	0.358	0.956
Total	2.02	
Average score	0.337	

$$\text{AVE} = (0.367 + 0.354 + 0.333 + 0.251 + 0.357 + 0.358) / 6 = 0.337$$

$$\text{R}^2 = 0.956$$

$$GoF = \sqrt{0.337 \times 0.956}$$

$$GoF = \sqrt{0.317} = 0.568$$

The GOF index for the model yielded a value of 0.568 which indicates that the empirical data fits the model satisfactorily.

8.4.1.1.4 Summary of first model iteration and motivation for developing the second model

Towards arriving at a best-fit model measuring the performance of VM, a first model is developed in this section. The findings from the first model development show that the model has some shortcomings. The shortcomings are presented in Table 8.12, For instance, outer loadings indicated that some loadings have values below 0.6 and will thus be eliminated. The model also lacks predictive power and the SRMR value was more than 0.08. In addition, the discriminant validity could only pass through cross-loading and did not support the Fornell-Larcker criterion. According to Shanmugapriya and Subramanian (2015), the discriminant validity test should be able to pass through cross-loadings and the Fornell-Larcker test. This shortcoming created the need for developing a second model.

Table 8.12: Summary of the first model fit indices

Fit indices	Standard value	First model value	Remarks
Outer loadings	All values should be above threshold of 0.50 according to Amora (2021) and Yim (2019)	Some values fall below the threshold of 0.5	Not satisfactory
AVE	The AVE number must be 0.5 or higher (Dash and Paul 2021)	Values are lower than 0.5	Not satisfactory
Composite reliability	Between 0.70 to 0.95 (Hair Jr and Sarstedt 2019)	Above 0.70	Satisfactory
Cronbach alpha	Cronbach Alpha should be above 0.6 (Hair <i>et al.</i> 2017)	Above 0.80	Satisfactory

Rho_A	Rho coefficient should be between 0 to 1.00 (Hair <i>et al.</i> 2012; Hair Jr, Howard and Nitzl 2020)	Above 0.902	Satisfactory
VIF	The multicollinearity value for the study should not be above 3 (Hair Jr and Sarstedt 2019)	Below 3	Satisfactory
Co-efficient of R ²	Hair Jr and Sarstedt (2019) reported that an R ² of above 0.7 can be deemed substantial and adequate	0.956	Adequate
Quality of path model Q ²	Q ² greater than zero means that the model has a predictive power whereas a value less than zero means that the model has low predictive power (Hair Jr and Sarstedt 2019; Sarstedt, Ringle and Hair 2021)	0.416	Adequate
Predictive capacity of model RMSE	According to Hair, Sarstedt and Ringle (2019), Purwanto and Sudargini (2021), and Shmueli <i>et al.</i> (2019), the predictive power of the model is based on the following: <ul style="list-style-type: none"> • If the RMSE in the PLS predict is more than the LM benchmark for all the variables, then the Minority of RMSE of 	All RMSE of the PLS predict is lower than LM benchmark.	Model has medium predictive power.

	<p>PLS predict > LM benchmark Model has medium predictive power 451 model has no predictive power.</p> <ul style="list-style-type: none"> • If the majority of the prediction errors (RMSE) in the PLS predict are more than the LM benchmark, it means that the model has low predictive power. • If a minority of the prediction errors (RMSE) in the PLS predict are more than the LM benchmark, it means that the model has medium predictive power. • If none of the prediction errors (RMSE) in the PLS predict are more than the LM benchmark, it means that the model has high predictive power. 		
Goodness of fit	The GOF must have a value between 0 and 1 where values of 0.10 (Al-Mutairi <i>et al.</i>), 0.25 (medium) and 0.36 are regarded as	0..568	Satisfactory

	large (Purwanto and Sudargini 2021)		
Standard root mean square residual (SRMR)	The value of SRMR should be below 0.08 and a lower SRMR indicates better fit (Hussain <i>et al.</i> 2018).	0.101	Not satisfactory
Norm fit index (NFI)	The closer the value of NFI to 1, the better fit	0.324	Not fit

8.4.1.2 Second PLS-SEM iteration

This section presents the analysis of the second model development or the second iteration towards achieving the best fit model. Similar to the first model development, the first step of the analysis was evaluating the outer measurement of the model that is made up of the internal consistency, followed by the discriminant validity and evaluating the inner structural model.

8.4.1.2.1 Second iteration results for the measurement model (CFA)

The result in Table 8.12 presents the findings from the internal consistency reliability for the second model. The table shows that some indicators with loadings below 0.5 have been eliminated from the model. The construct ‘internal reliability’ and ‘validity’ that are broken down into Cronbach’s alpha, composite reliability and Rho are presented in Table 8.7. Based on the first iteration, constructs with loading values of below 0.50 were eliminated. This is based on the considerations of Amora (2021) and Yim (2019) who stated that loading values of 0.50 are highly recommended. Subsequently, the second iteration was conducted which produced the new outer loadings and the new path coefficients as shown in Figure 8.3 and Table 8.13. The following collaboration variables were eliminated as they fell below the 0.50 thresholds: COL11 (clients support and participation) with 0.488, COL13 (risk sharing) with 0.372, COL14 (cooperation) with 0.178, and COL2 (resource sharing) with 0.268. For integration variables, INT1 (availability of resources) with 0.403 and INT3 with (communication of

participants) were eliminated. Also, for standardisation variables, ST1 (clients' capacity to convey demands to the design team) with negative 0.011, ST2 (mandatory VM training certification for all construction professionals) with 0.311, and ST3 (customizing VM for the Nigerian construction industry) with 0.488 were eliminated. In addition, DT1 (electronic meeting tools) with 0.363, DT2 (knowledge of cybersecurity) with 0.436, DT3 (engineering design) with 0.438, DT7 (augmented reality technologies) with 0.497, DT9 (digital twin) with 0.475, DT11 (virtual reality) with 0.360, and DT9 (blockchain technology) with 0.483 were also eliminated in digital technologies variables. For VM performance output, OUT1 (increased efficiency in achieving tasks) with 0.479, and OUT4 (risk management) with 0.496. All the variables eliminated did not meet the threshold.

Table 8.13: Internal consistency reliability and validity for the second model

Latent Variable Constructs	Coding	Measurement Variables	Factor loadings	pA	Cronbach Alpha	Composite reliability	AVE	VIF
Integration	INT10	Enough time to conduct VM studies	0.687	0.860	0.854	0.882	0.387	1.788
	INT11	Prompt response among professionals during VM meetings	0.706					1.692
	INT12	Open information system	0.568					1.416
	INT13	Equal contribution of participants	0.623					1.457
	INT14	Constant communication among participants	0.616					1.413
	INT2	Regular workshop meetings	0.557					1.364
	INT4	Early goal definition	0.502					1.373
	INT5	Clear objectives of workshop	0.664					1.559
	INT6	Experienced VM facilitator	0.706					1.802
	INT7	Knowledge of VM	0.577					1.448
	INT8	Accelerated decision-making	0.654					1.601
INT9	Efficient ideas and alternatives gathered in early stage	0.564	1.383					
Stsandardisation	ST10	Government commitment to implement VM	0.741	0.865	0.845	0.874	0.438	1.601
	ST11	VM action plan for implementation	0.715					1.573

	ST12	Input of government and its agencies	0.648					1.476
	ST4	Active client's support and participation	0.503					1.297
	ST5	Attendance of policymakers on constant basis	0.577					1.578
	ST6	Inclusion of VM clause in procurement act	0.636					1.659
	ST7	Regulation of VM activities	0.722					1.751
	ST8	Collaboration of government officials and professional bodies	0.693					1.742
	ST9	Presence of VM guidelines and legal framework	0.686					1.618
Collaboration	COL1	Information Sharing	0.623	0.878	0.872	0.890	0.450	1.613
	COL10	Dispute resolution techniques	0.600					1.384
	COL12	Group goal setting	0.501					1.311
	COL3	Partnership	0.703					2.023
	COL4	Decision alignment	0.659					1.606
	COL5	Teamwork	0.769					1.764
	COL6	Knowledge sharing	0.714					1.650
	COL7	Shared orientation	0.739					2.163
	COL8	Coordination	0.620					1.827
	COL9	Interaction among participants in each phase	0.735					1.826
	DT10	Internet of Things (IoT)	0.692	0.687	0.686	0.792	0.391	1.500

Digital technologies	DT13	Building Information Modelling	0.655					1.411
	DT4	Cloud computing	0.696					1.471
	DT5	Advanced big data analytics	0.631					1.384
	DT6	Knowledge of administrative tools	0.527					1.509
	DT8	Mobile devices	0.526					1.366
Corporate Culture	CC1	Interpersonal relationship	0.570	0.907	0.919	0.925	0.370	1.617
	CC10	Creativity orientation	0.693					1.883
	CC11	Innovativeness	0.640					1.965
	CC12	Updated technological system	0.541					1.732
	CC13	Management commitment	0.607					1.750
	CC15	Teamwork	0.645					2.164
	CC16	Control of other construction professionals	0.545					1.726
	CC17	Smooth operation of VM activities	0.674					2.091
	CC18	Meeting targets with adherence to schedule	0.588					1.791
	CC19	Result oriented	0.639					2.274
	CC2	Assertion of policy within the value chain	0.567					1.461
	CC20	Client satisfaction	0.569					1.911
	CC21	Goal accomplishment	0.651					1.995
	CC22	Ensuring large market size	0.523					1.575
	CC3	High degree of flexibility	0.579					1.566
CC4	Cooperation among stakeholders	0.655	1.885					

	CC5	Motivation	0.674					1.816
	CC6	Education and Training	0.604					1.652
	CC7	Reward and incentive system	0.627					1.700
	CC8	Risk management	0.594					1.820
	CC9	Skill development and acquisition	0.555					1.687
VMoutput	OUT10	Improved project management	0.677	0.899	0.896	0.911	0.378	1.869
	OUT11	Elimination of delay	0.688					1.816
	OUT12	Better collaboration among professionals	0.563					1.463
	OUT13	Time management	0.614					1.512
	OUT14	Innovative designs	0.659					1.862
	OUT15	Optimisation of value	0.619					2.050
	OUT16	Cost saving practices	0.606					1.840
	OUT17	Efficient project delivery	0.660					1.833
	OUT18	Enhanced project functionality	0.675					1.884
	OUT19	Sustainability	0.581					1.576
	OUT2	Whole life asset management	0.517					1.515
	OUT3	Better quality system and performance	0.534					1.491
	OUT5	Material management	0.626					1.699
	OUT6	Conflict management	0.676					1.888
	OUT7	Long-term planning	0.546					1.484
	OUT8	Quality management system	0.609					1.637
	OUT9	Risk management	0.560					1.488

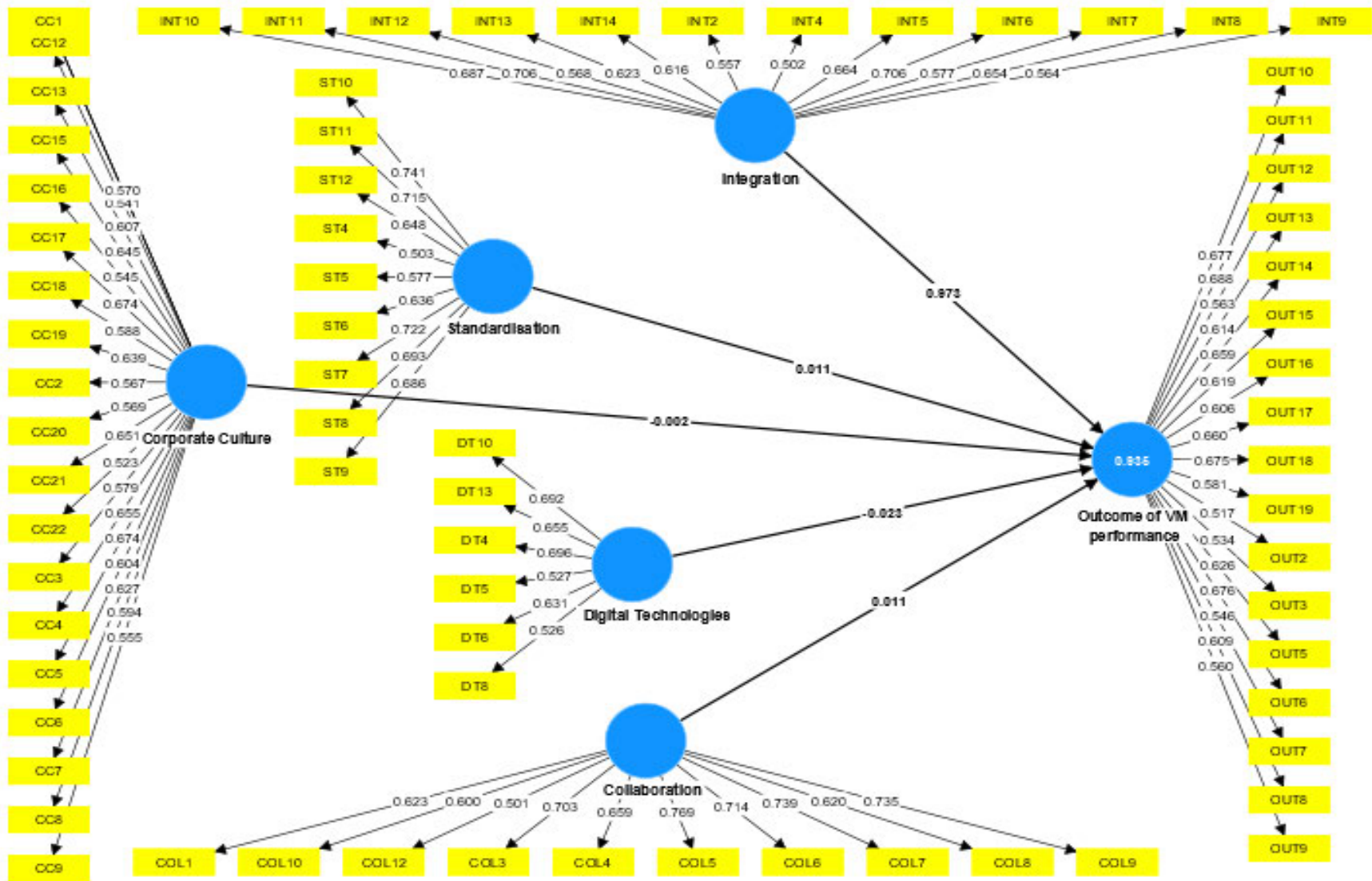


Figure 8.3: PLS-SEM model after second iteration

8.4.1.2.2 Discriminant validity of the second model

The discriminant validity test was also conducted for the second model in showing that the indicators for each construct are different from the indicators of other constructs in the path model. The cross-loading of each construct was used in testing the discriminant validity and the outcome is presented in Table 8.14. The use of cross-loadings for verifying discriminant validity was also used in literature such as that by Henseler, Ringle and Sarstedt (2015), Hussain *et al.* (2018), and Purwanto and Sudargini (2021).

Table 8.14: Discriminant validity test for the second model using cross-loading.

	Collaboration	Corporate Culture	Digital Technologies	Integration	Outcome of VM Performance	Standardisation
CC1	0.426	0.570	0.230	0.118	0.121	0.365
CC10	0.496	0.693	0.276	0.224	0.236	0.485
CC11	0.517	0.640	0.092	0.099	0.108	0.472
CC12	0.521	0.541	0.071	-0.004	-0.001	0.431
CC13	0.523	0.607	0.062	0.035	0.025	0.417
CC15	0.403	0.645	0.031	0.089	0.090	0.482
CC16	0.459	0.545	0.025	0.119	0.112	0.471
CC17	0.569	0.674	0.092	0.215	0.228	0.512
CC18	0.414	0.588	0.049	0.149	0.152	0.390
CC19	0.430	0.639	0.092	0.059	0.056	0.437
CC2	0.424	0.567	0.215	0.165	0.150	0.459
CC20	0.320	0.569	0.046	-0.006	-0.004	0.469
CC21	0.335	0.651	0.097	0.169	0.179	0.456
CC22	0.400	0.523	0.153	0.138	0.144	0.333
CC3	0.361	0.579	0.203	0.160	0.153	0.479
CC4	0.416	0.655	0.254	0.227	0.217	0.354
CC5	0.455	0.674	0.275	0.210	0.208	0.406
CC6	0.421	0.604	0.164	0.212	0.181	0.391

CC7	0.447	0.627	0.195	0.129	0.152	0.368
CC8	0.510	0.594	0.082	0.020	0.020	0.435
CC9	0.506	0.555	0.074	0.035	0.045	0.489
COL1	0.623	0.607	0.062	0.035	0.025	0.417
COL10	0.600	0.523	0.153	0.138	0.144	0.333
COL12	0.501	0.474	0.125	0.080	0.082	0.445
COL3	0.703	0.645	0.031	0.089	0.090	0.482
COL4	0.659	0.545	0.025	0.119	0.112	0.471
COL5	0.769	0.674	0.092	0.215	0.228	0.512
COL6	0.714	0.588	0.049	0.149	0.152	0.390
COL7	0.739	0.639	0.092	0.059	0.056	0.437
COL8	0.620	0.569	0.046	-0.006	-0.004	0.469
COL9	0.735	0.651	0.097	0.169	0.179	0.456
DT10	-0.157	-0.046	0.692	0.291	0.276	-0.162
DT13	-0.170	-0.136	0.655	0.287	0.234	-0.186
DT4	0.151	0.234	0.696	0.217	0.218	0.165
DT5	0.351	0.432	0.527	0.181	0.158	0.274
DT6	-0.041	0.094	0.631	0.200	0.161	-0.000
DT8	0.382	0.475	0.526	0.266	0.267	0.321
INT10	0.117	0.213	0.341	0.687	0.677	0.074
INT11	0.091	0.177	0.315	0.706	0.688	0.101
INT12	0.093	0.128	0.189	0.568	0.563	0.108
INT13	0.072	0.107	0.203	0.623	0.614	0.102
INT14	0.203	0.239	0.187	0.616	0.659	0.170
INT2	0.052	0.099	0.317	0.557	0.517	0.056
INT4	0.131	0.128	0.285	0.502	0.411	0.063
INT5	0.290	0.274	0.208	0.664	0.626	0.216
INT6	0.115	0.153	0.293	0.706	0.676	0.127
INT7	0.100	0.113	0.175	0.577	0.546	0.117
INT8	0.128	0.166	0.259	0.654	0.609	0.022

INT9	0.168	0.166	0.209	0.564	0.560	0.047
OUT10	0.117	0.213	0.341	0.687	0.677	0.074
OUT11	0.091	0.177	0.315	0.506	0.688	0.101
OUT12	0.093	0.128	0.189	0.468	0.563	0.108
OUT13	0.072	0.107	0.203	0.523	0.614	0.102
OUT14	0.203	0.239	0.187	0.616	0.659	0.170
OUT15	0.138	0.142	0.144	0.502	0.619	0.100
OUT16	0.149	0.165	0.134	0.491	0.606	0.121
OUT17	0.198	0.206	0.196	0.542	0.660	0.161
OUT18	0.081	0.121	0.214	0.559	0.675	0.066
OUT19	0.171	0.146	0.136	0.469	0.581	0.094
OUT2	0.052	0.099	0.317	0.557	0.517	0.056
OUT3	0.100	0.156	0.220	0.474	0.534	0.129
OUT5	0.290	0.274	0.208	0.604	0.626	0.216
OUT6	0.115	0.153	0.293	0.506	0.676	0.127
OUT7	0.100	0.113	0.175	0.477	0.546	0.117
OUT8	0.128	0.166	0.259	0.554	0.609	0.022
OUT9	0.168	0.166	0.209	0.464	0.560	0.047
ST10	0.425	0.497	0.149	0.148	0.169	0.741
ST11	0.459	0.543	0.134	0.150	0.142	0.715
ST12	0.508	0.573	0.194	0.070	0.090	0.648
ST4	0.307	0.324	-0.075	0.069	0.066	0.503
ST5	0.400	0.399	-0.074	0.041	0.027	0.577
ST6	0.403	0.404	-0.039	0.062	0.054	0.636
ST7	0.468	0.455	0.015	0.130	0.130	0.722
ST8	0.426	0.433	0.076	0.106	0.089	0.693
ST9	0.452	0.450	-0.030	0.098	0.130	0.686

The findings from Table 8.14 revealed that the cross-loading provides an acceptance validation for the discriminant validity. This is because loadings for variables that determines all the constructs are higher than loadings of other constructs in the same row. The loadings for each indicator were highlighted in bold as shown in Table 8.14.

8.4.1.2.3 Evaluation of the inner structural model

According to Hair, Sarstedt and Ringle (2019), the inner structural model is evaluated by examining the coefficient of determination which is denoted as ' R^2 '. The goodness-of-fit (Goffnett) was also determined. Also evaluated is the quality of the PLS path model that was calculated using the blindfolding procedure in SmartPLS. Finally, the predictive power of the model using PLS predict procedure was examined.

Determining the value of R^2

The R^2 , also known as the coefficient of determination, was used in measuring the overall effect size and variance explained in the endogenous construct (VM performance). The analysis from the model shows that the R^2 yielded a value of 0.935 for construction VM performance that serves as the endogenous variable. This implies that the five exogenous variables sufficiently explain 93.5% of the variance in VM performance. Hair *et al.* (2019) reported that an R^2 of above 0.7 can be deemed substantial and adequate. Therefore, the R^2 value for this study is substantial and adequate.

Quality of the PLS path model (Q^2)

The next step is to assess the absolute model fit using the model's predictive accuracy Q^2 , root mean squared error (RMSE) and the overall goodness of fit (Goffnett). According to Danks and Ray (2018) and Shmueli *et al.* (2019), for the model's predictive accuracy, Q^2 values > 0 are satisfactory. This was achieved by conducting a blindfolding procedure. High predictive accuracy (Q^2) is achieved when there

are considerably small differences between the original values and the predicted values (Hair, Sarstedt and Ringle 2019). For an endogenous construct to demonstrate the predictive accuracy of the structural model, Q^2 values are required to be larger than zero (0). This is shown in Table 8.15.

Table 8.15: Predictive relevance of the PLS path model for the first model

	SSO	SSE	$Q^2 (=1-SSE/SSO)$
Integration	2482.000	2482.000	
Collaboration	3830.000	3830.000	
Standardisation	4120.000	4120.000	
Digital Technologies	2340.000	2340.000	
Corporate Culture	3194.000	3194.000	
VM Performance	2.749.000	1980.000	0.425

Table 8.15 shows that Q^2 yields a value of 0.425 which is greater than zero. This therefore confirms that the model has predictive power to determine the endogenous variable. According to Hair Jr and Sarstedt (2019), a Q^2 value higher than 0.02, 0.15 and 0.35 reflects small, medium, and large predictive power of the PLS path model respectively. Since the value of Q^2 for this study is 0.425, it is sufficient to affirm that the model has a large predictive power.

Predictive capacity of the model

The SmartPLS predict function was used in assessing the predictive capacity of the model. The predictive capacity was used to verify the usefulness of the model in future after adding a new construct to the model. The technique used in calculating the predictive capacity has been explained sufficiently in the previous section.

Table 8.16: Comparing RMSE values via PLSpredict

	PLS – SEM values	LM values	LM – PLS SEM	
Outcomes	RMSE	RMSE	Difference	Predictive Power
OUT10	1.042	1.240	0.198	High
OUT11	1.061	1.213	0.152	High
OUT12	0.970	1.187	0.217	High
OUT13	1.081	1.307	0.226	High
OUT14	1.150	1.407	0.257	High
OUT15	1.175	1.405	0.230	High
OUT16	1.115	1.254	0.139	High
OUT17	1.119	1.295	0.278	High
OUT18	1.179	1.395	0.343	High
OUT19	1.173	1.343	0.397	High
OUT2	0.971	1.145	0.286	High
OUT3	1.105	1.329	0.413	High
OUT5	1.022	1.099	0.307	High
OUT6	1.039	1.200	0.238	High
OUT7	1.094	1.271	0.262	High
OUT8	1.079	1.297	0.328	High
OUT9	1.095	1.177	0.363	High

According to Shmueli *et al.* (2019) and Hair Jr *et al.* (2021), the predictive power of a model is determined by focusing on the indicators supporting the endogenous construct as shown in Table 8.16. This is followed by comparing the prediction error of the PLS predict (Nicał *et al.*) against the LM benchmark. Shmueli *et al.* (2019) recommended that if the minority of the prediction error (RMSE) in the PLS predict is more than the LM benchmark, it means that the model has a medium predictive power. After the second iteration, the hypothesised model has a medium predictive power because none of the

indicators in the PLS-SEM analysis has higher RMSE values as against the LM values as shown in Table 8.16. The conditions for predictive power are explained in detail in Chapter 7.

8.4.1.2.3 Standardised root mean square residual (SRMR)

The Standardized Root Mean Square Residual (SRMR) is a statistic used to assess the goodness of fit of a structural equation model, typically in the context of partial least squares structural equation modeling (PLS-SEM). It measures the discrepancy between the observed data and the model-predicted values, standardized by the degrees of freedom. In your description, you've noted that the SRMR values are automatically generated in the SmartPLS program to evaluate model fit. Generally, an SRMR value below 0.08 is considered acceptable, indicating a reasonably good fit between the model and the data. However, lower SRMR values are often seen as indicating an even better fit, suggesting that the model fits the data closely. The findings from the analysis, as presented in Table 8.17, likely show the SRMR values for your specific structural equation model. Researchers and analysts typically use these values to assess whether their model adequately fits the data. An SRMR value below 0.08 suggests that the model is a reasonably good fit, but further examination may be needed to determine the model's overall quality and validity.

Table 8.17: Model fit for the second model.

	Estimated Model
SRMR	0.094
d_ULS	25.249
d_G	4.913
Chi-square	4479.096
NFI	0.519

8.4.1.2.4 Goodness of fit

In evaluating the overall predictive power of the model (including the performance of both outer and inner models), this study adopts a global criterion of GoF to examine the overall model fit (GoF index) as proposed by Henseler and Sarstedt (2013).

The calculation follows: $GoF = \sqrt{\text{Average AVE} * R^2}$

Table 8.18: Goodness of fit index for the first model

Construct	AVE	R ²
Integration	0.387	
Collaboration	0.450	
Standardisation	0.438	
Digital technologies	0.391	
Corporate culture	0.370	
VM performance	0.378	0.935
Total	2.414	
Average score	0.402	

$$AVE = (0.387 + 0.450 + 0.438 + 0.391 + 0.370 + 0.378) / 6 = 0.402$$

$$R^2 = 0.935$$

$$GoF = \sqrt{0.402 \times 0.935}$$

$$GoF = 0.613$$

The GOF index for the model yielded a value of 0.613 which indicates that the empirical data fits the model satisfactory.

Table 8.19: Summary of second iteration model

Fit indices	Standard value	Second model value	Remarks

Outer loadings	All values should be above threshold of 0.50 according to Amora (2021) and Yim (2019)	All values above the threshold of 0.5	Satisfactory
AVE	The AVE number must be 0.5 or higher (Dash and Paul 2021)	Values are lower than 0.5	Not satisfactory
Composite reliability	Between 0.70 to 0.95 (Hair Jr and Sarstedt 2019)	Above 0.70	Satisfactory
Cronbach alpha	Cronbach Alpha should be above 0.6 (Hair <i>et al.</i> 2017)	Above 0.60	Satisfactory
Rho_A	Rho coefficient should be between 0 to 1.00 (Hair <i>et al.</i> 2012; Hair Jr, Howard and Nitzl 2020)	Between 0 to 1	Satisfactory
VIF	The multicollinearity value for the study should not be above 3 (Hair Jr and Sarstedt 2019)	Below 3	Satisfactory
Co-efficient of R ²	Hair Jr and Sarstedt (2019) reported that an R ² of above 0.7 can be deemed substantial and adequate	0.935	Satisfactory
Quality of path model Q ²	Q ² greater than zero means that the model has a predictive power whereas a value less than zero means that the model has low predictive power (Hair Jr and Sarstedt 2019; Sarstedt, Ringle and Hair 2021)	0.064	Satisfactory
Predictive capacity of model RMSE	According to Hair, Sarstedt and Ringle (2019), Purwanto and Sudargini (2021), and Shmueli <i>et al.</i> (2019), the predictive	All RMSE of the PLS predict is lower than LM benchmark.	Satisfactory

	<p>power of the model is based on the following:</p> <ul style="list-style-type: none"> • If the RMSE in the PLS predict is more than the LM benchmark for all the variables, then the Majority of RMSE of PLS predict > LM benchmark Model has medium predictive power • If the majority of the prediction errors (RMSE) in the PLS predict are more than the LM benchmark, it means that the model has low predictive power. • If a minority of the prediction errors (RMSE) in the PLS predict are more than the LM benchmark, it means that the model has medium predictive power. • If none of the prediction errors (RMSE) in the PLS predict are more than the LM benchmark, it means that the model has high predictive power. 	<p>Therefore, model has a medium predictive power.</p>	
<p>Goodness of fit</p>	<p>The GOF must have a value between 0 and 1 where values of 0.10 (Al-Mutairi <i>et al.</i>), 0.25 (medium) and 0.36 are regarded as large (Purwanto and Sudargini 2021)</p>	<p>0..613</p>	<p>Satisfactory</p>

Standard root mean square residual (SRMR)	The value of SRMR should be below 0.08. A lower SRMR indicates better fit (Hussain <i>et al.</i> 2018).	0.094	Not satisfactory
Norm fit index (NFI)	The closer the value of NFI to 1, the better fit	0.419	Not fit

8.4.1.3 Third PLS-SEM iteration

After the conclusion of the second iteration, a third iteration was carried out using the SmartPLS 4 software. Based on the second iteration, constructs with loading values below 0.60 were eliminated. This is based on the considerations of Henseler, Ringle and Sinkovics (2009) who state that loading values of around 0.60 are highly recommended.

The following integration variables were eliminated as they fell below the 0.60 thresholds. These includes INT12 (Open information system) with 0.568, INT2 (Regular workshop meetings) with 0.557, INT4 (Early goal definition) with 0.502, INT7 (Knowledge of VM) with 0.577, and INT9 (Efficient ideas and alternatives gathered in early stage) with 0.564. The following collaboration variables were also eliminated; ST4 (Active client’s support and participation) with 0.503), and ST5 (Attendance of policymakers on constant basis) with 0.577. COL12 (Group goal setting) with 0.501 was eliminated in Collaboration variable. DT6 (Knowledge of administrative tools) with 0.527 and DT8 (Mobile devices), In addition, CC1 (Interpersonal relationship) with 0.570, CC12 (Updated technological system) with 0.541, CC16 (Control of other construction professionals) with 0.545, CC18 (Meeting targets with adherence to schedule) with 0.588, CC2 (Assertion of policy within the value chain) with 0.567, CC20 (Client satisfaction) with 0.569, CC22 (Ensuring large market size) with 0.523, CC3 (High degree of

flexibility) with 0.579, CC8 (Risk management) with 0.594, and CC9 (Skill development and acquisition) with 0.555 were eliminated from Corporate Culture variables. In VM outcome, OUT12 (Better collaboration among professionals) with 0.563, OUT19 (Sustainability) with 0.581, OUT2 (Whole life asset management) with 0.517, OUT3 (Better quality system and performance) with 0.534, OUT7 (Long-term planning) with 0.546, and OUT9 (Risk management) were also eliminated as they did not meet the threshold.

The next check is the internal consistency reliability which is determined by the Cronbach’s alpha and Composite reliability (CR). As shown in Table 8.20, the latent variables all possess high-reliability levels during the final iteration as all constructs recorded values above 0.6. Next were the validity checks (both convergent and discriminant). For the convergent validity, the AVE values of 0.5 and above are considered satisfactory. After the third iteration, collaboration, integration, standardisation, digital technologies, and corporate culture all had AVE values of 0.575, 0.571, 0.582, 0.504, and 0.534 respectively which were above the 0.5 threshold (Henseler, Ringle and Sarstedt 2015), and hence satisfactory as shown in Table 8.21. The next step is to examine the discriminant validity. For distinct constructs, a threshold value of 0.85 and below is acceptable (Henseler et al., 2015). For the third iteration, the respective HTMT values satisfy this criterion as shown in Table 8.20. To check for collinearity issues, the variance inflation factor (VIF) should be 3 or less than 3 (Hair, Ringle and Sarstedt 2011). From Table 8.21, all VIF values are below 3, which indicate no collinearity problems in the constructs after the third iteration.

Table 8.20: Final result of the heterotrait-monotrait ratio (HTMT)

Latent constructs	Collaboration	Corporate culture	Digital technologies	Integration	Outcomes of VM Performance	Standardisation
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Collaboration	0.689					
Corporate culture	0.537	0.659				
Digital technologies	0.114	0.183	0.636			
Integration	0.211	0.284	0.563	0.686		
Outcome of VM Performance	0.216	0.278	0.617	0.565	0.661	
Standardisation	0.420	0.452	0.087	0.174	0.179	0.694

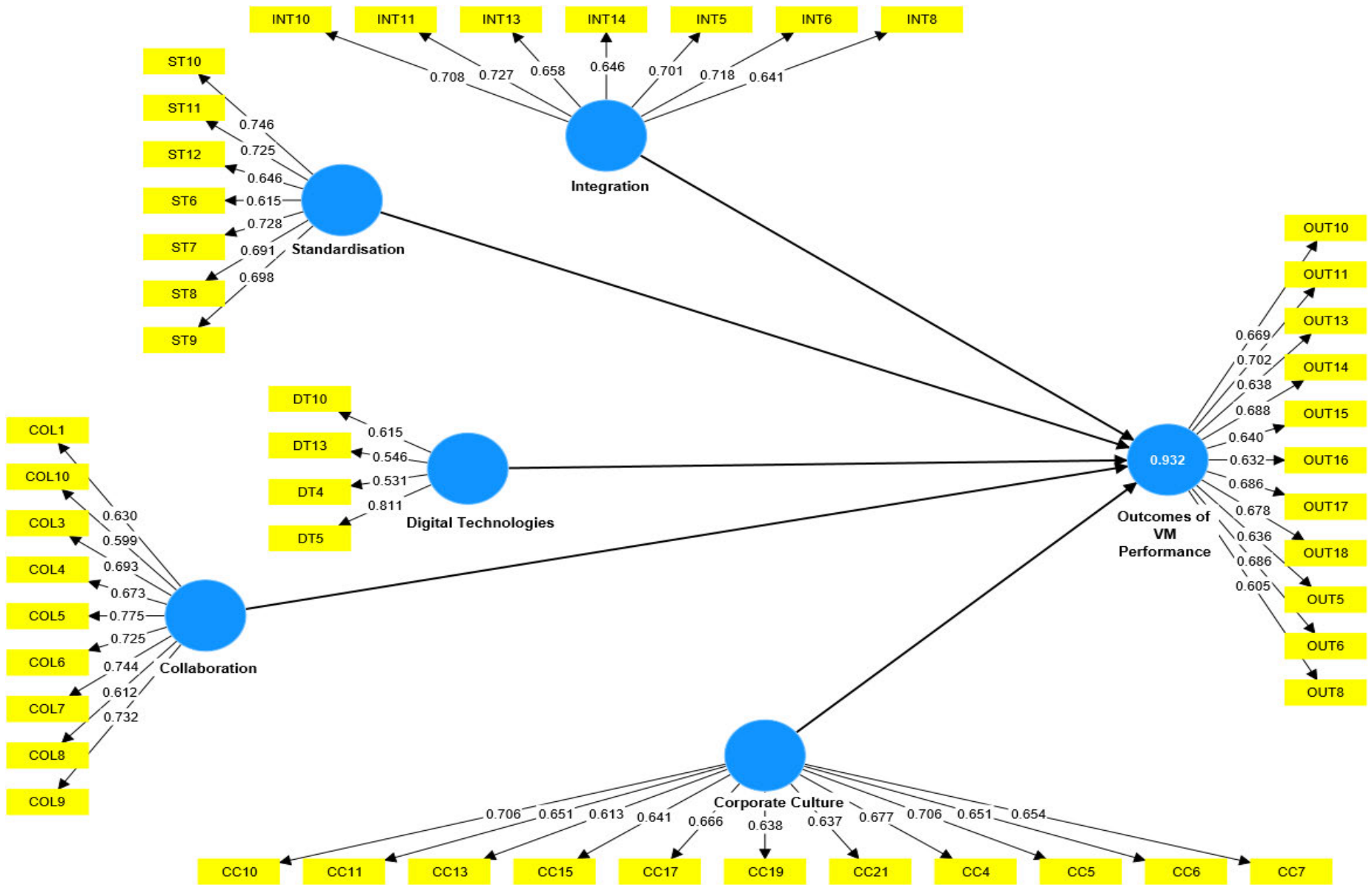


Figure 8.4: Third Model for Value Management

Table 8.21: Third iteration results for the measurement model (CFA)

Latent Variable Constructs	Coding	Measurement Variables	Factor loadings	pA	Cronbach Alpha	Composite reliability	AVE	VIF
Integration	INT10	Enough time to conduct VM studies	0.727	0.813	0.812	0.861	0.571	1.566
	INT11	Prompt response among professionals during VM meetings	0.708					1.601
	INT13	Equal contribution of participants	0.658					1.401
	INT14	Constant communication among participants	0.646					1.349
	INT5	Clear objectives of workshop	0.701					1.524
	INT6	Experienced VM facilitator	0.718					1.589
	INT8	Accelerated decision-making	0.641					1.395
Standardisation	ST10	Government commitment to implement VM	0.741	0.841	0.826	0.866	0.582	1.595
	ST11	VM action plan for implementation	0.715					1.545
	ST12	Input of government and its agencies	0.648					1.459
	ST6	Inclusion of VM clause in procurement act	0.636					1.557
	ST7	Regulation of VM activities	0.722					1.676
	ST8	Collaboration of government officials and professional bodies	0.693					1.650
	ST9	Presence of VM guidelines and legal framework	0.686					1.543

Collaboration	COL1	Information Sharing	0.623	0.876	0.871	0.890	0.575	1.607
	COL10	Dispute resolution techniques	0.600					1.384
	COL3	Partnership	0.703					1.905
	COL4	Decision alignment	0.659					1.606
	COL5	Teamwork	0.769					1.757
	COL6	Knowledge sharing	0.714					1.645
	COL7	Shared orientation	0.739					2.157
	COL8	Coordination	0.620					1.816
	COL9	Interaction among participants in each phase	0.735					1.824
Digital technologies	DT10	Internet of Things (IoT)	0.692	0.875	0.801	0.825	0.504	1.391
	DT13	Building Information Modelling	0.655					1.379
	DT4	Cloud computing	0.696					1.210
	DT5	Advanced big data analytics	0.631					1.044
Corporate Culture	CC10	Creativity orientation	0.706	0.876	0.875	0.894	0.534	1.694
	CC11	Innovativeness	0.651					1.625
	CC13	Management commitment	0.613					1.679
	CC15	Teamwork	0.641					1.819
	CC17	Smooth operation of VM activities	0.666					1.635
	CC19	Client satisfaction	0.638					1.968
	CC21	Goal accomplishment	0.637					1.630
	CC4	Cooperation among stakeholders	0.677					1.571
	CC5	Motivation	0.706					1.584

	CC6	Education and Training	0.651					1.533
	CC7	Reward and incentive system	0.654					1.591
VMoutput	OUT10	Improved project management	0.669	0.873	0.871	0.895	0.537	1.616
	OUT11	Elimination of delay	0.702					1.703
	OUT13	Time management	0.638					1.446
	OUT14	Innovative designs	0.688					1.807
	OUT15	Optimisation of value	0.640					1.819
	OUT16	Cost saving practices	0.632					1.787
	OUT17	Efficient project delivery	0.686					1.788
	OUT18	Enhanced project functionality	0.678					1.696
	OUT5	Material management	0.636					1.563
	OUT6	Conflict management	0.686					1.663
	OUT8	Quality management system	0.605					1.425

8.4.1.3.1 Evaluation of the inner structural model

The inner structural model was evaluated in accordance with the recommendations of Hussain *et al.* (2018) and Hair, Sarstedt and Ringle (2019). It is noteworthy to indicate that the same recommendations for evaluating the inner structural model were also adopted in the first and second models' development. The factors considered in evaluating the inner structural model includes evaluating the coefficient of determination which is denoted as "R²". The goodness-of- fit (Goffnett), the quality of the PLS path model and the predictive power of the model was also considered.

8.4.1.3.2 Determining the value of R²

The R², also referred to as the coefficient of determination, played a crucial role in assessing the extent to which the five exogenous variables explained the variance in VM performance. According to the model analysis, the R² produced a value of 0.932 for VM performance as the endogenous variable, indicating that these five exogenous variables effectively account for 92.3% of the variation in VM performance.

38.4.1.3.3 Quality of the PLS path model (Q²)

The quality of the PLS path model was estimated by determining the value of Q² that was calculated using the blindfolding procedure in SmartPLS and performed under the cross-validated redundancy. The Q² is calculated with the aim of determining the sufficiency of the exogenous variable in predicting the endogenous variable. A Q² value greater than zero implies that the exogenous variable can sufficiently predict the endogenous variable whereas a value lower than zero indicates that the PLS path model is weak, and the exogenous construct is not sufficient in explaining the endogenous variable. Q² was extracted from the SmartPLS software using blindfolding and cross redundancy procedure. The table 8.22 demonstrates that the value of Q², obtained through blindfolding and cross redundancy procedures using SmartPLS software, is 0.421. This result serves as confirmation that the exogenous construct exhibits strong predictive capabilities regarding the endogenous variable.

Table 8.22: Quality of the PLS path for the third model

	SSO	SSE	Q² (=1-SSE/SSO)
Integration	2450.000	2450.000	
Collaboration	2765.000	2765.000	
Standardisation	2940.000	2940.000	
Digital Technologies	2112.000	2112.000	

Corporate Culture	3176.000	3176.000	
VM Performance	2532.000	2532.000	0.421

According to the predictive power of a model is determined by focusing on the indicators supporting the endogenous construct as shown in Table 8.22. This is followed by comparing the prediction error of the PLS predict against the LM benchmark.

In accordance with Shmueli *et al.* (2019) and Hair Jr *et al.* (2021), the assessment of a model's predictive capability involves a two-step process. First, it involves a focus on the indicators supporting the endogenous construct, as presented in Table 8.22. Subsequently, the prediction error of the PLS predict is compared to the LM benchmark. Following Shmueli *et al.* (2019) recommendation, if the minority of the prediction error (RMSE) in the PLS predict is greater than that of the LM benchmark, it signifies that the model possesses moderate predictive power. However, after the third iteration, the hypothesized model demonstrates high predictive power. This is evident as none of the indicators in the PLS-SEM analysis exhibit higher RMSE values compared to the LM values, as indicated in Table 8.23. A comprehensive explanation of the conditions for predictive power can be found in Chapter 7.

8.4.1.3.4 The predictive capacity of the model

After identifying the predictive ability of the exogenous variable on the endogenous variable in the previous section, this section examines the overall predictive capacity of the model with the assumption that a new construct is added in the future. The predictive capacity was calculated using the SmartPLS predict function. The outcome from the SmartPLS regarding the predictive capacity of the model is presented in Table 8.23.

Table 8.23: Comparing RMSE values via PLSpredict (best fit model)

	PLS – SEM values	LM values	LM – PLS SEM	
Outcomes	RMSE	RMSE	Difference	Predictive Power
OUT10	1.042	1.112	0.070	High
OUT11	1.065	1.154	0.089	High
OUT13	1.080	1.213	0.133	High
OUT14	1.151	1.308	0.157	High
OUT15	1.175	1.326	0.151	High
OUT16	1.121	1.217	0.096	High
OUT17	1.127	1.277	0.150	High
OUT18	1.192	1.322	0.130	High
OUT5	1.008	1.089	0.081	High
OUT6	1.034	1.127	0.093	High
OUT8	1.070	1.201	0.131	High

8.4.1.3.5 Goodness of fit index

The goodness-of-fit index for the third model was calculated in this section using the formula recommended by Tenenhaus et al. (2005). According to Henseler and Sarstedt (2013), a GoF value must have a value between 0 and 1 where values of 0.10, 0.25, and 0.36 are regarded as large. However, a too high value may be deemed problematic for the model, and it is calculated using the mean of AVE and multiply with the R^2 as shown below. Finally, the overall predictive power of the model (including the performance of both outer and inner models) was calculated as follows:

$$GoF = \sqrt{\text{Average AVE} * R^2}$$

$$AVE = 0.571 + 0.582 + 0.575 + 0.504 + 0.534 + 0.537 = 3.303/6 = 0.551$$

$$R^2 = 0.932$$

$$GOF = \sqrt{0.551 \times 0.932}$$

$$GOF = 0.717$$

The value acquired from the goodness-of-fit calculation shows that the GOF index for the third model was measured as approximately 0.717. The finding from the calculation indicates that the empirical data fits the third model satisfactory.

8.4.1.3.6 Standardised root mean square residual (SRMR)

The SmartPLS program automatically generates the SRMR (Standardized Root Mean Square Residual) as a measure of model fit criteria. An SRMR value below 0.08 is considered acceptable, but a lower SRMR value is considered even better. The results obtained from the analysis conducted in the SmartPLS program regarding SRMR are displayed in Table 8.24. According to the table, the SRMR is calculated to be 0.066, signifying that the study model exhibits a strong fit.

Table 8.24: Model fit for the second model.

	Estimated Model
SRMR	0.066
d_ULS	11.335
d_G	1.913
Chi-square	1958.366
NFI	0.693

8.5 DISCUSSION OF DELPHI SURVEY RESULTS

After presenting the findings from the Delphi study, this section of the research study delves into the discussion and validation of the various dimensions, sub-dimensions, and related factors that were identified by the panel of experts. These dimensions are perceived as significant and are believed to have a notable influence on the performance of VM (Value Management) practices in the construction industry in Nigeria.

8.5.1 Objective DS01 – Main Dimensions

The first Delphi specific objective was to determine the various dimensions (main and sub-dimensions) that contribute to the enhanced VM performance in Nigeria. From the review of existing models, frameworks and their corresponding constructs across several contexts, this study identified five key dimensions in ensuring the improvement of VM performance. It is upon these dimensions that the conceptual VM performance model for this study was achieved.

The study's findings indicate a strong consensus among the participants regarding the attributes that determine the influence of enhanced VM performance in the construction industry. Notably, according to the survey's research, corporate culture emerges as one of the VM factors with the most substantial impact on VM performance. In the meantime, this research identified corporate culture and the use of digital technologies as one of the overlooked components in existing VM models, the analysis's findings verified the importance of the study's gaps derived in the research. The result of the current study is consistent with those of earlier research on VM performance, corporate culture, and the use of digital technologies. Zou, Zhang and Wang (2008) stated that corporate culture is an important factor in building collaborative working relationships among VM teams.

According to insights gathered from the Delphi study conducted by experts, the incorporation of digital technologies emerged as the second most critical factor in enhancing VM (Value Management) performance within the construction industry. This research underscores the advantages associated with the integration of digital tools, including improved teamwork, cost-effective construction, expedited decision-making processes, and enhanced communication on construction projects. Aghimien *et al.* (2022) and Baarimah *et al.* (2021) also highlight the paramount importance of employing digital technologies in VM practices to address issues like a lack of

familiarity with electronic VM systems and inadequate communication among VM teams. Additionally, since the VM process relies heavily on information sharing, the consideration of data security and privacy becomes a crucial element in determining the adoption and acceptance of technology in this context. The findings from this study also coincide with the findings of Punnyasoma, Jayasena and Tennakoon (2019). Punnyasoma, Jayasena and Tennakoon (2019) and Baarimah *et al.* (2021) have pointed out that concerns related to data insecurity and a lack of privacy in handling information have acted as deterrents to the adoption of certain digital technologies in construction projects. These concerns resonate with challenges encountered in the VM (Value Management) process as well, emphasizing the importance of addressing data security and privacy issues when implementing digital technologies in both construction and VM practices. In addition, Park *et al.* (2017) also justified this assertion that the integration of digital technologies like BIM in VM practices lead to improved value delivery to clients in the construction industry. The study also corroborates the findings of Aghimien *et al.* (2022) that digital technologies provide VM teams with the capability to identify design clashes that may have been missed by the project's design team at an early project stage. This early detection offers the opportunity to make timely corrections, thereby preventing unnecessary costs, delays, and material wastage during the construction phase. Additionally, as noted by Ganesan *et al.* (2020), digital tools enable VM teams to efficiently collect, store, and analyze data. This data-driven approach empowers them to make well-informed decisions crucial for the overall success of the project.

The experts identified collaboration as the third most crucial variable that can be used to enhance VM performance in the built environment. According to this study, collaboration is the process by which two or more independent professionals or stakeholders in a building project cooperate to plan and carry out VM operations in construction. The results from the research corroborates with the findings

of Ojo, Ogunsemi and Ogunsina (2021), Ojo and Ogunsemi (2019), and Ojo and Ogunsemi (2018) which revealed that collaboration is crucial for the performance of VM in the construction industry. According to the experts, based on the variable's median score, collaboration has a significant impact on the performance of VM. The findings from this study align with the research of Rahman *et al.* (2014), who emphasized that collaboration in the construction industry occurs when building professionals come together to coordinate and synchronize their objectives, information, and decision-making processes with the aim of achieving a shared and common goal. Building on this perspective, Ojo, Ogunsemi and Ogunsina (2021) further inferred that collaboration entails a shared sense of responsibility and commitment among stakeholders to work together in achieving a common goal. These attributes underscore the significance of collaboration within the VM (Value Management) process, particularly in ensuring the timely delivery of construction projects.

The experts in the study also recognized that integration and standardization play pivotal roles in enhancing the performance of VM, with both attributes receiving high median scores of 7. In this study, integration is characterized as the process of combining various forms of knowledge, expertise, and technology to enhance project outcomes, with a particular focus on ensuring the timely and efficient completion of construction projects. These findings align with prior research by Aghimien and Oke (2015), Kineber *et al.* (2020b), and Thneibat, Thneibat and Al-Tamimi (2021), all of whom underscored the critical importance of integration in improving VM performance by synchronizing information, processes, and people. Li, Wang and Alashwal (2021) also highlighted that integration is vital for enhancing the functionality and performance of building projects throughout their lifecycle, from pre-construction to post-construction phases. Consequently, the effectiveness of VM (Value Management) performance is intricately connected to the characteristics and aspects related to VM integration.

In this study, standardization is characterized by several key components, including input from relevant governmental and local authorities to regulate VM (Value Management) activities, the formulation of a VM study plan for implementation, the client's ability to effectively communicate their requirements to the design team, the government's commitment to VM implementation, regular attendance of decision-makers, and active client support and participation. The Delphi study's findings highlight that the experts involved in the research considered standardization to have a significant impact on VM performance. These findings align with the work of Kim *et al.* (2016) and Aghimien and Oke (2015), who also identified government interest in VM adoption, preparedness, client participation, and public awareness of VM advantages as critical performance criteria for VM. Tanko *et al.* (2018) further emphasized the role of the government in generating VM initiatives and regulations, given its status as a major consumer and investor in construction projects, including property and infrastructure development assets. This underscores how government actions can play a pivotal role in promoting widespread adoption and enhancing the performance of VM within the construction industry among building professionals.

In conclusion, therefore, the various dimensions (main and sub-dimensions) that contribute to improved VM performance in Nigeria were validated by the experts. Hence, the experts for this study were in full agreement with the adoption of these five dimensions in developing a VM performance model for the built environment.

8.5.2 Objective DS02 – Integration

The second objective of the Delphi study was to determine the impact of integration in improving the performance of VM in the construction industry in Nigeria. Out of the 17 identified integration practices, seven of them possessed a high significance rating of 9. This includes knowledge about

VM (median value of 9 and mean of 8.90), regular workshop meetings (median of 9 and mean value of 8.65), commitment of participants (median of 9 and mean value of 7.45), early goal definition (median of 9 and mean value of 7.70), experienced VM facilitator (median of 9 and mean value of 8.40), dedicated personnel (median of 9 and mean value of 8.57), and constant communication (median of 9 and mean value of 8.35). These findings concur with those of numerous other researchers' investigations. Ilayaraja and Eqyaabal (2015) and Kineber *et al.* (2021) affirmed that to achieve VM performance, it is crucial to have the necessary knowledge, experience, and awareness of the VM approach, such as life-cycle costing, innovative thinking, and the Function Analysis System Technique (FAST) diagram. Lack of awareness and knowledge, complicated internal linkages, and poor decision-making methods, according to Kolo and Ibrahim (2010), are some of the key factors for bad VM performance in the construction sector. VM has been around for a long time, and there is a plethora of publications (research papers, articles, journals, and so on) about it. The depth of awareness, understanding and expertise among practitioners on how to do VM, on the other hand, is extremely poor. It is a tremendous concern that underdeveloped nations are still trying to promote knowledge about how to integrate VM principles in the built environment in a systematic way. Therefore, construction professionals and participants should engage in charrettes, seminars, or pre-workshops early in the construction phase to agree on strategies, commitments, disagreements, and programs to achieve these integration process. Findings from the study of Whyte and Cammarano (2012) show that VM has the potential to increase value and effectiveness at the stages of the project life cycle. Time limitations, lack of understanding, participation of the team members, level of information, early goal definition, communication, commitment, and initiative of members can negatively influence the level of VM exercise and influence the quality of the final decision. The VM expert could also be forerunners who helped advance the use of VM in construction projects.

According to this conclusion, integration factors would inevitably have an impact on the performance of VM. Therefore, training in VM should be provided to those in the built environment. In conclusion, therefore, the various integration factors for improving the performance of VM identifies from the literature were all validated by the experts. In developing a VM performance model for the built environment, it is necessary to be aware of the various integration variables through which improved VM practices can be improved.

8.5.3 Objective DS03 - Standardisation

The third objective of the Delphi study aimed to assess the influence of standardization strategies on VM (Value Management) performance within the Nigerian construction industry. A review of the literature highlighted the findings of Othman *et al.* (2021), Ojo, Ogunsemi and Ogunsina (2021), and Kim *et al.* (2016), which collectively underscored the significance of standardization as a crucial factor for enhancing VM performance. To evaluate this impact, the experts in the study provided their ratings using a 10-point Likert scale, as detailed in Table 8.3. The experts considered “Input of government and its agencies ($M = 9, \bar{x} = 8.85, \sigma_X = 1.15$), “Mandatory VM training certification for all construction professionals ($M = 9, \bar{x} = 8.10, \sigma_X = 1.24$)”, “Presence of VM guidelines and legal framework ($M = 9, \bar{x} = 8.34, \sigma_X = 0.78$)”, and “Active client’s support and participation ($M = 9, \bar{x} = 8.12, \sigma_X = 1.75$)” respectively. This corroborates the findings of Perera, Hayles and Kerlin (2011) who mentioned that a key impediment to the implementation of VM is the lack of participation from project owners. Consequently, the active involvement and commitment of clients are pivotal factors for the successful deployment and performance of VM (Value Management). Similarly, policymakers within the construction industry should be ready to instill this approach as an integral part of their organizational culture and practices. This emphasis on client engagement and a culture of VM

adoption can significantly contribute to its effectiveness within the industry. Policy makers, government agencies and leadership of the built environment are significant organizer and administrators to include a wide choice of options to support the adoption of sustainable materials and technological innovations (Hwang, Zhao and Ong 2015). Consequently, the active support and engagement of the government in the implementation of VM (Value Management) within ongoing construction developments will be of utmost importance, as highlighted by (Tanko *et al.* 2018). To address responsibilities such as obligatory environmental requirements and sustainability criteria, it is essential for authorities to collaborate with clients and senior management to establish clear definitions and offer suitable assistance, which could include financial incentives or rewards. This collaborative approach can help resolve issues related to sustainability and regulatory compliance in construction projects. As a result, improvements in VM implementation techniques will be noted.

Table 8.3's results revealed a consensus among the mentioned strategies, with Interquartile Deviations (IQD) of 0.00 and 0.05. Notably, "presence of VM guidelines and legal framework" and "active client's support and participation" exhibited a stronger consensus with an IQD of 0.00 compared to the other standardization variables. This suggests that these two factors, "presence of VM guidelines and legal framework" and "active client's support and participation," play a predominant role in enhancing VM (Value Management) performance. Consequently, there is a compelling need to educate both private and public clients about the potential and benefits of applying VM in construction projects. These findings align with the work of Othman *et al.* (2021) and Aghimien, Oke and Aigbavboa (2018). Madushika *et al.* (2020) Tanko *et al.* (2018) emphasized the critical nature of client involvement and commitment for successful VM deployment and performance, while Tanko *et al.* (2018) highlighted the government's capacity to drive VM initiatives and regulations as a major consumer and investor in the construction sector. Hence, fostering client engagement and a corporate

culture supportive of VM is paramount to its success. It also has a significant amount of capital development in the form of property and infrastructure development assets. Inadequate expert engagement and poor facilitation skills might have a detrimental impact on VM activities. This corroborates with the findings of Jaapar *et al.* (2009).

8.5.4 Objective DS04: Collaboration

The fourth objective of the Delphi study aimed to determine the influence of collaboration on the performance of VM (Value Management) in Nigeria. This objective was pursued because effective VM practices can be strongly influenced by the level of collaboration among professionals involved. A review of the literature, including studies by Ojo and Ogunsemi (2019) and Whyte and Cammarano (2012), highlighted various strategies that can be employed to promote collaboration. A total of 15 such strategies were extracted from the literature and presented to the experts with the goal of identifying the strategy with the highest impact on VM. The experts ranked these strategies on a scale of 1-10, where "1-2" represented "no impact" and "9-10" signified "very high impact." The consensus among the experts was that all collaborative features had a high impact on VM performance.

Interaction among participants in each phase and information sharing were considered by the experts to have an exceedingly high impact on VM performance. This corroborates the findings of Lotfi *et al.* (2013) and Whyte and Cammarano (2012) who revealed that sharing of information ensures value in the value chain. According to Lotfi *et al.* (2013), the sharing of information among the professionals will enhance interaction, cooperation, and coordination thereby enhancing VM performance. Also, the experts considered "dispute resolution techniques", "active client's support and participation", "shared orientation", "teamwork", "knowledge sharing", "improved communication and understanding among stakeholders", "group goal setting", "human relations among team members", "cooperation", and "coordination" as having a high impact on the

performance of VM. The opinion of the expert coincides with the studies conducted by Ojo, Ogunsemi and Ogunsina (2021), Othman *et al.* (2020), Kineber *et al.* (2021c), and Mohamad, Shen and Yu (2015) who found that the structure of an organisation will assist in providing the framework that determines who employees interact with when carrying out a task. Ojo, Ogunsemi and Ogunsina (2021) affirmed that collaboration assists in allowing an organization to meet its objective faster and at a lower cost than when working independently. This implied that cooperation includes assuming equal responsibility and dedication to achieving a shared objective. Collaboration is essential for completing the project on time due to these traits.

8.5.5 Objective DS05: Corporate Culture

The fourth objective of the Delphi study was to investigate the influence of corporate culture dimensions on VM (Value Management) performance in Nigeria. This objective was motivated by the need to address a gap in the existing VM model. Despite numerous studies acknowledging the impact of corporate culture on the performance of construction firms worldwide, there was a noticeable lack of research on how corporate culture specifically affects VM performance in the Nigerian context. This objective sought to bridge that research gap and shed light on the relationship between corporate culture and VM performance in Nigeria (Coffey and Willar 2010; Stare 2011; Abdelrahman and Papamichail 2016; Riad, Labib and Nawar 2016; Panuwatwanich and Nguyen 2017)

The literature review concerning corporate culture reveals that corporate culture can be categorized into four dimensions: clan culture, adhocracy culture, hierarchy culture, and market culture. Each of these dimensions was presented to the respondents for them to evaluate and rank using a 10-point Likert scale. In the context of this study, clan culture is described as a culture where stakeholders

prioritize fostering teamwork, mentoring, and partnerships within the construction industry. This type of culture emphasizes collaboration and a sense of belonging, where individuals work closely together to achieve common goals. The experts indicated interpersonal relationship ($M = 9, \bar{x} = 8.20, \sigma_X = 1.64$), Teamwork ($M = 9, \bar{x} = 8.25, \sigma_X = 1.65$), Motivation ($M = 9, \bar{x} = 8.05, \sigma_X = 1.61$), regular communication ($M = 9, \bar{x} = 8.30, \sigma_X = 1.30$). This implies that stakeholders adopting a clan culture for its construction activities will be driven by the desire to ensure interpersonal relationship, teamwork, motivation, and regular communication with workers and professionals in its space. The findings from this study correlate with the study done by Naranjo-Valencia, Jiménez-Jiménez and Sanz-Valle (2019), Cao *et al.* (2015) and Abdelrahman and Papamichail (2016) that ensuring teamwork, motivation, and regular communication ensures improved performance of activities in the workplace. The experts also rated management commitment ($M = 8, \bar{x} = 7.75, \sigma_X = 1.77$), continuous improvement ($M = 8, \bar{x} = 8.75, \sigma_X = 1.41$), cooperation among stakeholders ($M = 8, \bar{x} = 7.65, \sigma_X = 1.56$), and skill development and acquisition ($M = 8, \bar{x} = 8.05, \sigma_X = 2.26$) as having a high degree of impact on VM performance. Iroanya (2012) and Whyte and Cammarano (2012) also found that motivation, teamwork, interpersonal relationship among the different stakeholders ensures the collaboration and integration during VM activities and during workshop meetings.

In relation to adhocracy culture, the experts in the study considered variables associated with adhocracy culture, such as risk management, reward and incentive systems, updated technology systems, growth and development opportunities, availability of new resources, and a high degree of flexibility, as having a significant impact, with mean scores ranging from 7 to 8. However, it's important to note that consensus was not reached for the variable of risk management, as indicated by an Interquartile Deviation (IQD) score of 1.50, even though experts rated it as having a high

impact. These expert opinions align with the concept of adhocracy culture, which is characterized by fostering innovation and risk management within the built environment. Adhocracy culture encourages adaptability and creative problem-solving, making it particularly relevant in industries like construction where dynamic challenges and opportunities are common (Ahmed, John and Nicholas 2012; Ranesh 2012; Whyte and Cammarano 2012). The lack of consensus on the importance of risk management, as indicated by an Interquartile Deviation (IQD) score of 1.50, despite experts rating it as having a high impact, is an interesting observation. This discrepancy might be attributed to the challenges associated with risk management practices in Nigeria, as suggested by (Iqbal *et al.* 2015), There may be concerns about the effectiveness of existing risk management processes or their implementation within the construction industry. However, it's worth noting that some scholars, such as (Nnadi, Enebe and Ugwu 2018), hold a more optimistic view, suggesting that risk management practices in the country are improving over time. This divergence in perspectives highlights the complexity of risk management and its varying perceptions within the Nigerian context.

As a result, the scholars' divergent viewpoints signifies that they were unable to agree on a risk management variable. Also, Coetzee (2010) suggested that updated technology systems can improve the performance of VM. The author opined that VM team can work on the internet and use new and updated technologies for VM practice.

The impact of variables related to market culture on VM (Value Management) performance in the Nigerian construction industry is presented in Table 8.6. Market culture, as previously identified, is characterized by a focus on achieving results and satisfying clients without necessarily adhering to the principles governing the value chain. The experts' consensus, which indicated that client satisfaction (mean score = 8, \bar{x} = 7.90, σ_X = 1.86) and being result-oriented (mean score = 9, \bar{x} = 8.32, σ_X = 0.39), have a very high level of impact on VM performance, is not surprising. These

results imply that for VM to operate effectively and efficiently in Nigeria, it is crucial to embrace a culture that prioritizes client satisfaction. In conclusion, the research underscores that the behavior of stakeholders within the construction value chain is significantly influenced by the corporate culture they adhere to. Adopting a culture that emphasizes client satisfaction can contribute to the successful implementation of VM practices in the Nigerian construction industry.

Regarding hierarchy culture, Table 8.6 indicates that consensus was reached for all the variables associated with this culture. Notably, the control of other construction professionals during VM activities was rated by the experts as having a very high impact on the performance of VM (mean score = 9, $\bar{x} = 8.75$, $\sigma_X = 1.41$). This observation aligns with the principles of the Principal-Agent Theory (PAT), which emphasizes the significance of controlling professionals or stakeholders in the built environment. Within a hierarchy culture, there is typically a strong emphasis on top-down control and adherence to established processes and structures. This control is seen as essential for ensuring that VM activities are executed effectively and that the desired outcomes are achieved.

The theory mentioned that it is crucial to establish control in the value chain as this will allow cooperation, coordination, and the smooth running of activities between construction stakeholders within the construction industry. In VM activities, power and control will allow the stakeholders involved in the workshop process to operate efficiently as some resources may not be under the control of the VM facilitator and may require him/her to acquire these from the other stakeholders involved in the VM process. Therefore, if a VM facilitator controls the resources that another stakeholder needs, the VM facilitator has power over the stakeholder.

8.5.6 Objective DS06: Digital Technologies

The final objective of the Delphi study aimed to assess the level of significance of digital technologies in enhancing the performance of the VM (Value Management) process within the construction industry. This objective sought to understand how the adoption and integration of digital technologies impact the effectiveness and efficiency of VM practices in construction projects. Of the 18 digital technologies, 9 of them possess a very high significance rating (median value of 9). These include Building Information Modelling (BIM), Big Data Analytics, Internet of things (IoT), Additive manufacturing (3D printing), Administrative tools (Microsoft suites, Primavera), Cloud computing, electronic meeting tools (Zoom, Microsoft Teams, etc.), and Engineering design (Computer-aided design). The findings with the study of (Park *et al.* 2017; Punnyasoma, Jayasena and Tennakoon 2019; Baarimah *et al.* 2021).

In their research, it was affirmed that digital technologies are intelligent systems that foster communication, collaboration, and teamwork. Various digital technologies are revolutionizing the methods employed in construction activities, and the utilization of these digital tools can enhance the efficiency and success of the VM (Value Management) process. Additionally, technologies such as Building Information Modeling (BIM), cloud computing, and the Internet of Things (IoT) have the potential to significantly enhance communication and teamwork among project teams, including VM teams. These technologies can play a pivotal role in streamlining processes, improving decision-making, and optimizing the overall performance of construction projects (Oke *et al.* 2021).

Indeed, the application of Big Data Analytics (BDA) can empower VM teams to efficiently collect, store, and analyze vast amounts of data and information. This capability enables them to make well-informed decisions crucial for the success of construction projects. BDA can process large datasets

quickly and extract valuable insights, which can be instrumental in optimizing various aspects of the VM process, identifying opportunities for improvement, and ensuring that projects are executed successfully and efficiently (Ganesan *et al.* 2020). This corroborates the work done by Park *et al.* (2017) who mentioned that a lot of data and information are generated during VM activities.

Regrettably, the adoption of digital technologies within the construction industry in developing countries such as Nigeria has faced significant hurdles, as highlighted by (Oke and Arowoia 2021). However, despite these challenges, it's important to recognize that technology-driven VM processes have the potential to offer substantial benefits. Construction stakeholders can enhance project value, effectively navigate rapidly changing information landscapes, collaborate with multicultural teams, and generate innovative solutions by embracing digital technologies within the VM framework. Overcoming the barriers to technology adoption in construction can lead to improved efficiency and outcomes in construction projects.

8.5.7 Objective DS07 - Barriers to using digital technologies in VM practices.

The seven objective of the Delphi study was to determine the barriers to using digital technologies in VM practices. Of the 14 factors identified, the expert ranked lack of proper digital training, increased budget for maintaining digital technologies, high cost of acquiring needed digital technologies required in for VM process, poor digital culture in the built environment, and unavailability of needed innovative technologies with a median value of 9, indicating strongly agree. These findings resonate with the studies of Aghimien *et al.* (2022), Punnyasoma, Jayasena and Tennakoon (2019), and Coetzee (2010). In their study, they verified that construction workers tend to resist change, while also highlighting the limited awareness and comprehension of the advantages associated with

incorporating digital technologies into construction management procedures. This could be attributed to the complexity of digital technologies which requires specific expertise to operate.

When such expertise is lacking, the adoption of these technologies can become challenging. The Value Management (VM) process necessitates a workshop led by a facilitator, involving brainstorming and idea evaluation. This can be perceived as intricate, particularly in the construction industry of developing nations where VM knowledge is limited (Kineber *et al.* 2020b). This complexity, combined with the intricate nature of most digital tools, can impede the integration of these technologies into the VM process. This finding aligns with Aghimien, Aigbavboa and Oke (2020b), which observed that certain digital technologies are intricate, often requiring experts who are frequently unavailable within the construction industry. Additionally, concerns regarding the security of shared information during the VM process can act as a deterrent to technology adoption, as noted in this current study. This is consistent with prior research indicating that data insecurity and privacy concerns have hindered the utilization of some digital technologies in construction projects (Aghimien *et al.* 2021). Since the VM process is rooted in properly gathering and analysing information, ensuring that the information is safe and retrieved correctly is important. As such, the issue of data insecurity that has characterised most digital tools (Parn and Edwards 2019) can serve as a severe drawback for the deployment of these technologies in the VM process.

Moreso, previous studies done by Parn and Edwards (2019) have noted that the construction industry presently exhibits a limited digital culture. Nevertheless, an enhancement in the industry's willingness to embrace technological advancements will promote the utilization of digital tools in Value Management (VM) practices. This, in turn, will result in clients increasingly demanding the incorporation of digital technologies in the execution of their projects—a current factor discouraging

the adoption of digital tools in the construction sector (Yahya *et al.* 2019). Prior research has emphasized the importance of clients' requests for digital technology use in their projects as a driving force for technology adoption (Aghimien *et al.* 2021). Often, clients may be hesitant to bear the additional costs associated with VM or extra technologies, potentially stemming from prevailing industry norms. If the adoption of technologies becomes a standard practice, embracing them for the VM process is likely to encounter minimal or no resistance (Punnyasoma, Jayasena and Tennakoon 2019). Furthermore, study by Olanipekun and Sutrisna (2021) have noted that when workers lack awareness of the advantages offered by technology, they often exhibit resistance towards its adoption. Some view emerging technologies as potential job threats, which further fuels their resistance. Consequently, in order to promote the effective utilization of digital tools for enhancing the Value Management (VM) process, it becomes crucial to educate VM experts about the potential benefits associated with implementing these technologies.

Moreover, experts have also highlighted that the availability of relevant digital technologies poses a significant barrier to the adoption of digital tools in Value Management (VM) and other construction management activities that necessitate digital transformation within the construction industry. Therefore, when these technologies are accessible, it becomes imperative to have the appropriate expertise capable of effectively handling them. The construction industry in developing countries, including Nigeria, grapples with a shortage of skilled personnel (Olanipekun and Sutrisna 2021), which hampers the successful integration of technologies. This observation aligns with the findings of Emmanuel, Omoregie and Koloko (2018) and Oke and Arowoia (2021), who have both noted that the absence of well-trained personnel proficient in handling digital tools is a significant impediment to technology adoption in many countries. Consequently, organizations need to invest in

the training and continuous development of their workforce to ensure the availability of the right expertise, ultimately paving the way for the widespread use of digital tools in VM practices.

8.5 CONCLUSION

This chapter of the research presented a summary of the first and second Delphi results as well as subsequent discussions. The chapter also presented for the computation for every question variable to determine the attributed that have an impact on efficient VM performance in the Nigerian construction industry. Likewise, the barriers to using digital technologies for VM were also presented and discussed. Based on the Delphi specific objectives, this chapter also discussed the findings and supported them with literature. Furthermore, this chapter delved into examining the impact of improved Value Management (VM) factors such as standardization, integration, and collaboration on VM performance. It also validated a previously identified gap in the study, namely the intersection of corporate culture and digital technologies. To perform this validation, calculations were conducted using Excel spreadsheets, employing median, mean, and interquartile deviation (IQD) metrics. The chapter was then concluded with a comprehensive discussion of the findings, aligning them with the objectives of the Delphi study. Remarkably, the expert participants in the study shared a consensus on VM management in Nigeria, with strong support for nearly all variables associated with VM. The results of the Delphi study played a pivotal role in uncovering significant factors and constructs vital for enhancing VM, ultimately contributing to the development of a comprehensive integrated model for enhancing VM performance in Nigeria. The subsequent chapter delves into a detailed discussion of these constructs and their contributions to the model.

CHAPTER NINE

CONCEPTUAL INTEGRATED VM PERFORMANCE MODEL

9.1 INTRODUCTION

After presenting the Delphi study and its findings, this chapter delves into a detailed examination of the conceptual framework, or model that forms the foundation of this research. Within this chapter, you will find the hypothesized integrated model for Value Management (VM) performance within the construction industry. This model is the result of a thorough evaluation of four preceding VM models, as introduced earlier in this thesis (Chapter Two). Furthermore, this chapter provides an in-depth exploration of the VM performance model and its primary variables. It also briefly addresses gaps identified in previous models, including corporate culture and digital technologies, which were discussed in Chapter Three. To conclude, this chapter presents the rationale behind the selection of variables within the model and justifies their inclusion, ultimately offering a comprehensive overview of the research framework.

9.2 SELECTION OF VARIABLES FOR VM PERFORMANCE

The literature on Value Management (VM) practice within the construction industry widely acknowledges a common challenge: the absence of a universal indicator capable of reliably assessing the performance of VM in construction projects. To advance the practice of VM in construction and ensure its effectiveness, it becomes imperative to establish a well-structured measurement system. This measurement system should encompass variables that enable continuous monitoring and serve as benchmarks for assessing VM practice in the construction sector. Consequently, this chapter introduces an integrated conceptual model for VM practice in the construction industry, equipped with robust performance indicators and constructs. This model is designed to address the

aforementioned issue and provide a comprehensive framework for evaluating VM performance in construction projects. As highlighted by Ngulube, Mathipa and Gumbo (2015), a conceptual model plays a vital role in visually depicting the relationships between independent and dependent variables, aiding in a clearer understanding of the subject matter.

The examination of previous Value Management (VM) models designed for the construction industry reveals a common approach where various constructs are amalgamated to gauge VM performance. For instance, as highlighted by Ojo, Ogunsemi and Ogunsina (2021), the effectiveness of VM practices within the construction sector is often assessed by considering factors such as standardization, collaboration, and communication among diverse stakeholders. Mohamad (2014) and Mohamad Ramly (2015) maintained that VM in the construction industry is determined by the degrees of interaction, certain cultural dimensions and the system thinking approach are found to have significant influence in maximising participation among project team members during the entire VM process. In addition, Whyte and Cammarano (2012) and Ahmed, John and Nicholas (2012) developed a VM model for the construction industry adopting constructs such as risk management, integration, collaboration, and communication. Aghimien *et al.* (2022) also indicated that the practice of VM in the construction industry can be improve using digital technologies. Furthermore, Othman *et al.* (2020) developed a model and adopted collaboration, corporate culture, and integration. Therefore, based on the review of literature and previous models for VM, this study proposes five constructs which qualified for the Delphi process and were validated by experts as they contribute significantly to enhanced VM performance.

9.2.1 Collaboration

Collaboration is one of the critical VM process that must be fulfilled for ensuring effective VM performance. From the study, resource sharing, partnership, decision alignment, team building

activities, knowledge sharing, shared orientation, communication among professionals in each phase, client's support and participation, VM guidelines and legal framework, improving communication and understanding among stakeholders, group goal setting, equal contribution of participants, risk sharing and human relations among team members were found to be VM collaborative attributes for ensuring VM performance for the built environment. Regarding improving the performance and delivery of construction projects in the construction industry, collaboration among members of the construction industry has been suggested by scholars (Ferme *et al.*, 2018; Ahn *et al.*, 2016; Qiang *et al.*, 2021). Also, Tran (2021) affirmed that there is a need for enormous collaboration in the building industry due to the difficult, complex, geographically dispersed, and multi-organisational nature of the industry. Similarly, Lofgren and Eriksson (2009) and Danilo and Patricia (2018) indicated that integration and collaboration serve as a tool for ensuring a better production process towards increasing the construction project performance. It can be deduced that the ability to bring VM teams together is the similarity between collaboration and integration. This study affirmed that collaboration entailed the coming together of two or more independent building professionals collaborating to schedule and implement construction project processes to enhance the performance of building projects. Also, to increase the value of the project, Liu (2018) submitted that collaboration enables firms to concentrate on performing their core skills, thereby adding value to the entire project. Cao and Zhang (2011) opined that collaboration allows firms to acquire knowledge from other firms. Similarly, Asri *et al.* (2021) reported that collaboration allows the sharing of knowledge due to its capability for establishing a learning platform. Ferme *et al.* (2018) affirmed that collaboration allows an organisation to meet its objective faster and at a lesser cost than when professionals work independently. Cao *et al.* (2010) indicated that collaboration can be broken down into several components such as decision synchrony, incentive alignment, joint knowledge creation,

communication, resource sharing, goal congruence and information sharing. Shin *et al.* (2011) looked at the advantage of collaboration from another angle and concludes it gives the firm access to a new resource that can be informed of technology. Zhao and Moh (2016) believed that towards enhancing the performance and delivery of construction projects in building firms through VM, collaboration in the form of cross-sectional team effort is of utmost importance. Kokkonen and Vaagaasar (2018) affirmed that the most crucial of all the collaboration tools is the use of information technology for effective means of communication. Edwards *et al.* (2016) and Mallett (2017) also confirmed that the sharing of information solely depends on collaboration among construction professionals. Meng (2012) indicated that collaboration provides the opportunity to work jointly across organization boundaries. Tomelleri *et al.* (2015) stated that collaboration occurs when building professionals agree to harmonize and align their objectives, information, and decisions to achieve a common goal. It can be inferred from the above that collaboration entails accepting equal responsibility and commitment to achieve a common goal. These characteristics make collaboration crucial in VM process for achieving on-time delivery of the project.

Table 9.1: Conceptual Model Latent Constructs

Constructs	Measurement variables
Integration (IN)	Knowledge about VM
	Regular workshop meetings
	Commitment of participants
	Early goal definition
	Clear objectives of workshop
	Experienced VM facilitator
	Availability of resources
	Accelerated decision making
	Efficient ideas and alternatives gathered in early stage
	Enough time to conduct VM studies
	Open information system
	Prompt response among professionals during VM meetings

	Equal contribution of participants
	Constant communication
Standardisation (ST)	Input of government and its agencies
	Mandatory VM training certification for all construction professionals
	Presence of VM guidelines and legal framework
	Government commitment to implement VM
	Inclusion of VM clause in procurement Act
	Attendance of policymakers on constant basis
	Regulation of VM activities
	Collaboration of government officials and professional bodies
	Customising VM for the Nigerian construction industry
	Active client's support and participation
	VM action plan for implementation
	Clients' capacity to convey demands to the design team
Collaboration (COL)	Information sharing
	Resource sharing
	Partnership
	Decision alignment
	Teamwork
	Knowledge sharing
	Shared orientation
	Coordination
	Interaction among participants in each phase
	Dispute resolution techniques
	Client's support and participation
	Group goal setting
	Risk sharing
	Cooperation
Corporate culture (CC)	Interpersonal relationship
	Teamwork
	Management commitment
	Cooperation among stakeholders
	Motivation
	Education and Training
	Skill development and acquisition
	Risk management
	Reward and incentive system

	Creativity orientation
	Innovativeness
	Updated technology system
	High degree of flexibility
	Regulation of VM activities
	Assertion of policy within the value chain
	Control of other construction professionals`
	Smooth operation of VM activities
	Meeting targets with adherence to schedule
	Result oriented
	Client satisfaction
	Goal accomplishment
	Ensures large market size
Digital Technologies (DT)	Internet of things (IoT)
	Building information modelling (BIM)
	Augmented reality technologies (smart phones, video games, etc.)
	Mobile devices
	Digital twin
	Administrative tools (Microsoft suites, Primavera)
	Virtual reality (sophisticated headsets, LCD displays, etc.)
	Cloud computing
	Block-chain technology
	Electronic meeting tools (zoom, Microsoft teams, etc.)
	Knowledge of cyber-security
	Advanced Big data analytics
	Engineering design (Computer-aided design)
Outcome of VM (VMoutput)	Cost-saving practice
	Material management
	Time Management
	Risk management
	Whole life asset management
	Conflict management
	Long-term planning
	Quality management system
	Waste reduction
	Improved project management
	Elimination of delay

	Effective project delivery
	Better quality system and performance
	Innovative designs
	Optimisation of value
	Increased efficiency in achieving tasks
	Better collaboration among professionals
	Enhanced project functionality
	Sustainability

Source: Researcher's review of literature

After both rounds of the Delphi, experts achieved consensus as all the factors constituting the main variables had strong scores and ratings. Subsequently, the variables were further refined to improve the grammatical composition (wording) and overall structure which reduced the number of variables for each factor and to avoid repetition of variables. For examples, integration with seventeen (17) variables was reduced to fifteen (15) variables; standardisation features with ten (10) variables was increased to twelve (12) variables; collaboration features with eighteen (18) variables was reduced to fourteen (14) variables. The two additional constructs are the identified gaps from the past models which are corporate culture (CC) with thirty-one (31) variables was reduced to twenty-two (22) variables and the use of digital technologies (DT) which has eighteen (18) variables was reduced to (13) variables. It is proposed that all the constructs will ensure the performance of VM in the Nigerian construction industry. The outcome variable from the model represents the performance of VM of twenty-two (22) variables as presented in Table 9.1. Both additions are the gaps in VM performance models that were discussed and treated comprehensively in Chapter Three of this research. Both variables were also included in the Delphi study and their factors also achieved consensus. The next section discusses the three factors mentioned earlier, namely IN, ST, and CO and how they contribute to enhanced VM performance.

9.2.2 Standardisation

This study recognizes the impact of standardization as one of the performance indicators of VM. Standardization in this study was categorised into; input by relevant governmental and local authorities, VM study plan for implementation, clients' enforcement ability to communicate requirements to design team, government commitment to implement VM, regular attendance of decision-makers, and active client's support and participation. This supports the findings of Kim et al. (2016) and Aghimien et al. (2018), who saw government interest in VM adoption, preparedness, client participation, and public awareness of VM advantages as performance criteria for VM. According to Kineber et al. (2021), the initiative-taking efforts of the US government and its public agencies are enabling to enhance the implementation of VM throughout the US construction sector. Ahmad (2011) highlights the Malaysian government's efforts by mandating VM approval for all government construction projects. When working on building projects for the US and Australian governments, similar VM approval rules are necessary. This demonstrates how government actions have contributed to the broad adoption and performance of VM among building professionals. Kineber et al. (2021) also recommended client support and active involvement with the successful performance of VM. According to Perera and Karunasena (2004), a key impediment to the implementation of VM is the lack of participation from project owners. As a result, the client's involvement and commitment are critical to the success of VM's deployment and performance. Similarly, policymakers in the construction industry should be prepared to make this a part of their corporate culture. The government can generate all of VM's initiatives and regulations because it is the largest consumer and investor. It also has a significant amount of capital development in the form of property and infrastructure development assets (Tanko et al., 2017). Policy makers, government agencies and leadership of the built environment are significant organizer and administrators to

include a wide choice of options to support the adoption of sustainable materials and technological innovations (Hwang and Tan, 2012). As a result, the government's support, and active engagement in the application of the VM on current construction development will be critical (Tanko et al., 2017). The responsibility (i.e., obligatory environmental requirements) for implementing sustainability criteria will be resolved if authorities collaborate with the client and senior management to clearly define and provide appropriate assistance (i.e., financial rewards). As a result, improvements in VM implementation techniques will be noted. Zainul-Abidin (2014) further revealed that engagement between stakeholders and experts increases the likelihood of clients and end-users respecting sustainability achievement. According to Jaapar et al. (2009), inadequate expert engagement and poor facilitation skills might have a detrimental impact on VM activities.

9.2.3 Integration

The VM integration process is the technique of bringing together diverse knowledge, expertise, and technology in order to optimize project results, which is particularly important for assuring the timely completion of construction projects (Takim and Nawawi, 2011; Olanipekun, 2015; Olanipekun *et al.*, 2017; Mohd Isa *et al.*, 2018) and it provides improved value to owners while also maintaining maximum efficiency across all design, fabrication, and construction phases. (Olanipekun, 2015). From the reviewed literature, it can be discovered that VM integration process is an attribute for ensuring the performance of VM. These are but not limited to awareness/knowledge of VM participants which is a paramount attribute that must be considered before VM can be successfully implemented in the built environment. Increased awareness among professionals can improve the performance of VM in the built environment. Ilayaraja and Eqyaabal (2015) and Kineber *et al.* (2021) affirmed that in order to achieve VM performance, it is crucial to have the necessary knowledge, experience, and awareness of the VM approach, such as life-cycle costing, innovative thinking, and

the Function Analysis System Technique (FAST) diagram. Lack of awareness and knowledge, complicated internal linkages, and poor decision-making methods, according to Kolo and Ibrahim (2010), are some of the key factors for bad VM adoption in the construction sector. VM has been around for a long time, and there is a plethora of publications (research papers, articles, journals, and so on) about it. The depth of awareness, understanding and expertise among practitioners on how to do VM, on the other hand, is extremely poor. It is a tremendous concern that underdeveloped nations are still trying to promote knowledge about how to integrate VM principles in the built environment in a systematic way. According to Luvara & Mwemezi (2017), the most significant barrier is a dearth of awareness of VM in Tanzania's building sector. The use of VM in Sri Lankan construction projects is inadequate, according to Ekanayake et al. (2018), due to a lack of awareness and knowledge of VM methods. Construction professionals and participants should engage in charrettes, seminars, or pre-workshops early in the construction phase to agree on strategies, commitments, disagreements, and programs to achieve these VM integration processes (Mahame et al., 2018). Also, the studies conducted by Cao and Zhang (2011) and White and Marasini (2014) recognised the importance of involving professionals in a construction projects. Sabiua *et al.* (2019) maintained that VM integration process refers to the procedure adopted for improving construction project performance through the syncing of information, process, and people. This opinion recognizes that VM integration as a tool for ensuring operational performance. Annamalai and Ganapathy (2021) described VM integration as a systematic approach in construction for effective role in reducing cost and improving the delivery, functionality, or quality of the project. The author described VM integration process as the level in which VM experts collaborate tactically to handle inter- and intra-organizational operations. This view also recognised that VM integration process occur within and outside the firm. In support of this opinion, various research indicated that VM integration process can be grouped into

different phases. Integration is defined in this research as the informal or formal activity of combining information, procedures, and people into a single structure on a construction project (Kissi *et al.*, 2015; Kinebar *et al.*, 2020; Thneibat *et al.*, 2021). The phases of integration can only be achieved through applying different practices necessary for VM integration (Coetzee 2010; Alshehri 2020). Aghimien and Oke (2015) concluded that the initial involvement of construction stakeholders is the most crucial practice for VM integration. In support of this opinion, Olanipekun *et al.* (2017) discovered that when stakeholders like architects, engineers, construction managers, clients, occupants, and government agencies participate in the early-stage construction schedule, performance will be enhanced. Team colocation on a construction project was identified by Kokkonen and Vaagaasar (2018) to have a key component for VM integration process. Xie *et al.* (2010) contended that colocation ensures better communication and interaction, thereby removing misunderstandings at the design stage. Ballard *et al.* (2015) asserted that another practice of VM integration is risk-sharing. Lavikka *et al.* (2015) opined that colocation performs a significant role in complementing the formal contracts for construction projects as it creates trust and improves the relationship among members. Risk sharing is included as a VM integration process because firms that agree to integrate their activities with other firms are vulnerable to other firms. The relevance of VM in the decision-making process among construction professionals was recently proved by Noor *et al.* (2015) to be very significant. The role of VM guarantee that construction firms realise value in their projects while also meeting the expectations of their clients. It also oversees the related budget limitations as well as a constraint for reducing the additional cost while maintaining project quality and dependability (Aigbavboa *et al.*, 2016). From the foregoing, the success of VM performance is more related to the VM integration attributes.

9.2.4 Corporate Culture

Organisational culture is one of the major attributes in VM for ensuring VM performance in the building industry. Cadden *et al.* (2013) established that organizational culture is a form of behaviour developed over time by an organisation to adapt to problems. It can be deduced that these scholars recognised organisational culture as a behavioural pattern exhibited in an organisation. Likewise, Tedla (2016) categorised organisational culture has a form of business arrangements. In support of this assertion, Owoyemi and Ekwoaba (2014) avowed that organisational culture is an effective tool for decision making utilised by members of an organisation for adapting to internal and external problems. Naranjo-Valencia *et al.* (2011) opined that organizational culture functions as a business structure that allows the effortless sharing of information among members of an establishment. It can be deduced from the scholars within this category that they perceive corporate culture as a tool or strategy for arranging and managing an organisation. Organisational culture, according to Taghizadeh *et al.* (2012), is a system of shared inferences that individuals have about the company. Features such as management support, invention and risk-taking, focus to employees in the organisation, and ambition should be included in the corporate structure to promote VM. The senior management of the organization must coordinate their processes, strategies, and regulations with the associated project to implement VM throughout the organization (Taghizadeh *et al.*, 2012). Organisational culture is influenced by factors such as the organization's structure, the system, and procedures by which work is completed, employee preferences, the organization's customs and beliefs, and management and leadership styles. Moreover, this approach of continual improvement necessitates that the manager function as a genuine leader in the firm, ensuring that all employees participate and becoming active in all value chain operations. Combined standards, beliefs, and assertions involving the way in which employees should behave and interact, the way issues are being addressed and how

actions are taken, and how roles and responsibilities should be conducted, altogether make up organizational culture. The background and environment of a firm, as well as the people that run and work for it, all have a role in its culture. Good governance necessitates a thorough understanding of the company's culture. Top management will be better equipped to integrate strategy and accomplish their goals if they comprehend their company structure. Organisational culture, according to Nguyen and Watanabe (2017), is a collective understanding of organisational work practices among organizational units that may differ from others. The several essential success variables that have been investigated in project management include factors related to managerial involvement, information sharing, personal relations, employees' participation, and decision making (Nguyen and Watanabe, 2017). In a similar line, Olawumi et al. (2016) suggested that VM training is essential for professionals in the built environment to adopt it. Engaging VM professionals from developed countries to give all VM tools and procedures might potentially be a training option. Construction professionals will be trained in VM, reducing the scarcity of VM expertise in the market (Kim et al., 2016). Malla (2013) further suggests that remunerating participants in VM studies should increase the use of VM in building projects. Hayatu (2015) acknowledges this and argues that collaboration among these experts to adopt VM can improve working relationships and reduce unethical behaviour among participants. The capability of VM organizations to promote collective delivery options will help to align the interests of numerous construction stakeholders to maximise the value of clients' money. According to Oke and Aigbavboa (2017), appropriate VM training not only helps construction practitioners, but also encourages its widespread use. Hayatu (2015) further argues that raising project owners' knowledge of VM will stimulate its use in more building projects. The study of Coetzee (2010) also suggested the use of information technology, i.e. electronic VM exercise such as video conferencing as a tool to improve the performance of VM. The study opined that VM team

can work on the internet and use new and updated technologies for VM practice. The findings corroborate the study of Fan et al. (2010).

9.2.5 Digital Technologies

Aghimien *et al.* (2018a) have noted that digital tools comprise software, methods, hardware, complex and massive data to unearth the significant patterns and trends needed to make informed decisions. Cloud computing has also been noted as a viable tool for successfully delivering construction works (Atobishi, Gábor and Podruzsik 2018). This technology allows computing resources to be shared among diverse participants (Amarnath, Sawhney and Maheswari 2011).

Additionally, the utilization of visualization tools such as augmented reality (AR) and virtual reality (VR) offers an immersive experience of the real world, using virtual data to minimize errors in projects (Zhang *et al.* 2020). Research demonstrates that VR enhances site safety and productivity through VR-supported tools (Li *et al.* 2018; Zhang *et al.* 2020), while AR reduces on-site errors and rework with AR-based tools. Sensing and data-gathering technologies like sensors, laser scanners, and drones are also effective in project delivery. Drones can be combined with Building Information Modeling (BIM) for 3D modeling and innovative applications (Mahajan 2021). Laser scanning provides valuable project information by capturing specific construction scenes, contributing to the creation of virtual environments (Aryan, Bosché and Tang 2021). Blockchain technology further facilitates sustainable construction and adherence to project budgets and schedules (San, Choy and Fung 2019). Leveraging technology-driven Value Management (VM) processes, construction participants can deliver enhanced value in projects. For example, BIM, cloud computing, and the Internet of Things (IoT) improve communication and collaboration among project teams, including VM teams (Aghimien *et al.* 2018a). Moreover, BIM enables VM teams to detect design clashes that may have been overlooked by the project's design team, facilitating timely corrections and avoiding

unnecessary costs, delays, and material wastage during construction (Ibrahim, Hashim and Jamal 2019). Additionally, Big Data Analytics (BDA) (empowers VM teams to effortlessly gather, store, and analyze data, aiding informed decision-making crucial to project success (Atobishi, Gábor and Podruzsik 2018).

9.3 MODEL SPECIFICATION AND JUSTIFICATION

The major aim of this thesis is to develop an improved model for enhancing VM performance. The model will be used to successfully benchmark VM performance in Nigeria. Despite the debates and reviews surrounding the concept of VM, there has been a dearth of literature on VM performance model specifically for the built environment, a gap this study intends to address. Variables must be included in the measuring system to track performance and serve as a standard for VM in the construction built environment with reliable performance indicators and constructs. The review of past VM models for the construction industry shows that they combine different constructs as a measurement for VM performance. For instance, Ojo, Ogunsemi and Ogunsina (2021) indicated that the practice of VM in the construction industry is determined by standardisation, collaboration, and communication among different stakeholders. Mohamad (2014) and Mohamad Ramly (2015) maintained that VM in the construction industry is determined by the degrees of interaction, diversity of visualization aids, certain cultural dimensions and the system thinking approach are found to have significant influence in maximising participation among project team members during the entire VM process.

Furthermore, Whyte and Cammarano (2012) and Ahmed, John and Nicholas (2012), laid the foundation for a Value Management (VM) model tailored to the construction industry. This model incorporated key elements such as risk management, integration, collaboration, and communication.

Building upon a comprehensive review of existing literature and previous VM models, this study introduces five essential constructs for the development of a VM model specifically designed for the Nigerian construction sector. These primary constructs within the model encompass collaboration (COL), integration (IN), and standardization (ST). Additionally, two supplementary constructs have been identified based on gaps observed in prior models: corporate culture (CC) and the utilization of digital technologies (DT). It is proposed that the incorporation of all these constructs will significantly enhance the effectiveness of VM practices within the Nigerian construction industry.

Based on the main dimensions and constructs peculiar to the existing models of VM, the proposed VM performance model for this study examined the relationship of integration, collaboration, and standardisation (essential variables measured from previous studies) with the inclusion of corporate culture and the use of digital technologies (exogenous variables) and their roles in ensuring enhanced VM performance (endogenous variables). These factors are expected to play a pivotal role in achieving successful construction project delivery. Additionally, this study aims to assess and predict the relative importance of these primary dimensions (exogenous variables) in enhancing Value Management (VM) performance. It seeks to determine whether VM performance is contingent on the presence of these variables and the benefits derived from the incorporation of corporate culture and digital technologies. Moreover, the proposed model's variables will be measured using both objective and subjective methods, striking a balance as needed. The conceptual model underlying this study posits that enhanced VM performance is established through the interplay between the main (exogenous) variables and their underlying factors, which are linked through both objective and subjective measurements. These variables, key factors, and constructs were identified through a thorough review of existing models, pertinent literature, and the insights gained from the Delphi

survey. As a result, they are recognized as critical determinants contributing to enhanced VM performance in the Nigerian construction industry.

9.4 STRUCTURAL COMPONENT OF THE MODEL

The present conceptual model for this study theorizes that enhanced VM performance for the built environment in Nigeria is derived from the possession of Collaboration (COL), integration (INT) features, Standardisation (ST) features, corporate culture (CC), and digital technologies (DT). The VM performance model to be tested in the postulated hypothesis has never been tested and is a multidimensional structure composed of INT, ST, COL, CC, and DT. In this conceptualized model, enhanced VM in the built environment is related to the evaluation of several variables. It is difficult to discuss integration features without referring to the variables of collaboration, corporate culture, and digital technologies. Therefore, the result will determine the exogenous variables that is the most relevant because the responses of individuals may vary in different circumstances.

9.5 OUTCOMES OF IMPROVED VM PERFORMANCE MODEL

As shown in Figure 9.1, enhanced VM performance model posits that improved VM performance for the built environment in Nigeria is derived from the possession of INT, COL, ST, CC, and DT. This study recognised the performance indicators of VM as the expected benefit or output for adopting VM in the construction industry. The study found that cost saving practice, time-saving practice, material management, risk reduction, whole life asset management, long-term planning, improvement in project complexities, stakeholders health and safety, process improvement, quality management system, logistics management and elimination of delay were the major performance indicators for successful VM performance. Tony and Tam (2013) recommended that cost savings is the major output and for adopting VM in the construction industry. Madushika *et al.* (2020) opined

that time saving, cost saving, and quality management system are the major performance indicators for adopting VM in the construction industry. In the same vein, Ranesh, Zillante and Chileshe (2012) and Nnadi and Ezemerihe (2018) ascertained that adopting VM is a valuable strategy for dealing with risks and uncertainties that may arise throughout the construction process, as well as for improving risk response efficiency. As a result, risk consultants are advised to use VM approaches as a strategy to curb the issue of risk for effective project delivery. VM technique, according to Lalevee et al. (2020), might be effective in integrating sustainable components in the process of developing construction projects, which is a primary performance/output of VM methods. Furthermore, the data suggested that one of VM's key objectives is to ensure the safety and wellbeing of construction personnel. Alshehri (2020) backed up this claim, stating that VM is critical throughout the briefing stage, particularly in terms of occupational safety and wellbeing of professionals, design process, cost and quality, contract strategy, and time performance. Quality management was also proven to be a significant output of VM performance. Incorporating VM in the construction sector, according to Xiaoling et al. (2013) and Zuofa and Ochieng (2017) will increase the quality standard and efficiency. This supports the findings of Oke, Aghimien and Olatunji (2015) and Martens and Carvalho (2016), who found that implementing VM effectively enhances the quality of construction projects. Othman *et al.* (2020) also created a framework that outlines the actions and procedures required to integrate the VM idea into the design process as a means of minimizing construction waste. The framework was created in response to the requirement to meet sustainability goals by reducing construction waste throughout the design phase. This is because decisions taken early in the design process have a considerable influence on the project's long-term viability.

In addition, VM is a key contributor to the development of innovative solutions to minimize construction waste and achieving sustainability goals. Sustainable development that balances social, economic, and environmental goals is now on the agenda for the global construction industry (Zuofa and Ochieng 2017). The term "sustainability agenda" relates to environmental conservation, social prosperity, and improved economic performance (Yu *et al.* 2018). At the inception and planning stages of the construction project, VM can incorporate a sustainable process (Abidin and Pasquire 2007). Incorporating sustainability into the building process from the beginning and all through the construction process is critical for the success and productivity of a construction project as it enhances decision-making among professionals (Yu *et al.* 2018). The process of selecting a good site location, sustainable materials, determining excellent design features, and ensuring sustainable construction practices is an essential attribute of VM and it helps to minimize environmental and social damage. The basic premise of this concept is to incorporate sustainability concept into the VM process to help minimize the conflicting terms of cost and sustainability when creating, characterizing requirements and purpose to produce solutions that best satisfy the client's investment needs while also meeting environmental and social needs. Integrating VM with sustainability has the goal of putting this subject at the center of VM discourse and operations. As part of the endeavor to transit toward more resource-efficient building, Kineber *et al.* (2020b), suggested incorporating sustainability into VM. The qualities of VM, such as the collaboration of professionals with mixed skills and competency ensures an effective job plan, promote high engagement, sharing of knowledge, and efficiency. Better corporate decisions, higher productivity, improved goods and services, improved communication process, cooperation, and decisions that can be backed by all stakeholders are just a few of the benefits of VM. According to Oke, Aghimien and Olatunji (2015) and Yu *et al.* (2018), dedication to economic sustainability includes strengthening operating efficiency through effective utilization of

resources (human, materials, finance), effective design, and good management, planning, and control; environmental sustainability includes using natural resources, encouraging renewable resources, and protecting the soil, water, and air from contaminations, among other things; and social sustainability includes interdisciplinary collaboration. Al-Yousefi (2008) identified several benefits of using VM as a framework for encouraging and launching sustainability ideas, including increased tool and resource effectiveness, improved applications, and operational maintenance. Kelly et al. (2004) in Kineber *et al.* (2020a) stated that the integration of VM with sustainability is encouraged by multidisciplinary stakeholder commitment, organized and formal VM study, acceptance of sustainable principles as project objectives, and a focus on project cost delivery. As a result, VM is a viable and recommended means of achieving sustainability (Kineber *et al.* 2020a).

9.6 MEASUREMENT COMPONENTS OF THE MODEL

The measurement component of the hypothesized model comprises the following VM performance variables: Integration (IN) with 15 measurement variables; Collaboration (COL) with 14 measurement variables; Standardisation (ST) with 12 measurement variables; Corporate culture (CC) with 22 measurement variables; and Digital technologies (DT) with 13 measurement variables. From this model, the successful delivery of construction projects through VM practices can be measured and is guaranteed if the variables listed above are put into consideration before the beginning of a project.

9.7 CONCLUSION

This chapter discussed the conceptual framework (model) underpinning this study. The hypothesized VM performance model was also presented in this chapter based on rigorous review of six previous VM models which was presented earlier in this thesis (Chapter Two), a literature review, and Delphi

survey findings, Integration (IN), Collaboration (COL), and Standardisation (ST) were adopted from the reviewed models and as main constructs. The Delphi study identified and validated factors of corporate culture (CC) and Digital technologies (DT). The theorized model proposes that VM performance is a multidimensional structure composed of five (5) latent variables, including Integration (IN), Collaboration (COL), Standardisation (ST), Corporate culture (CC), and use of digital technologies (DT). These five latent variables are also regarded as the critical success factors for improved VM performance. The next chapter presents the findings of the field survey based on VM performance model.

CHAPTER TEN

PRESENTATION AND DATA ANALYSIS OF FIELD SURVEY

10.1 INTRODUCTION

In the preceding chapter, we introduced and thoroughly discussed the conceptual framework for our research, which is illustrated in Figure 9.1 (Model 1.0). This theoretical framework is underpinned by literature and informed by insights gathered from experts through the Delphi study. This chapter shifts the focus towards the analysis of data collected through the questionnaire survey. The analysis encompasses several facets, including descriptive statistics, inferential statistics, and hypothesis testing. To conduct the descriptive analysis, we employed the Statistical Package for Social Science (SPSS) Version 25 software. For the inferential statistics, we utilized the SmartPLS 4 software. This chapter will provide a comprehensive presentation and discussion of the findings derived from these analyses, shedding light on the key insights and outcomes of our research.

10.2 DATA COLLECTION AND PRESENTATION

The responses from the questionnaire survey were collected using Google Forms and their response was extracted into an Excel spreadsheet. The Excel spreadsheet was then inputted into the SPSS and SmartPLS software. The SPSS was used in running descriptive statistics such as frequencies, percentages, and cumulative percentage whereas the SmartPLS was used in running the structural equation modelling (SEM) that formed the inferential part of this chapter. A total of 227 questionnaires were distributed to the respondents and 202 were retrieved and used for this study. According to Lefcheck (2016), and Hair Jr, Howard and Nitzl (2020), a general requirement for conducting PLS-SEM is that the sample size must be over 200 and also, the number of latent construct leading to the outcome variables should be multiplied by ten times for the minimum number of

samples The number of latent variables in this study is 5 variables leading to improved VM performance, indicating a minimum sample size of 50 which is satisfactory. Thus, this sample size was deemed adequate for this study. According to Hair Jr *et al.* (2021), the model fit of SEM depends on the sample size. The scholars affirmed that achieving a model fit for a sample size below 100 will be difficult, depending on the software used for conducting SEM.

Bag (2015) indicated that there are numerous types of software that could be used for conducting SEM which include AMOS, EQS, LISREL and SmartPLS. Of all these software types, the SmartPLS is unique owing to its capacity to produce SEM from a small size. The SmartPLS software is also unique because it adopts partial least square which is different from covariance-based and component-based SEM (Hair *et al.* 2019). The differences amongst these forms of SEMs and the software used was explained extensively in Chapter six. Also, the reason for choosing SmartPLS was justified in the research methodology chapter. According to Sarstedt and Cheah (2019), the SmartPLS software is widely acknowledged for its capacity to handle a small sample size of 100 to 300. This opinion validates the use of SmartPLS for conducting SEM in this study. This chapter commences with analysing the descriptive statistics while the subsequent section is based on the inferential statistics.

10.3 DESCRIPTIVE STATISTICAL ANALYSIS OF FIELD DATA

10.3.1 Biographical Information

To fully obtain the profile of the respondents, this study conducted frequency distributions of the data of the participants (professionals from the built environment from academia, and the construction industry). Background data obtained were respondents' gender, level of education, professional qualifications, years of experience, and number of projects involved in past years. These data were

required to ascertain the experience and knowledgeability of the respondents to enhance the credibility of the data provided. To this end, five questions were presented in the first section of the questionnaire and the data presented were expressed in frequency and percentages as shown in Table 10.1.

Table 10.1: Demographics of respondents

Question			
1.	Gender	Frequency	Percent (%)
	Male	160	79.2
	Female	42	20.8
	Total	202	100.0
2.	Level of education	Frequency	Percent (%)
	ND (National diploma)	4	2.0
	HND (Higher national diploma)	29	14.4
	Bachelor's degree (BSc/BTech)	43	21.3
	Master's degree	108	53.5
	Doctorate (PhD)	18	8.9
	Total	202	100.0
3.	Professional qualification	Frequency	Percent (%)
	Architect	20	9.9
	Construction Manager	87	43.1
	Construction Project Manager	41	20.3
	Engineer (Mechanical, Civil, etc.)	43	21.3
	Quantity Surveyor	11	5.4
	Total	202	100.0
4.	Year of experience in the construction industry	Frequency	Percent (%)

	1 - 5years	25	12.4
	6 - 10 years	54	26.7
	11 - 15years	69	34.2
	16 – 20years	28	13.9
	More than 20 years	26	12.9
	Total	202	100.0
5.	Number of projects respondents' have been involved in	Frequency	Percent (%)
	None	1	0.5
	1-2	6	3.0
	3-4	17	8.4
	5-6	18	8.9
	7-8	23	11.4
	9-10	20	9.9
	More than 10	117	57.9
	Total	202	100.0
Types of clients			
Percentage (%)	Government	Corporate Bodies	Individual
Never	14.9	9.4	2.0
Rarely	19.8	14.9	10.4
Sometimes	22.8	18.8	16.3
Often	24.3	29.2	23.3
Always	18.3	27.7	48.0

As shown in Table 10.1, more than half (79.2%) of the respondents are male while the remaining 20.8% are female. The high proportion of male respondents could be related to the assumption that

the construction industry is dominated by male professionals. Also, 108 (53.5%) of the total population possess a master's degree, followed by 43 (21.3%) with bachelor's degree. Moreover, 29 (14.4%) possess a higher national diploma, while respondents with doctorate and national diploma constituted 18 (8.9%) and 4 (2.0%) of the total population respectively. The high percentage of respondents with a master's degree indicates the high quality of responses obtained during the field survey. The majority of the respondents were construction managers representing 87 (43.1%), followed by engineers representing 43 (21.3%), followed by construction project managers representing 41 (20.3%), whereas architects and quantity surveyors were represented by 20 (9.9%) and 11 (5.4%) respectively.

A further look at Table 10.1 shows the respondents' year of experience in the construction industry. A total of 25 (12.4%) of the respondents had one to five years of experience, 54(26.7%) had six to 10 years, 69(34.2%) had between 11-15 years, 28(13.9%) of the respondents had between 16-20 years, while 26 (12.9%) of the respondents had more than 20 years of work experience. This implies that 87.6% of the respondents had more than five years of experience in the construction industry which suggests that the respondents who contributed to this research were well knowledgeable in their respective disciplines within the built environment. This improves the validity of the outcomes generated from this study.

Furthermore, the survey on working experience as shown in Table 10.1. depicts that a total of 6 (3.5%) of the respondents have been involved in 1-2 projects, 17 (8.4%) have been involved in 3-4 projects, 18(8.9%) have been involved in 5-6 projects, 23 (11.4%) have been involved in 9-10 projects. Finally, the result showed that most of the respondents 117 (57.9%) of the total population have been involved in more than 10 projects.

Table 10.2 presents the respondents' major clients. It was achieved by requesting the respondents to rate the frequency of obtaining projects from them using a five-point Likert scale ranging from 'never' to 'always'. The figure shows that the majority (48.0%) of the construction projects handled by the respondents are obtained from an individual. This is followed by corporate bodies that provide one third (27.7) of the construction projects whereas the respondents seldom obtain a construction project from the government. Thus, it can be deduced that the government rarely invest directly in the Nigerian construction industry.

10.4.2 Analysis of the best fit model

This section is focused on comparing the analysis of the models that were developed in this study with the intention of identifying the best fit model amongst them. The models were compared based on the model fit indices that are made up of the VIF (multicollinearity), quality of the PLS path model or model predictive power (Q^2). The normed fit index (NFI), model predictive accuracy (Q^2), root mean square error and goodness-of-fit were used as the comparison factor for determining the best fit model. The analysis examined in determining the best fit model for VM was deemed best practice in reporting SEM based on recommendations provided by Henseler, Ringle and Sarstedt (2015), Hair Jr and Sarstedt (2019), and Shmueli *et al.* (2019). The findings from a comparison among the models are presented in Table 10.2.

Table 10.2: Analysis of the best fit model

	Acceptable thresholds	Model 1	Model 2	Model 3
Standardised root mean square residual SRMR	SRMR values < 0.08	0.101	0.094	*0.066
Normed fit index (NFI) Bentler and Bonett (1980)	Values closer to 1	0.324	*0.519	*0.693

Root mean square error (RMSE)	$Q^2_{\text{predict}} > 0$	*0.121	*0.052	*0.047
Goodness-of-fit	0.00 to 1.0	*0.568	*0.613	*0.717

Note* within the recommendable threshold

The result in Table 10.2 shows that the third model meets all the recommended thresholds for the fit indices. For instance, the SRMR for the third model is closer to zero, which satisfy the assertion made by Hussain *et al.* (2018) that SRMR value closer to zero is considered very fit. Although the SRMR for the first and second model can be regarded as acceptable in some cases, Hair Jr and Sarstedt (2019) and Henseler and Sarstedt (2013) stipulated that a model with a lower SRMR can be regarded as a better fit. Regarding the normed fit index (NFI), the third model was rated high again as the fit index yielded a value of 0.693. According to Purwanto and Sudargini (2021), a higher NFI closer to “1” is a better fit model. Although models one and two meet the threshold for the model fit indices regarding the GoF, RMSE and the model predictive accuracy, they were not picked as the best fit model because out of the five model indices criteria, they only meet three of the criteria in comparison to model three that meet all the criteria.

For instance, regarding AVE, the third model also performed better than the other two models because they did not satisfy the standard thresholds, whereas all the constructs for the third model were above 0.5 which satisfies the required standard. For discriminant validity, the first and second models only pass through the cross-loading test and failed the Fornell-Larker criterion. Finally, the multicollinearity (VIF) for the first and second model were high and above the standard VIF as indicated by Hair Jr and Sarstedt (2019), whereas the third model fit into the standard requirement for multicollinearity (VIF) testing. Finally, the standardised root means square residual (SRMR) and NFI

that were used in determining the model fit confirm that the third model is very fit in comparison to other models.

10.4.3 Hypothesised relationship of the VM performance model.

The hypothesized model for this study as shown in Figure 10.1 theorises that the independent variable (VM Performance Model - VMperf.) for the built environment in Nigeria can be enhanced by the possession of collaboration (COL), integration (INT), standardisation (ST), digital technologies (DT), and corporate culture (CC), which are the dependent variables. The five-construct model was analysed using PLS-SEM (SmartPLS 4 software). After three iterations, the model converged and was tested. The VM Performance Model (VMperf.) to be tested in the postulated hypothesis has been tested and is a multidimensional structure composed of COL, INT, ST, DT, and CC. In this conceptualized model, enhanced VM performance model for the built environment is related to the evaluation of several variables.

With the model fit evaluation adequately conducted, the structural model's feasibility can be enhanced by inspecting the statistical significance between the exogenous and endogenous constructs. In testing the significance of both the inner and outer model (coefficients), the PLS-SEM technique relies on a non-parametric procedure known as bootstrapping (Awang, Afthanorhan and Asri 2015). This procedure involves the random drawing of many subsamples (mostly 5,000) from the original sample with replacement to obtain the standard error, which provides the empirical or approximate *T-values*. These values are essential to test the significance of the structural path of the model (influence of exogenous constructs on endogenous constructs). Moreover, the results obtained from the bootstrapping procedure help in the approximation of data normality (Awang, Afthanorhan and Asri 2015). This was used to produce the β Value, and T-statistics test, p values and standard deviation as presented in Table 10.3. In this conceptualized model, improved VM performance is

related to the evaluation of several variables. The hypothesised model for this study is shown in Figure 10.1 (Model 1.0). Subsequently, the structural model (Model 2.0) which was developed based on the findings of the field data and analysed by PLS-SEM is discussed and presented in Figure 10.5.

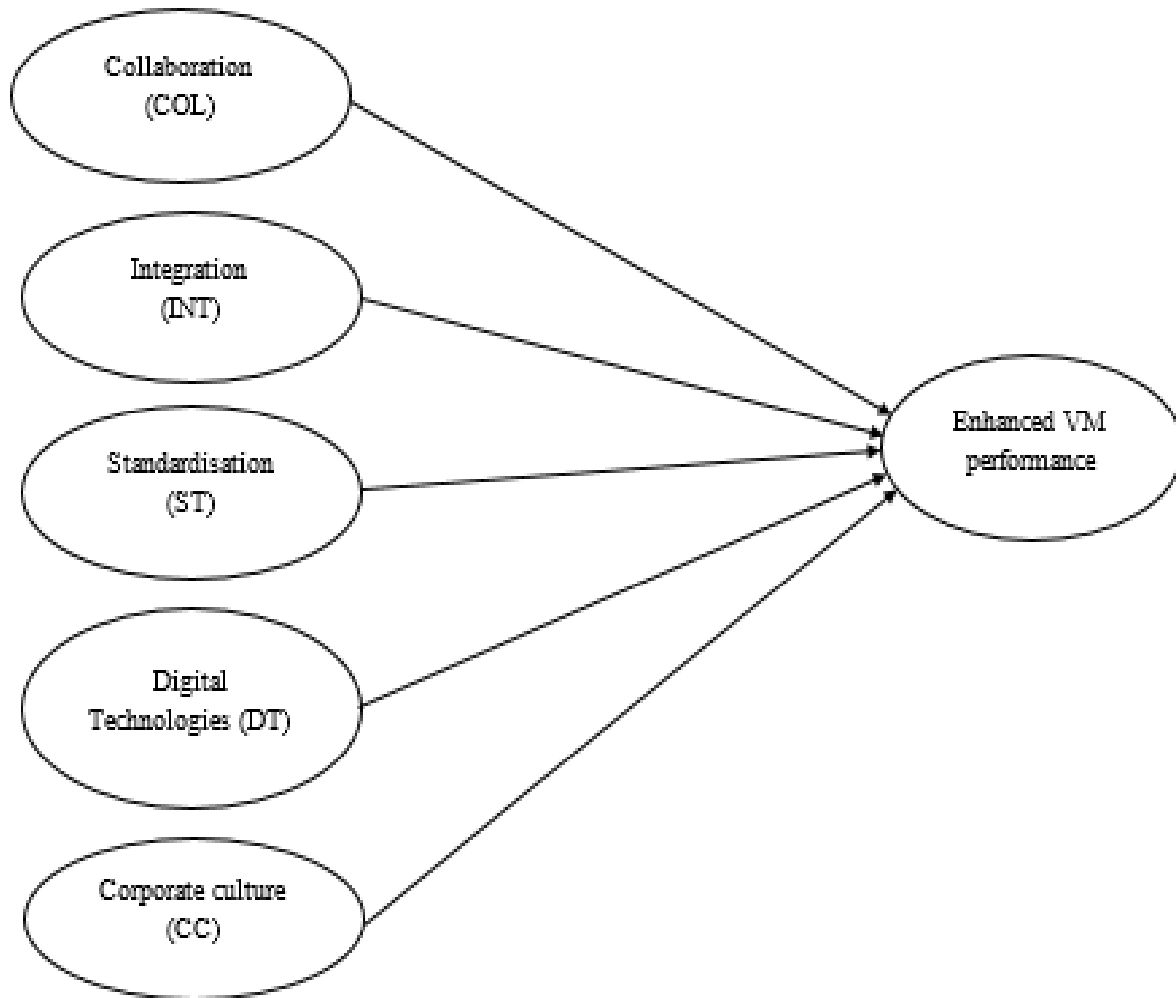


Figure 10.1: Hypothesised VM model (Model 1.0)

For this study, which has a sampling distribution of built environment professionals who are indeterminate, the bootstrapping procedure is suitable for checking the *T-value*. This value provides the confidence intervals for parameter estimates that help to generate statistical inferences. During the complete bootstrap procedure, SmartPLS 4 software also generates the sample mean value,

standard deviation, and p-values for each path model coefficient as shown in Table 10.3. According to Hair, Ringle and Sarstedt (2011), “acceptable t-values for a two-tailed test are 1.65 (significance level = 10 percent), 1.96 (significance level = 5 percent), and 2.58 (significance level = 1 percent)”. This implies that at 90% confidence interval, a T-value of 1.65 and above with a significant value of $p \leq 0.10$ indicates that the path coefficient is significant. Moreover, at a 95% confidence interval, a T-value of 1.96 and above with a significant value of $p \leq 0.05$ indicates that the path coefficient is significant. Similarly, at 99% confidence interval, a T-value of 2.58 and above with a significant value of $p \leq 0.01$ indicates that the path coefficient is significant (Hair, Ringle and Sarstedt 2011). Hair, Sarstedt and Ringle (2019) suggests that for exploratory research, a 95% confidence interval is often appropriate. Table 10.3 shows the various T-statistics and corresponding significant p-values associated with each path of the VM performance model. As shown in Table 10.3, corporate culture (CC) has the highest co-efficient value of 0.224. This implies that CC possesses a high level of variance and has the strongest effect on effective VM performance, followed by collaboration (COL) with 0.218, integration (INT) with 0.138, digital technologies (DT) with 0.125, and standardisation factors (ST) with 0.117.

Table 10.3: Significance of path coefficients of the best fit model

	Path coefficients (β)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics	P Values (95%)	Significance at 95% confidence level
COL > VMperf	0.218	0.216	0.066	1.971	0.034	Significant
INT > VMperf	0.138	0.124	0.053	1.983	0.026	Significant
ST > VMperf	0.117	0.119	0.071	1.975	0.041	Significant

DT > VMperf	0.125	0.228	0.076	2.256	0.029	Significant
CC > VMperf	0.224	0.141	0.085	1.988	0.039	Significant

Note: T ≥ 1.96, P ≤ 0.05, two-tailed test

A general rule for determining the level of significance of the exogenous variable was that the T-statistics must be greater than 1.96 based on the probability level of 95% or 0.05 (Holtzman and Vezzu 2011). Therefore, a prediction or a hypothesis was stated, namely that there is a positive significant impact of each exogenous variable on the endogenous variable. The exogenous variables include collaboration, integration, standardisation, digital technologies, and corporate culture.

Testing the direct influence of collaboration on VM performance

As depicted in the best fit model in Figure 10.2, Collaboration (COL) factor has a positive path coefficient β value of 0.218 (21.8% variance) on effective VM performance ($R^2 = 0.932$). It was also observed that at 95% confidence interval, collaboration possess a T-value of 1.971, which is above 1.96 and a significant p-value of 0.034 that is below the 0.05 threshold, indicating that collaboration factors are statistically significant. The COL construct with the highest outer loading was COL5 (Teamwork) with 0.769 which is the ability of construction professionals to work together on VM activities as a team.

Testing the direct influence of integration on VM performance

As depicted in the best fit model in Figure 10.2, the integration (INT) factor has a positive path coefficient β value of 0.138 (13.8% variance) on VM performance ($R^2 = 0.932$). It was also observed that at 95% confidence interval, INT possesses a T-value of 1.983, which is above 1.96, and a significant p-value of 0.026, which is below the 0.050 thresholds, indicating that integration is statistically significant. The INT construct with the highest outer loading is INT11 (prompt response among

professionals during VM meetings) with 0.727 which is one of the many crucial factors in ensuring the smooth running of VM activities.

Testing the direct influence of standardisation on VM performance

As depicted in Figure 10.2, standardisation (ST) factor has a positive path co-efficient β value of 0.117 (11.7% variance), and thus, a direct effect on VM performance ($R^2 = 0.932$). It was also observed that at 95% confidence interval, standardisation possesses a T-value of 1.975, which is above 1.96, and a significant p-value of 0.041, which is below the 0.050 thresholds, indicating that standardisation factor is statistically significant and directly contributes to VM performance. The standardisation construct with the highest outer loading was ST10 (government commitment to implement VM) with 0.741, which is a critical aspect of implementation.

Testing the direct influence of digital technologies on VM performance

As depicted in Figure 10.2, digital technologies (DT) factor has a positive path co-efficient β value of 0.125 (12.5% variance), and thus, a direct effect on VM performance ($R^2 = 0.932$). It was also observed that at 95% confidence interval, standardisation possesses a T-value of 2.256, which is above 1.96, and a significant p-value of 0.029, which is below the 0.050 thresholds, indicating that digital technologies factor is statistically significant and directly contributes to VM performance. The standardisation construct with the highest outer loading was DT4 (Cloud computing) with 0.696.

Testing the direct influence of corporate culture on VM performance

As depicted in the best fit model in Figure 10.2, the corporate culture (CC) factor has a positive path co-efficient β value of 0.224 (22.4% variance) on effective VM performance ($R^2 = 0.932$), making it the factor with the strongest effect on VM performance. It was also observed that at 95% confidence interval, CC possesses a T-value of 1.988, which is above 1.96, and a significant p-value of 0.039,

which is below the 0.050 thresholds, indicating that corporate culture is statistically significant. The CC construct with the highest outer loadings is CC10 (creativity orientation) and CC5 (motivation) with 0.706 respectively.

10.4.4 Interpretation of the best fit model

The previous section revealed that model three is the best fit model based on the findings from the outer model measurement and the inner structural model. The best fit model is shown in Figure 10.2 which is described as the integrated holistic improved VM performance model (Model 2.0). The model is backed by collaboration theory and goal setting theory as it explained all the constructs used in developing the model. The model shows that all the constructs that were introduced in the conceptual framework were retained in developing the model. However, some indicators used in measuring the constructs were eliminated to ensure a statistical fit for the model. For instance, the endogenous variable VM performance has five indicators. The exogenous construct such as integration has seven indicators, collaboration has nine indicators, standardisation has seven indicators, digital technologies have four indicators, and corporate culture has eleven indicators.

The model also shows that all the exogenous constructs explain above 5% of the variance in the endogenous variable. However, the corporate culture exogenous construct explains the highest variance change in determining effective VM performance in the Nigerian construction industry. Corporate culture accounts for a 22.4% variation in determining the performance of VM in Nigeria. The high percentage for corporate culture validates the gap identified in this study. The model shows that the indicators supporting corporate culture are creativity orientation, innovativeness, teamwork, smooth operation of VM activities, result oriented, goal accomplishment, cooperation among stakeholders, motivation, education and training, and reward and incentive system.

According to the model, after corporate culture, collaboration has the highest variance in explaining or determining the performance of VM in Nigeria. The model shows that collaboration has a 21.8% variance in determining the performance of VM. This implies that an increase in collaboration among VM members during VM activities will improve the performance of VM in Nigeria by 21.8%. The significant indicators determining collaboration are information sharing, dispute resolution techniques, partnership, decision alignment, teamwork, knowledge sharing, shared orientation, coordination, and interaction among participants in each phase.

The exogenous construct with another high variance in determining the performance of VM in the Nigerian construction industry is integration with a variance change of 13.8%. The indicators under the integration constructs include enough time to conduct VM studies, prompt response among professionals during VM meetings, equal contribution of participants, constant communication among participants, clear objectives of workshop, experienced VM facilitator, and accelerated decision-making. In addition, the use of digital technologies also showed a high variation in determining the performance of VM.

The model shows that digital technologies accounts for 12.5% change in the performance of VM. The indicators under digital technologies constructs include Internet of Things (IoT), Building Information Modelling, cloud computing, and advanced big data analytics. Lastly, standardisation construct accounts for 11.7% of VM performance and includes government commitment to implement VM, VM action plan for implementation, input of government and its agencies, inclusion of VM clause in procurement act, regulation of VM activities, collaboration of government officials and professional bodies, and presence of VM guidelines and legal framework.

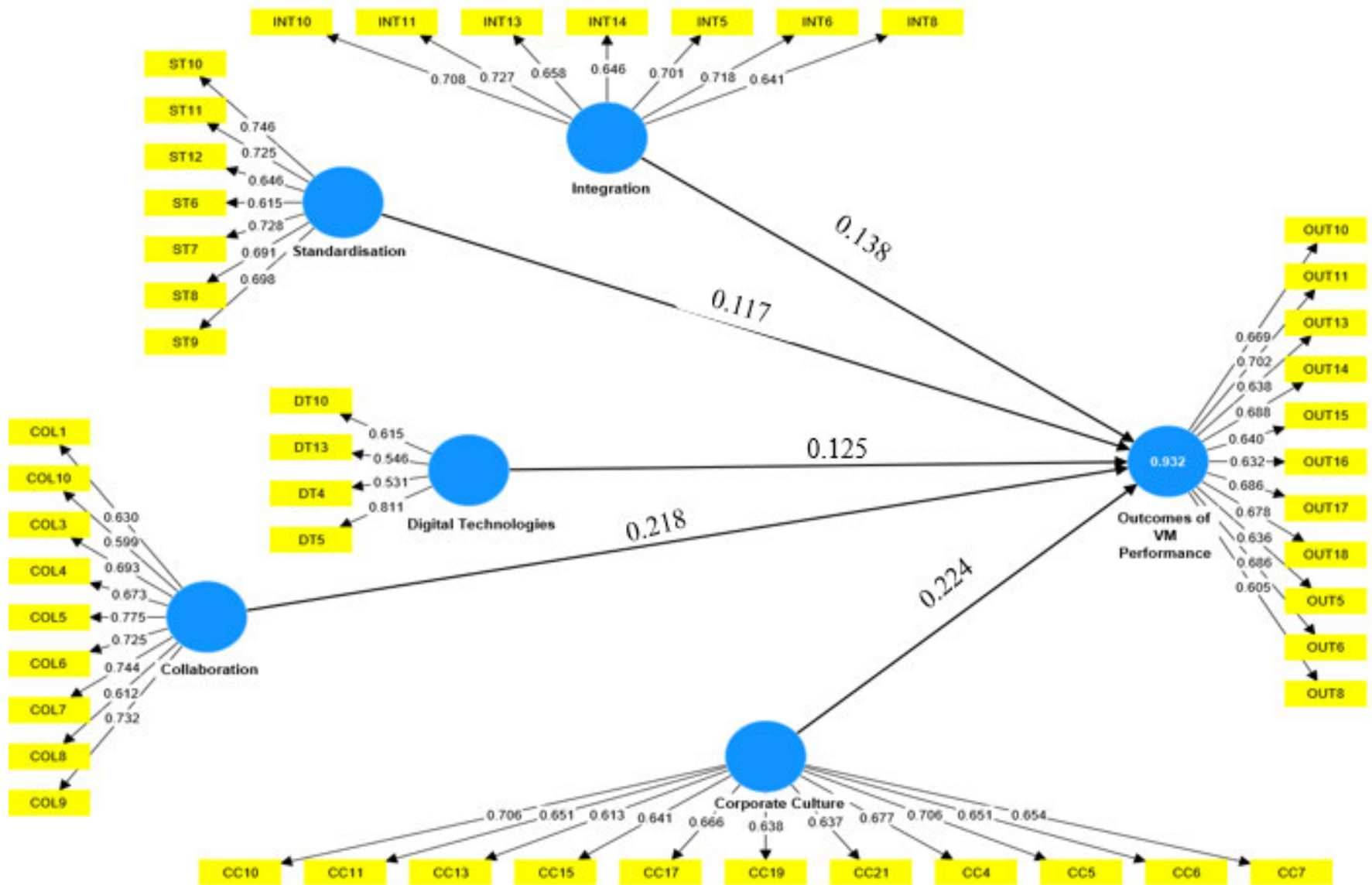


Figure 10.2: Integrated VM Performance Model (Model 2.0)

10.5 Summary of the VM Performance Model (Model 2.0)

Results from the final PLS-SEM analysis revealed that the various model fits and cut-off thresholds met the cut-off index criteria. The SRMR value was found to be 0.066 which is lesser than 0.08 (the accepted threshold). The model's predictive accuracy (Q^2) is 0.421. This satisfies the threshold as they were positive and > 0 . The overall GoF is found to be 0.717 which also meets the criterion for model fit. Hence, the final model as shown in Figure 10.2 meets the various cut-off index criteria. The model can therefore be considered as a good fit. Also, at 95% confidence interval, the path coefficients of all the five latent constructs possess a *T-value* of 1.96 and above with a significant value of $p \leq 0.050$, indicating that the path coefficients are statistically significant. Because Model 2.0 was exploratory of a priori model, there was no need for further analysis as the current model as shown in Figure 10.2 satisfied the necessary criteria. Therefore, the present model is acceptable with its level of fit. The lines of correlations indicate that the VM performance model consists of latent constructs that correlate with each other and are statistically significant. As depicted in Figure 10.2, COL explains 21.8% of the variance of VM performance, INT explains 13.8% of the variance of VM performance, DT explains 12.5% of the variance of VM performance, ST explains 11.7% of the variance of VM performance, and CC explains 22.4% of the variance of VM performance.

The hypothesized model for this study in Figure 10.1 theorises that the performance of VM in the built environment in Nigeria is directly related to the influence of the exogenous variables such as collaboration, integration, standardization, digital technologies, and corporate culture. The model is centered on the theory that the possession of these above-mentioned latent constructs will lead to improved VM performance in Nigeria. This firmly resonated with collaboration theory and goal setting theory. The model further theorises that successful delivery of construction projects is guaranteed if the performance of VM can be improved through the latent constructs. Hence, the

major contribution of this research to the body of knowledge is the development of improved VM performance model for the built environment in Nigeria.

10.6 CONCLUSION

This chapter presented a detailed summary of the field data obtained from the questionnaire survey conducted with 202 valid responses. The chapter drew on the knowledge and perception of professionals from the built environment from academia, and the construction industry. Furthermore, different reliabilities, consistencies, and validities were conducted to ascertain the validity of the variables. The postulated model for this study theorises that improved VM Performance for the built environment in Nigeria is directly related to the influence of exogenous variables (Collaboration [COL], Integration [INT], Standardisation [ST], Digital Technologies [DT], and Corporate Culture [CC]) in predicting the overall VM activities for the successful delivery of construction projects in Nigeria is valid.

In this chapter, the results of the PLS-SEM analysis (measurement model, structural model, model fits and model testing) were presented. The PLS-SEM results helped to determine whether the measurement variables of latent constructs measured the respective constructs they were expected to measure. In addition, the reliability and construct validity of the various latent construct were presented in this chapter. The analyses of the VM Performance Model were carried out which validates the hypothesised VM model. Through a non-parametric procedure known as bootstrapping, the statistical significance of the latent constructs on the outcome variables was reported. The chapter also presented the various model fits and cut-off thresholds such as the standardised root mean square residual (SRMR), normed fit index (NFI), model's predictive

accuracy (Q^2), root mean squared error (RMSE and Q^2_{predict}) and the overall goodness of fit (Goffnett), from which the Model 2.0 was established as the best fit.

Finally, all the five exogenous variables (COL, INT, DT, ST, and CC) have a direct influence on endogenous construct (VM performance). However, the correlations with the other exogenous construct in predicting effective VM performance were found to be statistically significant. Therefore, these latent constructs schematically represented in Model 2.0 adequately addresses VM performance.

CHAPTER ELEVEN

DISCUSSION OF FINDINGS

11.1 INTRODUCTION

The previous chapter presented the findings of the quantitative research (field survey) by conducting data analysis (descriptive and inferential). Based on the analysis using PLS-SEM (SmartPLS 4 software), the testing (model and structure) of the VM model was carried out which validates the hypothesized VM performance model. This current chapter discusses the results of the field survey by examining the influence of each latent construct (exogenous variables) on improved VM performance model (endogenous variables). The chapter further reviews the results of both the qualitative survey (Delphi study) and quantitative survey (field-based questionnaire) to check for convergence and divergence. Finally, the chapter discusses the model fit in relation to the various latent constructs and brings the chapter to a close.

11.2 RESULTS FROM THE QUESTIONNAIRE SURVEY

The VM model posits that improved VM performance model (VMperf.) for the built environment in Nigeria is derived from the possession of Collaboration (COL), Integration (INT), Standardisation (ST), Corporate culture (CC), and the use of Digital technologies (DT). Therefore, the testing of this hypothesis established that the outcomes of improved VM performance, which is predicted by the influence of the above-named five latent constructs, cannot be rejected. In addition, 202 completed questionnaires (cases) satisfy Wong's suggestions of sample sizes for PLS-SEM. Hair, Sarstedt and Ringle (2019) suggested that the number of latent variables leading to the outcome variables should be multiplied by ten times for the minimum number of samples. The number of latent variables in this study is five main paths

leading to improved VM performance, indicating a minimum sample size of 50 is satisfactory. The 202 cases obtained in this study further satisfy this assertion. Furthermore, sample sizes between 100 and 200 have been considered sufficient for PLS-SEM, according to Hair Jr *et al.* (2021), Sarstedt, Ringle and Hair (2021), and Hair Jr, Howard and Nitzl (2020).

Prior to discussing the sub-research questions, the descriptive findings were discussed to reveal the characteristics of the respondents. The first observation from the demographic characteristics of the respondents shows that all the respondents are qualified therefore capable of providing professional response. Also, most of the construction projects handled by the respondents are obtained from individual clients (48.0%). This is followed by corporate bodies that provide one-third (27.7%) of the construction projects whereas the respondents seldom obtain a construction project from the government. Thus, it can be deduced that the government rarely invest directly in the Nigerian construction industry. This is in comparison to other developing countries such as South Africa where the Government is the major client of the construction industry through the development of Reconstruction and Development Program (RDP) houses (Nokulunga, Didi and Clinton 2018).

11.2.1 The Influence of Integration on the Performance of VM

This research question was posed to determine the level in which integration features influence or impact the performance of VM. Prior to assessing the impact of integration on VM which represents the inner model of this study, the outer model was discussed. The outer model is focused on indicators that were used in measuring the integration features in this study. In this study, integration was described as the process of bringing together diverse knowledge, expertise, and technology to optimize project results, which is particularly important for assuring

the timely completion of construction projects. The review from the literature indicated that numerous strategies are adopted for ensuring effective integration. These strategies extracted from the literature were used as the indicators for measuring integration features.

A total of thirteen indicators was extracted from the literature and used in developing the model. The first iteration of the shows that all integration indicators have outer loadings above 0.5. Based on the rule stipulated in this study that indicators below 0.5 should be excluded from the model development, all integration indicators satisfied this rule and were all included in the second iterations. Therefore, a total of thirteen indicators were inputted into the model for the second iteration and put into the SmartPLS software. The second iteration shows that the composite reliability scores were very high and, according to Hair, Sarstedt and Ringle (2019), a very high composite reliability implies that some indicators are measuring the same thing. Thus, the indicators measuring the same or similar variables were merged into one. The VIF score was also used as a guideline in eliminating indicators that should be eliminated from the third iteration. The third iteration which serves as the final iteration shows that the indicators for integration were eliminated to five and the composite reliability was reduced to 0.883. According to Hair, Ringle and Sarstedt (2012) and Henseler (2016), composite reliability above 0.7 is satisfactory as it suggests that the indicators are suitable for measuring the constructs.

There were seven indicators used for measuring integration in the final model. They include, enough time to conduct VM studies, prompt response among professionals during VM meetings, equal contribution of participants, constant communication among participants, clear objectives of workshop, and experienced VM facilitator. The findings from the outer measurement model show that “enough time to conduct VM studies” has the highest loading of 0.727. This is followed by “experienced VM facilitator” with loading of 0.718. The next is “prompt response

among professionals during VM meetings” with loading of 0.708. This is followed by “clear objectives of workshop” with loading of 0.701. Others are equal contribution of participants, constant communication among participants, and accelerated decision-making with loadings of 0.658, 0.646, and 0.641 respectively. The findings from this study are similar to the studies of Shen and Ann (2012), Bennett and Mayouf (2021), Lin *et al.* (2011), and Ojo and Leung (2021) that enough time to conduct VM studies is a vital indicator for integration. It can be deduced from the review of literature that enough time to conduct VM studies is deemed helpful for acquiring a fruitful output from a VM study.

Kineber *et al.* (2023b) indicated that to enhance the implementation of VM, “enough time is needed to conduct VM” to enhance integration and collaboration among value members. In addition, Yu (2007) indicated that allocating enough time for VM studies will enhance communication and involvement of construction professionals during VM meetings. Allocating enough time to conduct VM is also very important to enhance collaboration among construction professionals.

The findings from the outer model measurement revealed that “experienced VM facilitator” has a loading of 0.718 which is the second largest factor loading after enough time to conduct VM studies. Oke and Aigbavboa (2017c) defined VM facilitator as an experienced value manager tasked with the responsibilities of planning and coordinating VM studies. Mohamad Ramly (2015) emphasized the significance of having a multi-disciplinary mix within a Value Management (VM) team as a crucial indicator for success during a VM workshop. Similarly, Tanko *et al.* (2018) identified the personality of the facilitator as a major performance factor in VM studies. Furthermore, Tanko *et al.* (2018) noted that the competence and qualifications of the facilitator play a pivotal role in the successful implementation of VM. Consequently, it

becomes evident that the proficiency of value managers or facilitators holds a fundamental role in enhancing the productivity of construction projects and achieving the ultimate objective of value optimization. Hwang, Zhao and Ong (2015). In addition, an experienced facilitator knows how to properly set a VM study agenda (Hwang, Zhao and Ong 2015). According to Abidin and Pasquire (2005), VM facilitator can relay clients' needs, to all team members and ensure that the demand is upheld throughout the decision-making process. However, because of incompatible objectives, values, and goals among participants involved in construction projects, conflicts will inevitably arise during the workshop process, which directly affects workshop satisfaction. Thus, this study strengthens the importance of VM facilitators.

Prompt response among professionals during VM meetings and equal contribution of participants were also recognised by the study's indicator as important drivers for enhancing the integration of VM in the construction industry. The Value Management (VM) process revolves around a participatory workshop where a diverse group of individuals from different disciplines collaboratively engage. Consequently, the active contributions and involvement of stakeholders are integral factors that significantly contribute to the successful execution of VM studies, as highlighted by (Yuan *et al.* 2016). The study of Shen *et al.* (2004) mentioned that lack of participation and interaction among members is one of the key problems in VM studies. Shen *et al.* (2004) mentioned that VM study teams comprise members from different disciplines, backgrounds, and organisations and these members are usually reluctant to speak out at the beginning of meetings because they are shy about speaking in public. Moreover, senior members may intentionally or unintentionally exert pressure on junior members, and this in turn prohibits the interaction and participation of junior members in meetings. For example, junior members may be afraid to criticize bad ideas from senior members. In addition, a few active members

may dominate the discussion in the analytical and creative phases due to conflicting objectives or interests. This would prevent other members from participating and, thus, uneven contribution from members occurs. It is concluded that these problems are the inherent limitations of face-to-face communication and that they have significantly degraded the effectiveness of various tasks to a great extent in VM studies. Therefore, the prompt response among professionals and equal contribution of participants during VM meetings occurs when professionals respond positively to ideas that are being generated during for the successful delivery of construction projects.

The study's results further support the notion that having a "clearly defined objective of a Value Management (VM) workshop" is essential for promoting integration and ultimately improving VM performance. This finding aligns with the insights from Abidin and Pasquire (2005), who asserted that VM is a methodical approach that involves determining the client's understanding of value in meeting their perceived needs by precisely defining and mutually agreeing upon project objectives and the most effective means to accomplish them. Additionally, Tanko *et al.* (2018) also underscored the importance of having clearly defined objectives in VM studies as a critical success factor for enhancing VM performance within the construction industry. However, Swan and Khalfan (2007) mentioned that the development of shared objectives is seen as one of the key backbones of a successful partnering arrangement and this could be achieved through an explicit intervention called a "partnering workshop". This workshop will often take place at the beginning of a project. The VM team will identify their shared objectives and embody this in a partnering charter which is a written record of the teams' shared objectives.

From the literature review, Luvara and Mwemezi (2017) found that "constant communication among participants" was found as the main driver of integration in Tanzania construction

industry. They indicated that interaction of a team during design stage means exchange of information from one part or design profession to the other, this leads to involved decisions and may result into making better decisions on the designs. Also, Aghimien, Oke and Aigbavboa (2018) mentioned that good communication within a team can improve team working skills, lead to positive collaboration and result in an optimistic project journey for the client. Hwang, Zhao and Ong (2015) further mentioned that communication and interaction among participants” is the most important factor that should be considered for VM performance. However, the review from the literature shows that communication is a requirement for integration whereas integration is essential for collaboration. Despite the significance of communication, in ensuring integration they cannot be fully achieved without agreement and cooperation among the construction professionals.

11.2.2 Collaboration Influence on VM Performance

The influence of collaboration on VM performance was determined through conducting a path co-efficient analysis of the best fit model that was presented. The outcomes were presented in the previous chapter. The outcome shows that there is a significant positive impact of collaboration on VM performance as the T-statistics which yielded a value of 1.971 which is above 1.96. It can be deduced that collaboration has a strong impact on the performance of VM based on the high value of the T-statistics. The findings support the studies conducted by Rahman *et al.* (2014), Donato and Shee (2015), and Koolwijk *et al.* (2018) who found that collaboration can provide solutions to the problem plaguing the construction industry. The review from the literature indicated that numerous strategies are adopted for ensuring collaboration. These strategies extracted from the literature were used as the indicators for measuring collaboration features.

This research question was posed to evaluate the collaboration measures for improved VM performance. A total of nine (9) variables that had a significant influence on collaboration features were observed from the final model. These includes, information sharing (0.623), dispute resolution techniques (0.600), partnership (0.703), decision alignment (0.659), teamwork (0.769), knowledge sharing (0.714), shared orientation (0.739), coordination (0.620), and interaction among participants in each phase (0.735). It was also observed that at 95% confidence interval, COL has a *T-value* of 1.971, which is above 1.96, and a significant p-value of 0.034, which is below the 0.050 thresholds, indicating that collaboration features are statistically significant and directly influence VM performance. With a path-coefficient β value of 0.218 (21.8% variance), COL has a strong effect on VM performance (0.932). COL is an umbrella term used to describe the coming together of two or more independent building professionals collaborating to schedule and implement construction project processes to enhance the performance of building projects. There is a wide range of approached and pedagogical forms through which COL enhances the successful delivery of construction projects. These includes information sharing, resource sharing, decision alignment, team building activities, knowledge sharing, interaction among participants, improved communication and understanding (Cao and Zhang 2011; Rahman *et al.* 2014; Donato and Shee 2015; Donato 2016; Mallett 2017; Ferme, Zuo and Rameezdeen 2018; Koolwijk *et al.* 2018).

The highest-ranked variable of COL construct is “teamwork” at 76.9% and its importance cannot be overstated. In VM, there is the need for members to work in unison, i.e., having a strong teamwork spirit, this will encourage active participation, better communication, and information dissemination. This confirms the work of Chiocchio *et al.* (2011), Kissi, Boateng and Adjei-

Kumi (2015b), and Nasir *et al.* (2016). According to Oke and Aghimien (2018), teamwork helps to improve working relationship among VM team. Through the incorporation of teamwork, VM team members can work together to achieve collaborative workshop practices during VM study thereby enhancing excellent working relationship (Othman *et al.* 2020).

The next highest ranked factor of the COL construct is “shared orientation (73.9)”. Shared orientation in a team has been found to improve individual effort and performance within VM team (Yu *et al.* 2005). Team orientation is essential in nearly every organisation and industry as it signifies a unified force working towards a shared purpose. The willingness and ability of team members to work together in a truly cooperative manner concerning the achievement of shared goals is referred to as shared orientation (Kelly, Male and Graham 2014). It reflects the extent to which a member has a positive attitude towards working in team-based settings such as eagerness to combine efforts with others, showing empathy and responsiveness in interpersonal relations and showing commitment to collective goals (Perera and Gunatilake 2020). Thus, an employee’s willingness to work interdependently rather than in an independent manner may correspond to his or her collectivist orientation.

Another highly ranked COL construct is “interaction among participants in each phase” with 73.5% which is a dynamic process that continues through the early design stages of a project Abidin and Pasquire (2007) mentioned that the pre-workshop stage can be improved where there is a close interaction between clients and the VM facilitators in determining the workshop scopes and identifying needs. The early interaction between clients and facilitators creates an opportunity to persuade clients’ commitment to it (Lin *et al.* 2011). The presence of the facilitator is ideal to advise and guide the team members into producing sustainable outcomes Leung, Yu and Liang (2014) also mentioned that the goal of a construction projects and

successful VM workshop can be enhanced through the participation and interaction of professionals and VM team members. Similarly, Thneibat, Thneibat and Al-Tamimi (2021) and Jaapar, Maznan and Zawawi (2012) suggests that successful project delivery through VM can be enhanced through better interaction between project stakeholders.

The importance of “knowledge sharing” and “information sharing” on VM performance cannot be emphasized. From the result, knowledge sharing is an indicator that contributes about 71.4% and 62.3% respectively to collaboration in VM performance. Knowledge sharing refers to the process by which information is exchanged between professionals and VM team member involved in a construction project or VM workshop (Zhang and Ng 2012). Serenko and Bontis (2016) mentioned that knowledge sharing allows VM members to put heads together, share, and search for their collective knowledge. Also, knowledge sharing does not just allow construction professionals to bring shared knowledge but also enables individuals to discuss and build on it (Imam 2021). Arif, Mohammed and Gupta (2015) opined that when people share what hasn't worked and their teammates can find their insights, it prevents somebody else from making the same errors – that's the importance of sharing information with colleagues.

When people are learning from each other and have a platform to share their knowledge, it is the best way to build a sense of community and create a learning culture because construction professionals can see and feel the benefits of both sharing and tapping into shared knowledge (Tahir, Khan and Nasir 2021). “Information sharing” is deemed a crucial prerequisite for the effective implementation of Value Management (VM) in contemporary construction practices. Researchers advocate that every stakeholder involved in the preliminary stages of a VM workshop should be get exchange of information typically takes place through a well-structured,

proactive, and team-based approach. This information should encompass details such as the procurement strategy, project timeline, project budget and quality considerations, project schedule, and any pertinent environmental concerns. This comprehensive information-sharing approach is vital for the success of VM initiatives in construction.

Partnership is another driver that contributes to collaborative working relationship in the construction industry. Koolwijk, van Oel and Bel (2022) indicated that partnerships can be perceived as extended collaborations among construction professionals especially VM members. In support of the significance of partnerships, Alinaitwe and Ayesiga (2013) opined that collaborative working cannot be achieved without encouraging partnerships and co-operation among the construction professionals. Therefore, the literature confirms that partnership is a vital indicator for measuring collaboration in the construction industry. In addition, “decision alignment” is another driver that contribute about 65.9% to collaboration construct in the construction industry. Decision alignment supports quality decision making at all levels of business and is a key component of successful business analysis. This is important when making investment decisions such as product development and innovation, which frequently involve people across multiple functions. The role of VM facilitator within decision alignment involves setting funding priorities, allocating resources among competing opportunities, balancing innovation, and incremental projects, and assure a steady stream of value-producing results. When a VM process is working well, an organisation management processes provide decision makers at all levels with the right information and incentives to make value-creating decisions.

Lastly, dispute resolution techniques (60.0%) is the final factor of the COL construct. VM techniques aim to identify project goals and achieve participant satisfaction. However, because

of incompatible objectives, values, and goals among participants involved in construction projects, conflicts will inevitably arise during the workshop process, which could directly affect VM workshop satisfaction. Leung, Yu and Liang (2014) mentioned that a good dispute management technique can enhance effective VM performance in the construction industry. Therefore, the use of effective dispute resolution techniques can help to dispose off conflicts and problems between VM professionals at the time they arise and to equip VM facilitators with both technical knowledge of VM and conflict management skills throughout the workshop process.

11.2.3 Standardisation Influence on VM Performance

This research question was posed to evaluate the influence of standardisation on the performance of VM in the construction industry. A total of seven (7) variables that had a significant influence on ST construct were observed from the final model. These includes government commitment to implement VM (0.741), input of government and its agencies (0.648), inclusion of VM clause in procurement act (0.636), regulation of VM activities (0.722), collaboration of government officials and professional bodies (0.693), and presence of VM guidelines and legal framework (0.686). It was also observed that at 95% confidence interval, ST has a *T-value* of 1.975, which is above 1.96, and a significant p-value of 0.041, which is below the 0.050 thresholds, indicating that standardisation factors are statistically significant and directly influence VM performance. With a path co-efficient β value of 0.117 (11.7% variance), Standardisation has a strong effect on the performance of VM ($R^2 = 0.932$). Standardisation is an umbrella term used to describe the acceptable guidelines regarding how a product or service is created or supported, as well as to how a business is operated or how certain required processes are governed.

The highest-ranked factor of the ST construct is government commitment to implement VM at 74.1% and its importance cannot be overstated. These findings align with the research conducted by Kim *et al.* (2016) and Aghimien and Oke (2015), both of whom emphasized that government interest in adopting Value Management (VM), the state of preparedness, active client participation, and public awareness regarding VM are critical factors influencing VM performance. Additionally, Othman *et al.* (2021) highlighted the importance of educating both private and public clients about the potential advantages of implementing VM in construction projects. Furthermore, the study underscores that government entities are well-positioned to oversee and regulate VM initiatives due to their substantial investments in property and infrastructure assets, making them major stakeholders in the construction sector. This further underscores the significance of government involvement and leadership in promoting and facilitating the effective adoption of VM practices in construction projects (Tanko *et al.* 2018).

Indeed, the active involvement and support of the government play a pivotal role in the successful implementation of Value Management (VM) in contemporary construction practices. Moreover, the government's capability to establish and enforce VM guidelines and roadmaps is not only imperative but also highly welcome. To facilitate this, it is recommended that the government institute a dedicated department for VM practice and formulate policies that offer rewards and remuneration to incentivize VM practitioners to share their experiences and knowledge with other stakeholders in the industry. As emphasized by Oke, Aghimien and Olatunji (2015), the government's role in the adoption of VM cannot be underestimated. Crafting policies and legislation is a core responsibility of the government, and these policies have a substantial impact on the adoption of any methodology, including VM. Therefore, the

government's active participation in the VM adoption process is crucial for its widespread and effective implementation within the construction sector.

The next highest ranked factor of the ST construct is “regulation of VM activities” Bowen *et al.* (2010b) mentioned that regulating VM activities is very important for effective VM performance. Edwards *et al.* (2010) also recommended that policy makers or government agencies should initiate a comprehensive program of continuing professional development activities designed to promote greater awareness and practice of VM. Another highly ranked ST construct is “VM action plan for implementation (71.5%)”. The VM action plan outlines the comprehensive VM process, which commences with the gathering and synthesis of information, followed by brainstorming and sorting of ideas, selecting ideas for further development, preparing an action plan, creating and distributing a workshop report, implementing the action plan, and concluding with a feedback workshop. This process underscores the importance of rigorous managerial planning and strategic actions to ensure the effectiveness of VM initiatives in achieving their objectives.

The next ranked factor of the ST construct is “collaboration between government officials and professional bodies is identified as a critical factor, with a significant percentage (69.3%) recognizing its importance. It's worth highlighting that such collaboration not only encourages other professional organizations to join the effort but also serves as a catalyst for the widespread application of Value Management (VM) in the country. This collaborative approach can further facilitate the establishment of international relationships with leading organizations experienced in VM applications, making it easier to access essential training and assistance. Therefore, it is strongly recommended that stakeholders across all construction-related disciplines and their

respective professional organizations join forces with the government to create a formidable team dedicated to promoting the adoption of VM in the Nigerian construction industry. This unity of purpose among stakeholders not only enhances the initial adoption of VM but also ensures its continued success and sustainability within the Nigerian construction sector.

Building on this, Kineber *et al.* (2023b) emphasized the global participation in the annual Value Summit organized by the SAVE (Society of American Value Engineers) as a means for countries to acquaint themselves with innovative VM applications across various disciplines and to establish valuable learning networks with VM experts worldwide. Consequently, it is highly recommended that Nigerian construction professionals actively engage in various VM training programs, workshops, and seminars organized by SAVE or other international VM institutions. Collaborating with construction industries in developed nations is crucial for training and conducting essential VM practical exercises. Moreover, fostering collaboration among all construction professional bodies, academic institutions, and government entities is perceived as vital, as highlighted by (Ojo, Ogunsemi and Ogunsina 2021). Such collaboration streamlines processes to facilitate the adoption of VM. This collaborative effort ultimately empowers the government and other construction clients to optimize the utilization of available construction resources, as emphasized by (Ojo and Leung 2021). Additionally, keeping a close track of VM adoption's performance on construction projects helps construction clients appreciate the tangible benefits of VM. Consequently, this data-driven insight aids decision-making regarding the integration of VM into construction projects, establishing benchmarks or thresholds where VM adoption becomes a standard practice.

The next ranked factor of the ST construct is “presence of VM guidelines and legal framework (68.6%). Ojo, Ogunsemi and Ogunsina (2021) stated that the outcome of training, the inputs of the sourced VM experts and legislated policy on the application of VM must be fused into the procurement Act and subjected to experimental adoption of VM with control group. Also, Kim *et al.* (2016) mentioned that local VM guidelines, technical norms, and standards are considered as manual documents that are necessary for the implementation of VM. A lack of practical guidelines for implementing VM in the construction industry is a key factor blocking the wide application of VM (Kissi, Boateng and Adjei-Kumi 2015b), because the theoretical knowledge from books and articles is not sufficient for ensuring the correct implementation of the VM procedure. Moreover, if there are no practical VM guidelines or manuals in the local language, it is difficult for industrial practitioners to be familiar with the VM methodology (Xiaoyong and Wendi 2012). Hence, to promote the application of VM, several documents specifically related to the local context should be published in the construction industry (Othman *et al.* 2021). Legal documents play a supporting role in implementing VM (Kim *et al.* 2016). There are many related difficulties when applying this methodology if there is not government legislation regulating, for example, the size of projects suggested for applying VM, specific rules for each type of project, the sharing among shareholders of benefits earned from applying VM, etc. (Sabiou and Agarwal 2016). Kim *et al.* (2016) indicated that VM, as a technique, when backed up with legislation and applied to all construction projects will ensure effective maximisation of function and removal of unnecessary costs. Governments, construction authorities, and regulators should play a lead role in promoting VM and should consider creating and establishing VM implementation based on law, as currently practiced in developed countries across the world.

The inclusion of a Value Management (VM) clause within the Procurement Act, which garnered a substantial percentage (63.6%), represents the final component of the Standardization (ST) construct. In line with this, Othman *et al.* (2021) emphasized that procurement approaches should exhibit flexibility, allowing for the application of VM at various stages of construction projects. This implies a need to revise the Public Procurement Act of 2007 in Nigeria to ensure the systematic integration of VM in construction projects. The government can play a crucial role in facilitating the adoption of VM by formulating policies, regulations, and guidelines that encourage and support its implementation, as highlighted by (Tanko *et al.* 2017).. Additionally, decision-makers are encouraged to actively participate in VM seminars or training sessions, as recommended by (Thneibat, Thneibat and Al-Tamimi 2021). This ongoing engagement in VM-related learning opportunities ensures that decision-makers remain well-informed about VM practices and principles, contributing to informed decision-making and the successful adoption of VM in construction projects.

11.2.4 The Influence Digital Technologies on VM Performance

This research question was posed to examine the influence of the use of digital technologies on VM performance. From the final model, the DT factor has a path co-efficient β value of 0.125 (12.5% variance) on VM performance ($R^2 = 0.932$). A total of four (4) variables that had a significant influence on DT factor were observed from the final model. This includes Internet of Things (0.692), building information modelling (0.655), cloud computing (0.696), and advanced big data analytics (0.631). It was also observed that at 95% confidence interval, DT has a T-value of 2.256, which is above 1.96, and a significant p-value of 0.029, which is below the 0.050 thresholds, indicating that the use of digital technologies is statistically significant and directly contributes to enhanced VM performance.

The highest-ranked factor of the DT construct is cloud computing (69.6%), followed by internet of things (69.2%), building information modelling (65.5%), and advanced big data analytics (63.1%) and their importance have been discussed by previous researchers. Indeed, the rapid advancement of digital technologies has brought about significant transformations in the construction industry, and the integration of these digital tools can greatly enhance the effectiveness of the Value Management (VM) process. One such technology is Building Information Modeling (BIM), which employs software models to simulate and manage the design and construction processes (Park *et al.* 2017). BIM has demonstrated its efficacy in construction projects by facilitating cost and time savings. Additionally, BIM provides the VM team with the capability to identify design clashes early in the project, even those that may have been overlooked by the project's design team. This early detection enables timely corrections, preventing unnecessary expenses, delays, and material wastage during construction, as noted by (Azmi, Chai and Chin 2018). Furthermore, Big Data Analytics (BDA) offers the VM team a valuable tool for collecting, storing, and analyzing data with ease. This capability empowers VM practitioners to make well-informed decisions critical to the success of construction projects. The integration of these digital technologies into the VM process not only enhances its efficiency but also contributes to more successful project outcomes (Oraee *et al.* 2019; Li, Wang and Alashwal 2021).

Moreover, these digital tools have fostered positive collaboration within construction projects, as observed by (Liu *et al.* 2021), and have enabled the industry to achieve more sustainable designs. The Internet of Things (IoT), which involves connecting objects using the internet and a predefined protocol with information sensors, as explained by (Ammar, Russello and Crispo

2018), has notably improved communication among project participants, as highlighted by (Punnyasoma, Jayasena and Tennakoon 2019). Furthermore, Parn and Edwards (2019) emphasized the significance of cyber-physical systems in the effective and efficient delivery of construction projects. Additionally, Big Data Analytics (BDA), which involves the analysis of complex and vast data to uncover significant patterns and trends for informed decision-making, as discussed by (Niu *et al.* 2021), enables better prediction of future occurrences within construction projects. Cloud computing, identified as a valuable tool for successful project delivery by (Amarnath, Sawhney and Maheswari 2011), allows for the sharing of computing resources among diverse project participants, as noted by (Oke *et al.* 2021). These technologies collectively contribute to improved project collaboration, sustainability, communication, and decision-making within the construction industry.

The findings strongly support the conclusion that the integration of digital technologies in construction projects can significantly enhance the Value Management (VM) process. This integration offers construction participants an opportunity to deliver enhanced value in their projects by leveraging technology-driven VM approaches. Computer-based software, Building Information Modeling (BIM), mobile devices, electronic meeting tools, cloud computing, augmented and virtual realities are identified as technologies that can profoundly impact the success of the VM process. The high predictive accuracy derived from regression analysis reinforces the importance of these technologies in VM. However, it's important to acknowledge that the utilization of these technologies faces constraints related to factors such as cost, awareness, the complexities associated with VM and digital tools, the digital culture prevalent in the construction industry, and the availability of technology and expertise. Despite these challenges, the quest to provide construction clients with value for their investments through

effective VM exercises underscores the necessity for construction management organizations to fully embrace the use of digital technologies throughout the entire project lifecycle, starting from project inception, and not limited to VM alone. This comprehensive adoption of digital tools can lead to more successful and value-driven construction projects.

To facilitate the adoption of relevant technologies in the Value Management (VM) practice, it is essential to raise awareness among VM experts regarding the importance of embracing these tools for enhancing VM processes. Client financial support can play a pivotal role in promoting the adoption of such technologies. Organizing workshops and seminars aimed at sensitizing experts to the advantages of these technologies in VM exercises and providing practical demonstrations of their benefits can significantly contribute to technology adoption in VM. Professional bodies can take the initiative to organize these awareness programs, with support from organizations responsible for delivering these technologies. Moreover, top management within construction organizations can play a crucial role by investing in the training and retraining of professionals on the usage of digital technologies. This training equips professionals with the necessary skills to effectively employ digital tools when engaging in VM exercises. Additionally, the establishment of favorable legislation and regulations that support the use of digital tools in construction projects is crucial. Such policies can promote a digital culture within the industry and mitigate resistance to change among industry practitioners. By creating an environment that encourages and facilitates the use of these technologies, the construction industry can harness their full potential for more successful and value-driven VM practices.

11.2.5 The Influence of Corporate Culture on VM Performance

This research question was posed to evaluate the influence of corporate culture on VM performance. A total of eleven (11) variables that had a significant influence on the CC factor were observed from the final model. These includes creativity orientation (0.706), innovativeness (0.651), management commitment (0.613), teamwork (0.641), smooth operation of VM activities (0.666), result oriented (0.638), goal accomplishment (0.637), cooperation among stakeholders (0.677), motivation (0.706), education and training (0.651), and reward and incentive system (0.654). It was also observed that at 95% confidence interval, CC has a *T-value* of 1.988, which is above 1.96, and a significant *p-value* of 0.039, which is below the 0.050 thresholds, indicating that corporate culture factors are statistically significant and directly influence VM performance. With a path co-efficient β value of 0.224 (22.4% variance), CC has the strongest effect on VM performance ($R^2 = 0.932$). CC is an umbrella term used to describe a better equipped and integrated strategy and accomplish their goals if they comprehend their company structure. Numerous critical determinants of success within the domain of corporate culture have been examined, encompassing aspects such as managerial engagement, the dissemination of information, interpersonal connections, educational and training initiatives, systems for offering rewards and incentives, risk allocation, effective oversight, active involvement of employees, and the process of decision-making (Ekanayake 2019; Ekanayake, Shen and Kumaraswamy 2019; Madushika *et al.* 2020). This study classified corporate culture into the following dimensions, namely clan, adhocracy, hierarchy and market culture. The dimensions used in measuring corporate culture were identified after reviewing literature on past studies.

Clan culture emphasizes fostering collaboration, mentorship, and partnerships throughout the construction value chain. In contrast, an adhocracy culture pertains to the readiness of construction project stakeholders to innovate and embrace risks within the value chain. Hierarchy culture promotes the establishment of control, authority, and enforcement mechanisms within the value chain. On the other hand, in a market culture, stakeholders prioritize client satisfaction above all else, irrespective of the principles and perspectives of other stakeholders. The review from the literature shows that there are numerous indicators that can be used in measuring each indicator. A total of thirty-two indicators was extracted from the literature related to corporate culture. Each indicator represents a different cultural dimension. However, a critical analysis of the indicators presented in Table 10.17 reveals that none of the indicators that measure hierarchy culture were included in the model. Körner *et al.* (2015) and Naranjo-Valencia, Jiménez-Jiménez and Sanz-Valle (2019) argued that when a construction stakeholder embraces a hierarchy culture, it promotes the implementation of control, the exercise of authority, and the enforcement of regulations within the value chain.

Regarding the cultural dimensions that were used in developing this model, the highest ranked factor of the CC construct is creativity orientation and motivation at 70.6% respectively as shown in Table 10.17 and their importance cannot be overstated. The findings from this study confirms the work done by Mohamad, Coffey and Attan (2012) who found that creativity orientation is a key factor in ensuring the performance of infrastructure project design. According to Arditi, Nayak and Damci (2017), adhocracy culture (creativity orientation) is one of the major corporate culture profiles for delays of construction projects. One can observe that during the creativity stage, ideas are conceived and developed to meet the necessary and preferred functions of a structured tree (Kineber *et al.* 2021b). Within this process, the members of the VM workshop

team engage in investigation, exploration, generation, and testing of alternative methods for task execution (Shen and Liu 2004). The creativity phase presents an excellent opportunity and motivation for team members to achieve their objectives by enhancing innovative ideas. Innovation stands as a key driver that can be sustained through a practical approach aimed at resource improvement (Munyasya and Chileshe 2018). Consequently, the VM facilitator plays a crucial role in fostering a positive environment, ensuring that criticism and suppression among VM team members are prevented (Coetzee 2009).

Also, the result found that innovativeness which represents 65.1% and reward and incentive system which represents 65.4% are also major indicators that determine an adhocracy culture. Value Management (VM) plays a vital role in fostering product innovation, a critical factor for a company's long-term success. Consequently, these findings suggest that the integration of VM is more likely to be prevalent in construction firms characterized by an adhocracy culture. This result underscores the importance of offering incentives to achieve well-defined organizational goals, including the adoption of VM and the attainment of competitive advantages. Atuahene and Baiden (2018) have asserted that leaders who embrace such cultures are risk-takers, and their followers or employees are similarly committed to taking calculated risks within the value chain. Furthermore, organizations with a strong emphasis on innovation and an effective reward and incentive system, indicative of an adhocracy culture, will motivate their staff to dedicate their time, resources, and efforts to VM. This dedication ultimately leads to the successful delivery of construction projects and the accomplishment of predefined objectives.

The next highly ranked factor of the ST construct is in the clan culture category which are cooperation among stakeholders (67.7%), (65.1%), management commitment (61.3%), and teamwork (64.1%). All these variables are categorized under clan culture. The findings from this

study corroborates with the study of Othman *et al.* (2021) who found that cooperation is a major corporate culture feature for construction firms. According to Khedhaouria *et al.* (2020), clan culture is the major corporate culture profile for construction firms. The profile is usually adopted owing to its capacity in fostering relationships among stakeholders. In support of this assertion, Hwang, Zhao and Ong (2015) opined that relationship, which is the major driver of VM, is strengthened in the face of an appropriate culture. Tanko *et al.* (2018) mentioned that interpersonal relationships, communication, cooperation, and collaboration with internal and external team members during and after a VM process is highly importance for effective VM performance. Hence, the introduction of a culture like the clan culture, which promotes the development of relationships within the value chain, holds immense significance for enhancing performance and ensuring the successful delivery of construction projects within the Nigerian construction industry. This culture fosters clear communication and transparency, creating an environment where every team member feels at ease expressing their thoughts and ideas. Such an environment is a critical prerequisite for the successful adoption of Value Management (VM). Moreover, the values of cooperation and collaboration hold fundamental importance in the context of Value Management (VM). VM inherently requires active collaboration among team members and stakeholders to jointly solve problems (Othman *et al.* 2021). Employees who lack a cooperative mindset may encounter difficulties when it comes to closely collaborating with their colleagues during a VM process (Kineber *et al.* 2021b). In competitive scenarios, a clan culture fosters an environment where team members can work together effectively to achieve victory (Cao *et al.* 2015). In organizational settings, the motivation to cooperate is driven by the desire to enhance shared understanding, minimize conflict, strengthen trust-based relationships,

and solidify commitments to clients. These factors collectively contribute to the successful integration of VM and its application in achieving positive outcomes.

Education and training of VM members was another indicator for clan culture that was identified from SEM analysis. Based on this discovery, it becomes evident that insufficient VM facilitation skills and a lack of knowledge and education in this area can significantly impact the presence and effectiveness of Value Management (VM) within the construction sector. Therefore, it is imperative for construction professionals to receive training in VM principles and practices. It is unrealistic for professionals lacking adequate facilitation skills to advocate for the implementation of VM in their projects. This aligns with the findings of Oke and Aigbavboa (2017c), which emphasize the crucial role of training and education in enhancing VM performance. Considering that VM has not been fully embraced within the Nigerian construction industry, one strategy to promote its adoption is to review the curricula of higher education institutions offering construction-related courses. By incorporating VM training into these programs, the dissemination and uptake of VM methodologies can be facilitated and accelerated, ultimately benefiting the industry as a whole.

Construction professionals can acquire training in Value Management (VM) through various avenues, including professional forums, seminars, workshops, and in-house mentoring programs. Olawumi, Akinrata and Arijeloye (2016) have emphasized that education and training in VM practices can significantly enhance its adoption and acceptance in the context of capital projects. Furthermore, VM training can be integrated with higher or postgraduate programs that focus on teaching VM techniques, which is recognized as a critical driver for VM adoption (Ojo, Ogunsemi and Ogunsina 2021). Academics play a crucial role in disseminating knowledge about

VM techniques, and it's advocated that VM education should be introduced not only at the postgraduate level but also as part of undergraduate courses in built environment programs (Ojo and Ogunsemi 2019). Ilayaraja and Eqyaabal (2015) have highlighted that VM specialists are effective educators of VM techniques, having received specialized training themselves. These specialists possess practical experience and certification, qualifying them to train others. In addition to these avenues, institutes specializing in VM also serve as training centers, offering courses and workshops for construction professionals interested in VM (Ojo and Ogunsemi 2018). The training typically progresses through different stages corresponding to various levels of expertise within these institutes, with the highest stage or level involving training to become a certified VM facilitator. To ensure widespread awareness and understanding of the benefits of VM, structured sensitization efforts can be employed to inform all construction clients about its advantages (Kissi, Boateng and Adjei-Kumi 2015b). This comprehensive approach to education and training contributes to the broader adoption and effective utilization of VM practices within the construction industry.

Another important variable in CC construct is “management commitment” which contributes 61.3% to the construct. Involvement and commitment of top management in VM creates a participative environment in the organisation which is very important in implementation of VM. An overall conclusion was made that the commitment of top management influences implementation and performance of VM. This means that with increased top management commitment in terms of providing leadership, providing critical resource, and getting involved in the application and performance of VM, the performance of VM is likely to be more successful.

Lastly, the findings from the SEM revealed that another culture capable of having a significant impact on VM performance is market culture as shown in Table 10.15. As previously mentioned, under the market culture, the agenda of the stakeholder is focused on ensuring that the client is satisfied regardless of the principles and opinion of other stakeholders. Atuahene and Baiden (2018) asserted that market culture is similar to a clan culture but the focus under market culture is “client satisfaction” and “goal accomplishment”. Studies such as those of Findler et al. (2007) and Tsai and Chi (2015) related to corporate culture from other disciplines also confirm that embracing a market culture encourages client satisfaction and goal accomplishment that in return improves the performance of VM.

Körner *et al.* (2015) also affirmed that corporate culture has a major impact on improving an organisation’s client satisfaction and their corporate social responsibility. Teräväinen *et al.* (2021) affirmed that consumers of firms that adopt a market culture are often satisfied. This, therefore, makes market culture significant with the intention of achieving success in VM and the successful delivery of construction projects. Also, VM workshop provides an opportunity to the participants in the decision process to identify the best value (project goal), but it is meaningless if the team members do not accept the common goal and implement it according to the schedule (Leung and Liu 2003). Hence, goal acceptance must be established in the teamwork to ensure that the defined goal will be implemented and accomplished in the actual process. Of course, the whole team must ensure that all members accept the project goal at the end of workshop, as it will subsequently enhance the working performance during the VM process. This, therefore, makes market culture significant with the intention of achieving VM performance success.

The findings from the study confirms that if construction project stakeholders adopt clan, market, and adhocracy cultures, there will be a further improvement on VM performance. Also, the support of regulatory bodies for construction professionals and stakeholders are critically necessary for encouraging the culture that supports effective integration and collaboration in the construction industry.

11.3 EXAMINING THE MODEL FIT AND CONSTRUCTS

With sufficient *T-values* and path coefficients obtained from the PLS-SEM analysis and model, all the latent constructs (exogenous variables) were found to have a direct positive influence on VM performance. Therefore, the hypothesis that VM performance is directly influenced by the influence of several latent constructs in predicting the performance of VM in the Nigerian construction industry is supported. The findings of this research (Model 2.0) support previous VM studies (Oke and Ogunsemi 2011; Hwang, Zhao and Ong 2015; Kissi, Boateng and Adjei-Kumi 2015b; Mohamad Ramly 2015; Nasir *et al.* 2016; Luvara and Mwemezi 2017; Ojo and Ogunsemi 2019; Madushika *et al.* 2020; Kineber *et al.* 2021b; Kineber *et al.* 2021d; Ojo, Ogunsemi and Ogunsina 2021; Othman *et al.* 2021; Lin *et al.* 2022a) which highlight VM as a multidimensional structure.

The hypothesised relationship among all the exogenous constructs (integration, standardisation, collaboration, corporate culture, and digital technologies) was discovered to be significant. The latent indicator that was used in measuring all the constructs was also found to be adequate and sufficient in determining VM performance. From the result, corporate culture was found to have the highest variance in explaining VM performance. This is followed by collaboration, integration, digital technologies, and standardisation. The model confirms that standardisation has the weakest impact on determining VM performance.

However, the various existing VM model provided several constructs for VM performance which are adopted by this current research study. One of the strengths of the previous existing model is that it improves on other existing models (as discussed in Chapter Two). This model was developed to explain the concept of VM practically, which has been described as indefinable. Therefore, the hypothesised relationship between the latent constructs and the outcome variables was found to be statistically significant as the constructs adequately measured VM whether directly or indirectly.

Also, with a path co-efficient β value of 0.224, corporate culture has the strongest effect of VM performance. Corporate culture (CC) is a comprehensive term utilized to characterize a more proficient and cohesive strategy, enabling organizations to achieve their objectives effectively when they possess a clear understanding of their company's structure. The various critical factors for success that have been examined within the realm of organizational culture encompass aspects such as managerial engagement, information dissemination, interpersonal relationships, education and training, reward and incentive systems, risk-sharing, effective supervision, employee involvement, and the decision-making process (Ekanayake 2019; Ekanayake, Shen and Kumaraswamy 2019; Madushika *et al.* 2020). Evidently, through effective corporate culture among construction professionals and value members, there will be an improve workflows that guides effective decision-making process in a positive workplace environment that creates an engaged, enthusiastic, and motivated workforce. Ultimately, the presence of this key performance indicators among construction professionals can lead to increased efficiency and productivity within the industry, hence the successful delivery of construction industry.

11.4 REVIEWING THE QUESTIONNAIRE AND DELPHI SURVEY

The Delphi results played a significant role in determining the various constructs that contribute to improved VM performance in the built environment in Nigeria. These constructs led to the

development of an improved VM performance model for the built environment in Nigeria. These VM performance constructs include Collaboration (COL), Integration (INT), Standardisation (ST), Digital technologies (DT), and Corporate Culture (CC). In this thesis, the mixed method was achieved as findings from the Delphi study were validated by a field study (questionnaire survey). The results confirm that the constructs have a direct influence on VM performance. The latent constructs, namely collaboration, integration, standardisation, digital technologies, and corporate culture, were found to have a statistically significant influence in achieving enhanced VM performance as shown in Model 2.0 (Chapter 10). This has been supported by existing literature. Therefore, the Delphi and questionnaire survey worked in tandem to determine the influence of the latent variables on the outcome variable (improved VM performance).

One of the merits of adopting the partial least squares – structural equation modelling using SmartPLS version 3.2 software to validate the findings from the Delphi survey was to ascertain which of the latent constructs had the strongest significant influence on VM performance. Therefore, instead of making a general statement that all the exogenous constructs have an impact on the endogenous construct, it was possible to determine the extent to which each of the exogenous constructs impacts on the endogenous variable. For instance, the SEM analysis shows that corporate culture has the highest impact on determining the performance of VM whereas, standardisation has the lowest impact for determining the performance of VM in the Nigeria construction industry. Therefore, by conducting this study, it becomes possible to precisely state those constructs that are statistically significant and contribute to VM performance.

11.4 CONCLUSIONS

In concluding this chapter, it can be established that the questionnaire survey findings largely support the opinions and responses made by the built environment experts during the Delphi study. The analysis of the findings affirms that the results obtained from the questionnaire survey align with the forecasts made by experts in the Delphi survey. The validated predictions indicate that integration, collaboration, standardization, the utilization of digital technologies, and corporate culture all exert a positive influence on the performance of Value Management (VM). Furthermore, this chapter demonstrates that the outcomes derived from the review of existing literature provide additional support to the findings extracted from this current study. In conclusion, the indicators that determine the performance of VM are improved project management, elimination of delay, time management, innovative designs, optimization of value, cost-saving practices, efficient project delivery, enhanced project functionality, material management, conflict management, and quality management.

CHAPTER TWELVE

CONCLUSIONS AND RECOMMENDATIONS

12.1 INTRODUCTION

The primary aim of this research was to develop a performance model for Value Management (VM) within the built environment in Nigeria, with a focus on identifying the specific factors contributing to effective VM performance. To accomplish this overarching goal, a mixed-method approach was employed, encompassing an extensive literature review, a Delphi study (a qualitative approach involving expert opinions), and a field questionnaire survey (a quantitative approach involving data collection). The data from the field survey were subsequently analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) through SmartPLS version 3.2 software. Both the Delphi study and the questionnaire survey operated in synergy to determine how latent variables influence the outcome variable, which is improved VM performance. This chapter provides a range of conclusions derived from the broader objectives of the research.

12.1.1 Research objective RO1

The research objective one (RO1) for this study was to establish key indicators for effective VM performance in the Nigerian construction industry, based on a review of the literature. Towards achieving this objective, an extensive review of literature was conducted. The review of literature was conducted across numerous disciplines such as construction, manufacturing, medicine, and marketing. Also, literature from both developed (Australia and Hong Kong) and developing (Ghana) was also reviewed. The findings from the review of literature show that the indicators that determine the performance of VM in the construction industry are a multi-faceted construct. Also, the indicators that guarantee the performance of VM have been a major concern for research

in other industries such as the manufacturing and health care industries. The research into examining the performance indicators of VM in the construction industry commenced around the early 2000s. The research commenced international reviews in developed countries like Australia and Hong Kong. The findings from the research reveal that in terms of reducing cost and enhancing the functionality of construction projects, the practice of VM must be encouraged in the construction industry. Therefore, one of the performance indicators of VM in the construction industry is cost saving practices, enhanced functionality, and successful delivery of construction projects. However, this can be enhanced by collaboration among professionals, integration, standardisation, effective corporate culture, and digital technologies.

The research also found that VM performance indicators in the construction industry are attributed to the benefit of adopting VM. The benefit includes improved project management, elimination of delay, time management, innovative designs, optimization of value, cost-saving practices, efficient project delivery, enhanced project functionality, material management, conflict management, and quality management. Literature in developing countries such as Ghana revealed that saving the construction time, reduced construction cost, and client's satisfaction is the major VM performance indicator in the construction industry. This was attributed to the poor value in projects experienced in the construction industry and so that more value for money could be obtained by enhancing project performance and removing unnecessary costs. This finding led to the development of second objective of this study.

12.1.2 Research objective RO2

The second objective of this research was to assess the underlying sub-variables that contribute to the effectiveness of Value Management (VM) in the construction industry. This objective was met through an in-depth literature review focused on VM practices within the construction sector. The

literature was systematically gathered from the Scopus and Web of Science databases, encompassing studies conducted in both developing and developed countries. Given the extensive research on VM in various fields, a meticulous filtering process was implemented to exclude literature that did not pertain specifically to the construction industry, ensuring the relevance of the findings.

Upon conducting a thorough literature review, it became evident that the primary variables contributing to enhanced Value Management (VM) performance in the construction industry are integration, collaboration, and standardization. Integration, in this context, was defined as the process of uniting diverse knowledge, individuals, expertise, and technology to optimize project outcomes, particularly emphasizing the importance of timely project completion. The literature review also revealed various strategies employed to foster collaboration, which encompassed practices such as information sharing, partnership-building, and interaction among participants at different project phases, among others. Standardization was identified as a key performance indicator for VM in the study, with standardization encompassing aspects like input from relevant governmental and local authorities, the development of a VM study plan for implementation, the ability of clients to effectively communicate their requirements to the design team, governmental commitment to VM implementation, consistent attendance of decision-makers, and active support and participation by clients. However, despite the insights gained from the literature review, it was noted that a comprehensive set of variables or constructs that could guarantee the successful application of VM in the Nigerian construction industry had not been thoroughly studied. The absence of an all-encompassing set of variables prompted the formulation of the next research objective.

12.1.3 Research Objective RO3

The third objective of the research was to investigate the gaps in the existing VM model necessary for consideration in the Nigerian construction industry. This objective was achieved by conducting a review of literature that are related to VM in the construction industry. The literature was targeted at examining the models that have been developed for VM in construction and manufacturing. The search of literature was focused on the theories that have been used in examining VM practice in the construction industry. The review of the literature showed that VM in the construction industry has been supported by theories such as collaboration theory, resource dependency theory, and goal-setting theory. These theories support collaboration, integration, and standardization. However, it was believed that VM in the construction industry has not been studied with an all-inclusive theory and construct or variable, thereby creating a gap. The gap identified in this study are corporate culture and the use of digital technologies which were used in developing the conceptual framework as shown in Model 1.0. These gaps were considered significant because collaboration and integration would be difficult without creating a culture that encourages the joint working and togetherness among stakeholders. Also, it is expected that the use of digital technologies would help to foster collaboration, communication, and integration among value members.

12.1.4 Research Objective RO4

The fourth objective of the research was to determine the sub-constructs that have a significant impact on VM performance in the Nigerian construction industry. This objective was achieved using the Delphi study that was targeted at seeking experts' view regarding the constructs and their indicators that were extracted from the literature. The advantage of, reason for and the technique adopted in conducting the Delphi study were explained succinctly in the research methodology

chapter. The findings from the Delphi study show that the constructs and their indicators extracted from the literature are capable of enhancing the performance of VM in the Nigerian construction industry. According to the experts, corporate culture and collaboration have been shown to have a very strong consensus and impact on the performance of VM in the Nigerian construction industry. The other factors with good consensus are integration, digital technologies, and standardization. The experts also confirmed that the indicators extracted from the literature in measuring each of the constructs are sufficient in determining the performance of VM in the Nigerian construction industry.

The experts indicated that for effective collaboration, it is necessary to ensure complete visibility and a shared understanding of the project. This can best be done by providing access to constructible models that connect the right people to the right data at the right time. Everyone should understand both the project's big picture and the specific parts of the many different jobs that need to be done. When collaboration is strong, project team members are engaged and willing to contribute their resources and knowledge towards achieving the goals together. For improved integration, experts emphasized the importance of consolidating diverse knowledge, individuals, expertise, and technology to maximize project outcomes, especially in ensuring the punctual completion of construction projects. Regarding the influence of corporate culture on VM performance in the construction industry, experts highlighted that clan, market, and adhocracy cultures represent the most significant cultural dimensions impacting VM performance within this sector. The recommendations provided by these experts were subsequently leveraged to construct a model for Value Management (VM) in the Nigerian construction industry, aligning with the next research objective. This model aimed to encapsulate the critical factors and dynamics relevant to VM within the specific context of the Nigerian construction sector.

12.1.5 Research Objective RO5

The fifth objective of this study involved the development of a VM performance model tailored for the construction industry in Nigeria. This objective was successfully attained by deriving insights and conclusions from the comprehensive literature review conducted and integrating them with the outcomes from the qualitative Delphi study. The combined findings and synthesized information served as the foundation for creating a robust VM performance model designed specifically to address the nuances and requirements of the Nigerian construction sector. The conceptual VM performance model (Model 2.0) constitutes five latent constructs (exogenous variables) which are significant to improved VM model (endogenous variable). These five latent constructs are Integration (INT), Collaboration (COL), Standardisation (ST), Digital technologies (DT), and corporate culture (CC). Through a field questionnaire survey and subsequently a PLS-SEM analysis, this model was developed. In the meantime, findings from PLS-SEM revealed that all constructs have a positive influence on improved VM performance. These findings served to validate the VM improvement model that was developed based on the literature review and the outcomes of the Delphi Study. Furthermore, the research objective aimed to test and validate the conceptual integrated VM model that was specifically crafted for the Nigerian construction industry. To achieve this objective, a questionnaire survey was administered to construction professionals and stakeholders within the Nigerian construction sector. The data collected through the questionnaire were analyzed using SmartPLS and Structural Equation Modeling (SEM), with the goal of developing the most fitting model after undergoing three iterations. Throughout these iterations, certain indicators used to measure the constructs were eliminated, aligning with the objective of refining and optimizing the model for accuracy and effectiveness.

Following the iterations and thorough SEM analysis, the research outcomes reveal that the model for Value Management (VM) in the Nigerian construction industry consists of five key factors or constructs. These constructs play pivotal roles in determining the performance of VM within this specific context, and they are integration, collaboration, standardization, digital technologies, and corporate culture. The SEM analysis findings further confirm that each of these constructs exerts an influence on the performance of VM in the construction industry. However, it is worth noting that among these constructs, standardization exhibits the least significant impact on the performance of VM in the Nigerian construction industry. These results from the SEM analysis validate the conceptual integrated VM model designed for the Nigerian construction industry, which was originally developed based on insights from the literature review and the Delphi study. The refined model reflects the critical factors and dynamics that are most relevant and influential within the Nigerian construction sector, thereby contributing to a more effective application of VM practices.

12.2 CONTRIBUTIONS AND VALUE OF THIS RESEARCH

This study has made valuable contributions to the field of Value Management (VM) on multiple levels. These contributions encompass the development and validation of a VM model tailored to the Nigerian construction industry, as well as theoretical, methodological, and practical advancements based on the research findings. However, it is noteworthy that the most substantial contribution of this study lies in the validation of the impact of digital technologies and corporate culture as predictive factors for VM performance. This validation was achieved within the context of other constructs, highlighting the significance of these two elements in influencing the effectiveness of VM practices.

12.2.1 Integrated VM Performance Model in the Construction Industry

Undoubtedly, the most significant contribution of this study lies in the development and validation of the integrated VM performance model tailored specifically for the Nigerian construction industry. This model sheds light on the substantial influence of integration, standardization, collaboration, digital technologies, and corporate culture on the performance of Value Management (VM) within this industry. Furthermore, this model contributes to existing literature by identifying gaps in previous VM models within the construction sector. Notably, it highlights the previously underrepresented aspects of digital technologies and corporate culture as pivotal elements in the VM context. Moreover, this study not only identifies these gaps but also validates their importance in determining the performance of VM within the Nigerian construction industry. The underlying framework of the model, which combines resource dependency theory and social identity theory, further enriches the understanding of VM in the context of the Nigerian construction industry. This integrated approach provides a robust foundation for comprehending the dynamics at play within VM practices, enhancing the overall knowledge and insights in this field. The combined theories underscore the five constructs used for developing the model, namely integration, collaboration, standardization, digital technologies, and corporate culture. The resource dependency theory recommends how the construction stakeholders should collaborate, integrate and structure their value chain during VM meetings whereas the social identity theory identifies the behaviour of construction stakeholders, thereby guiding their culture, level of trust and direction of communication.

12.2.2 Theoretical Contribution and Value

The findings from this study contribute to theory as it was revealed that the VM performance model for the Nigerian construction industry is a five-factor model. Despite the debates and

reviews surrounding the concept of VM practice, there has been little mention of VM performance model specifically for the built environment conducted in Nigeria, a gap which this study has addressed. The VM Performance Model that was developed has never been tested in a multidimensional structure composed of collaboration, integration, standardisation, digital technologies, and corporate culture.

The result emanating from the SEM analysis shows that constructs such as integration, standardisation, collaboration, digital technologies, and corporate culture were found to have a significant positive impact on VM performance in the construction industry although standardisation in VM practices was found to have a lowest impact in predicting VM performance in the construction industry. The finding contributed to theory as it shows that integration, collaboration, and other existing constructs used for modelling VM performance in the construction industry are not complete without encouraging effective corporate culture and the use of digital technologies. Also, the study contributed to the theory as it shows that the performance of VM in the Nigerian construction industry is multifaceted, depending on numerous indicators.

The review of literature also shows that there is no similar study to this present study regarding the modelling of VM performance for the Nigerian construction industry. Also, analysis of literature related to VM in the Nigerian construction industry revealed that there is no study that has adopted a combination of Delphi and SEM in modelling VM performance in the Nigerian construction industry. Thus, this study contributes to theory in forming a base on which researchers interested in VM in the construction industry can build. Finally, this study contributed to theory as it shows the dimensions of digital technologies and corporate culture responsible for VM performance in the construction industry. Apart from providing a theoretical contribution, this

study also contributed to the research methodology owing to the method used in conducting the research.

12.2.3 Methodological contributions and value

Many VM studies in Nigeria have used various statistical methods such as exploratory factor analysis (EFA), ANOVA, content analysis, and regression modelling to address issues related to VM. However, this research adopted a more robust choice of methodology by using mixed method (literature review, Delphi study, and field questionnaire) and subsequently partial least squares-structural equation modelling (PLS-SEM) to determine the constructs that predict VM performance, and hence, to develop a VM performance model. Moreover, the method combined with the analysis identified the constructs with a direct influence, indirect influence, and strong relationships with the outcome variables. The PLS-SEM further analysed and modelled several relationships simultaneously (iterations) between independent and dependent variables with a systematic and coherent procedure. Unlike the covariance-based SEM, which is a convenient approach for normal data, PLS-SEM analysis is suitable for non-normal data. Using the SmartPLS version 3.2 software, this study conducted a robust analysis using a three-step approach to evaluate the structural (inner) model, measurement (Strijker, Bosworth and Bouter) model (confirmatory factor analysis) and the model fit analysis.

The coherent and thorough nature of the PLS-SEM analysis can be adopted as a reference point for future VM research. The analysis examined the indicator reliability, internal consistency reliability, convergent validity, discriminate validity, collinearity, the explanatory power of model, predictive relevance of the model, the goodness of fit indices, path significance and several other quality checks before arriving at Model 2.0. Therefore, by conducting this study using PLS-SEM, it was possible to state precisely the constructs that are statistically significant and contribute to

VM such as corporate culture, integration, collaboration, and digital technologies, while standardisation had the lowest influence in determining the performance of VM. The data collection instrument (questionnaire survey) generally recorded high internal reliability; hence, it could be utilised for similar studies to validate this present study or adopted for other related studies. Apart from the obvious contribution to the methodological aspect of the body of knowledge, this research contributes to VM discussions in Nigeria for the successful delivery of construction projects.

12.2.4 Practical contribution of the study

This section presents the contribution of this study to practice as it examines the benefit of this study to construction stakeholders, professional bodies, the built environment, and the Nigerian construction industry. The knowledge of the influence or impact of the five constructs will assist construction stakeholders to plan better during the management of VM activities and workshop. For instance, the stakeholders would know the most suitable culture that encourages collaboration, cooperation, and client satisfaction is vital for the effective management of VM in construction.

The construction industry of developing countries including Nigeria are known for poor performance which can be attributed to; more design iterations, cost overrun, time overrun, the use of new and unfamiliar materials, enormous wastes, cost overrun, fragmentation, budget overrun, and delayed schedules which is affecting the sustainability of building projects. This model aims to alleviate the fragmentation within the construction industry and promote early collaboration among all professionals involved in value management activities. Furthermore, the constructs and their associated indicators utilized in developing this study's model will serve as a valuable reference for implementing value management practices in the Nigerian construction

sector. Additionally, the study highlights that risk in construction stems from exposure to economic fluctuations, which can result in either gains or losses during the project. The literature review findings attribute economic losses in terms of time and cost overruns within the Nigerian construction industry to the risks associated with project delivery in the country. This underscores the significant role of cost and time overruns as key contributors to risk in the Nigerian construction sector. The structural equation modeling (SEM) analysis indicates that effective adoption of the constructs used in developing this model has the potential to mitigate cost and time overruns.

The literature review on Value Management (VM) in the Nigerian construction industry, along with the Delphi findings, affirm the absence of policies or regulations governing VM practices in the country's construction sector. The study's results will serve as a foundational framework for regulatory bodies overseeing construction professionals, aiding them in establishing policies for the implementation of VM in the industry. Furthermore, these research findings will assist these regulatory bodies in prioritizing specific aspects of VM in their decision-making processes. The insights gained from the indicators related to standardization within the construction industry will also enable regulatory bodies to devise measures that enhance the adoption of VM practices. It is essential to emphasize that the integrated holistic VM model designed for the Nigerian construction industry must be actively utilized as a guiding tool to ensure that all necessary constructs and indicators for successful VM implementation in Nigeria are in place. This study offers an opportunity for further advancements in VM research within the construction industry, particularly in refining the indicators and constructs originally employed in the study to suit the context of other developing countries. Consequently, the following section presents

recommendations for refining the methodology, addressing theoretical considerations, and addressing policy implications.

12.3 RECOMMENDATIONS

This study makes the following recommendations from the methodological, theoretical, and practical contribution of this study:

12.3.1 Methodological recommendations

This study recognised that there is no perfect model capable of including all the population samples and sample sizes. Therefore, this study recommends that a similar study should be conducted with a different population size. For instance, a similar study could be conducted using the Delphi technique and SEM in other developing country such as Ghana, South African and others. Moreover, future research should be carried out to determine more latent constructs that could arise soon and that will contribute to VM performance for improving the current model. Technically speaking, there is no perfect model and as such, the VM model (Model 2.0) developed by this study can be improved upon.

The study also suggests promoting the utilization of a mixed-method approach, specifically combining the Delphi study and questionnaire surveys, in research related to Value Management (VM) within the construction industry. This recommendation stems from the subjective nature of VM, and the combination of these two methods facilitates the thorough testing and refinement of the constructs employed in developing the model. It is advised that the mixed-method approach commence with the Delphi study, followed by the questionnaire survey. Initiating with the Delphi study ensures that experts, who bring practical insights, validate the indicators derived from the existing literature, confirming their applicability in real-world practice. This sequential approach

helps ensure the robustness and relevance of the constructs used in the research. Finally, the questionnaire in return validates the responses of the experts.

It is also recommended that the questionnaire survey should be analysed using structural equation modelling (SEM). The use of SEM was recommended because of its strength over other univariate statistics such as regression, ANOVA and MANOVA owing to its ability to automatically show the pictorial impact of the endogenous variable on the exogenous variable. The use of SEM was also recommended because of its in-depth analysis on testing the analysis and also the ability to show the predictive power of the model. Therefore, for a similar study in other developing countries it is strongly recommended that SEM is used in analysing the questionnaire survey.

12.3.2 Theoretical recommendation

Despite the exhaustive discussions on VM practices over the past few years, the concept remains a dynamic issue that has continued to generate diverse opinions from both industry professionals, and academicians. Somehow, a VM performance model in the built environment domain is yet to be developed, a gap which the study had filled. This current study reviewed existing literature and conducted a robust review of nine existing VM models across several contexts.

This study identified four constructs that contribute to VM performance. The study also considered the inclusion of two constructs (research gaps) which resulted in five latent constructs. These were validated by built environment experts during a two-stage Delphi process before a questionnaire survey, which led to a VM performance improvement model. The constructs identified were collaboration, integration, standardisation, digital technologies, and corporate culture. It is therefore recommended that VM performance model developed in this study should form the basis

for understanding the concept in Nigeria in ensuring the successful delivery of construction projects.

12.3.3 Policy implication and practical recommendations

The recommendations for practice and policy implementation were made by virtue of the findings extracted from this research and are highlighted below:

1. The policy implication implies that VM performance in the construction industry can be enhanced through integration, collaboration, standardisation, digital technologies, and corporate culture.
2. In shaping the practice of Value Management (VM) within the Nigerian construction industry, it is advisable to base the model on the five constructs that served as the foundation for this study. Additionally, it is crucial to direct particular attention and emphasis toward fostering an efficient corporate culture and promoting the seamless integration of VM activities. These two aspects play a pivotal role in ensuring the successful implementation of VM practices within the industry. Also, value members should embrace a culture that enhances collaboration, motivation, and teamwork.
3. Regulatory bodies should ensure that incentives are provided to support construction professionals during VM activities which will help to foster integration.
4. The construction stakeholders should be responsive to the mode of information sharing within the value chain and also adopt an effective and fast communication channel.
5. To conclude, it is strongly recommended that regulatory bodies overseeing construction professionals, along with industry stakeholders and government authorities, collaborate to develop software based on the constructs identified in this study. This software can be employed to predict and assess the performance of Value Management (VM) within the

Nigerian construction industry. Such a tool would function as a valuable pre-test, helping to gauge and improve the effectiveness of VM practices in the Nigerian construction sector.

12.4 LIMITATIONS OF THE STUDY

The findings from this study have contributed enormously to the gap in existing knowledge of VM in the construction industry. Despite the contribution of this study to the existing knowledge, there are some inherent limitations within the study. Firstly, the research was conducted only in Lagos and Abuja States indicated in the research methodology chapter. This is because the two states account for the highest number of construction activities within the country. Also, the states were chosen because they exhibit different cultures and diversity in communication. However, a similar study can be conducted using other states in the country or other developing countries in Africa. The study was also limited in comparing the responses of the sub-main and nominated professionals regarding the performance of VM in the Nigerian construction industry. The use of SEM also poses a limitation to this study because the analysis is based on a causal model with raw data that creates the probability of supporting an a priori causal model.

The research was also limited in adding only two new constructs in modelling VM practice for the construction industry. Further constructs could be attached to the model and used for determining the performance of VM in the Nigerian construction industry. The study was also limited in testing the impact of the individual construct on VM in the construction industry. A further study could be conducted on examining the impact of construct among themselves. The study was also limited in consulting literature related to the Hong Kong, Australia, Ghana and Nigeria. A further study could be conducted reviewing literature from other countries globally. Likewise, the sample size used for this study serves as a limitation to this study and a larger size would be of more benefit

to this study. However, the sample size was justified by the sample population and the software (SmartPLS) used in conducting the SEM analysis. Finally, the investigation of the exogenous variable (VM performance) has shown that it is multi-faced and therefore needs further interpretation.

12.5 RECOMMENDATIONS FOR FURTHER RESEARCH

Based on some of the limitations observed, the following suggestions were made for further studies:

- The research suggests the need for further investigations to delve into the limitations identified in this study, as previously mentioned. Therefore, it is recommended that similar research be carried out in other developing countries, such as South Africa, Kenya, Ghana, and others. This comparative study can help in ascertaining whether the performance indicators of Value Management (VM) in the Nigerian construction industry align with those of other developing nations. Such cross-country comparisons would provide valuable insights into the generalizability and applicability of VM practices in diverse contexts.
- Further study could be conducted with the intention of adding a new construct to the model and used for determining the performance of VM in the Nigerian construction industry. Also, further study could be conducted on examining the impact of the construct among themselves.
- Additionally, it is suggested that further research should explore the development of software utilizing the constructs derived from this study for the purpose of predicting the performance of Value Management (VM) in the Nigerian construction industry. This software would serve as an invaluable pre-test tool for evaluating the effectiveness and

performance level of VM practices within the Nigerian construction sector. Such a software-based approach can offer a practical and data-driven means to assess and enhance VM implementation in the industry.

- A further study could also be conducted in other states within the country, adopting a different form of research methodology.
- Future studies need to validate the Author's integrated holistic VM performance model presented in Figure 10.5 (Model 2.0).

12.6 CONCLUSION

In this study, a Value Management (VM) performance model was created for the Nigerian construction industry. This model was built upon theories rooted in VM and the construction sector. The central hypothesis posited that the effectiveness of VM in the Nigerian construction industry is directly influenced by certain external variables. These exogenous variables, which were employed in constructing the model, include integration, standardization, collaboration, digital technologies, and corporate culture. The model's validity and predictive power were evaluated using structural equation modeling software, specifically SmartPLS. The outcomes of the analysis indicate that the model is indeed capable of sufficiently forecasting and anticipating the performance of VM within the Nigerian construction industry. This suggests that the chosen exogenous variables play significant roles in shaping VM outcomes in this context. Also, all the constructs have a positive impact on the performance of VM (VM) in the Nigerian construction industry. The study also shows that the model has a good discriminant validity and meets the threshold of the SRMR (standard root mean square) and NFI. The path co-efficient (Q^2) was also strong. Thus, the five-factor model as Figure 10.5 represents a proper prediction of enhancing VM performance in the Nigerian construction industry.

The utilization of the Delphi technique in this study offers a valuable avenue for making contributions on theoretical, methodological, and practical fronts. This is chiefly attributed to the diverse composition of respondents, which encompassed academics, construction professionals, and regulatory bodies with expertise in the construction industry. Moreover, the experts engaged in the Delphi study possessed extensive practical experience and a profound understanding of Value Management (VM) activities within the construction sector. The study's conceptual framework was subsequently subjected to validation through a questionnaire survey and subjected to analysis using Structural Equation Modeling (SEM). The SEM analysis underwent three iterative stages, each aimed at refining the model to achieve an optimal fit. The ultimate goal was to create a model that could effectively predict and enhance the performance of VM within the Nigerian construction industry. This comprehensive approach contributes to the study's robustness and applicability across various dimensions of research and practice.

The findings from this study provide the opportunity and information that can assist construction stakeholders, professionals, and the Nigerian government in planning and effectively managing VM activities. The study provides the indicators used in determining the performance of VM in the Nigerian construction industry. The indicators include project management, elimination of delay, time management, innovative designs, optimization of value, cost-saving practices, efficient project delivery, enhanced project functionality, material management, conflict management, and quality management. However, for VM activities to run smoothly and effectively, there must be an effective culture that encourages collaboration, cooperation, client satisfaction, and the involvement of all stakeholders.

In conclusion, this study underscores the complexity of enhancing the performance of Value Management (VM) in the construction industry. The study employed a robust modeling approach,

specifically Structural Equation Modeling (SEM), to comprehensively assess the impact of various multifaceted variables on VM performance within the Nigerian construction sector. The practical implication of this research is that the effectiveness of VM can be significantly improved by prioritizing integration, fostering collaboration, promoting standardization, embracing digital technologies, and cultivating an effective corporate culture within the construction industry. Furthermore, it is recommended that regulatory bodies for construction professionals, in collaboration with industry stakeholders and government agencies, develop software based on the constructs identified in this study. This software can be employed as a pre-test tool to evaluate and predict the enhancement of VM performance in the Nigerian construction industry. Looking ahead, the future of VM in the Nigerian construction industry should align with the five-factor model identified in this study. Notably, a strong emphasis on effective integration and the cultivation of a positive corporate culture should be at the forefront of efforts aimed at enhancing VM activities within the industry. These measures will contribute to the continued advancement and success of VM in the Nigerian construction sector.

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APPENDIX A

INVITATION LETTER TO PARTICIPATE IN DELPHI SURVEY

18 July 2023

Dear Sir/Madam,

Comfort Iyiola is enrolled in a Ph.D. program within the Faculty of Engineering and the Built Environment at Durban University of Technology, under the guidance of Dr. Modupe Mewomo. Her research focuses on creating a comprehensive framework to improve the efficiency of value management in the Nigerian construction sector. She is adopting a Delphi methodology and seeks to assemble a group of experts in the field to contribute to this initiative.

Your expertise would be highly appreciated if you could participate in this study.

Kind regards

Dr. Modupe Mewomo., Ph.D.

Acting Head of Department

Department of Construction Management and Quantity Surveying

Faculty of Engineering and the Built Environment

Email: modupeM@dut.ac.za.

Durban University of Technology, South Africa

APPENDIX B

DELPHI METHOD AND APPLICATION TO THIS STUDY

BACKGROUND INFORMATION

The Delphi Method

The Delphi method is a procedure utilized to collect data and address complex, non-analytical problems. It serves as a research tool by harnessing knowledge from individuals, typically experts, and then analyzing and synthesizing this information to arrive at a group consensus.

The Process

The process involves several rounds of questionnaires or surveys. The initial round is exploratory, where each expert receives a standardized questionnaire. In the subsequent round, participants are presented with the collective responses from the group, alongside their own responses from the first round. Each expert has the opportunity to modify their answers or express opinions on new issues raised in the previous survey. The third round aims to solidify a statistical consensus among the group.

The Application of Delphi

You have been invited to take part in the Delphi process as a participant in a Doctoral study focused on creating an integrated model to enhance the performance of value management in the Nigerian construction industry. The primary objective of this data collection is to pinpoint the variables and constructs that underpin value management performance within the Nigerian construction sector. Your insights and expertise in this field are highly valued and sought after for this research endeavor.

Time Commitment

The time commitment required for your participation is quite minimal. Each round of the questionnaire is expected to take approximately 25-30 minutes to complete and submit.

Schedule

The initial round questionnaire will be emailed to you in February 2022. After analyzing the responses, the researcher intends to distribute the second round questionnaire by the end of March 2022. If it is deemed necessary to attain a consensus on certain key issues, a third and final round questionnaire will be sent in April 2022. The final results will be made available to you by May 2022.

Your prompt and valuable contributions during this timeframe are greatly appreciated in advancing this research.

APPENDIX C

DELPHI INSTRUCTIONS FOR ROUND 1

DELPHI SURVEY- ROUND 1

Thank you for your willingness to participate in the Delphi panel for our research. Your commitment to this endeavor is highly valued. The following questionnaire is designed to gather your insights regarding the development of an integrated value management model for the construction industry in Nigeria.

This marks the initial stage of our Delphi study, and it should take approximately 20 to 25 minutes of your valuable time. Subsequent rounds will require considerably less time investment.

After completing the questionnaire, kindly send your responses in Word format to iyiolacomfort27@gmail.com. Please note that you will have the opportunity to revise your answers later, once all Delphi participants have completed the First Round survey and the results have been analyzed. The results will be presented in simple statistics, such as median responses.

INSTRUCTIONS

1. Please provide your responses to the following questions by marking an 'X' in the corresponding boxes.
2. As an expert, this survey seeks your evaluation of the dimensions (both main and sub-dimensions) that contribute to improving the performance of value management within the construction industry.

IMPORTANCE SCALE (probability in percentage)

0-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	71-80%	81-90%	91-100%
1	2	3	4	5	6	7	8	9	10
						X			

SIGNIFICANCE SCALE

No impact		Low impact		Medium impact		High impact		Very high impact	
1	2	3	4	5	6	7	8	9	10
						X			

Q1 MAIN VM DIMENSIONS: To determine the various dimensions that enhances value management performance in the construction industry.

	Kindly rate the impact of the following attributes on ensuring effective VM practice in the construction industry									
	No impact		Low impact		Medium impact		High impact		Very high impact	
	1	2	3	4	5	6	7	8	9	10
Integration							X			
Collaboration									X	
Standardisation								X		
Corporate culture										X
Digital technologies									X	

Are there any additional factors that influence effective value management practices within the Nigerian construction industry that have not been considered? If so, please specify the factor and assess its impact.

Variables	Rate 1-10

Q2: Kindly rate the impact of the following integration practices on the performance of VM in the construction industry.

Integration pertains to the practice, whether formal or informal, employed within a construction project to combine information, processes, and individuals into a unified framework.

	Kindly rate the impact of the following integration practices on the performance of VM									
	No impact		Low impact		Medium impact		High impact		Very high impact	
	1	2	3	4	5	6	7	8	9	10
Knowledge about VM									X	
Regular workshop meetings									X	
Commitment of participants									X	
Early goal definition									X	
Clear objectives of workshop								X		
Experienced VM facilitator									X	

Efficient project execution									X		
Availability of resources										X	
Involvement of decision makers and other key partners in VM workshop									X		
Accelerated decision making									X		
Efficient ideas and alternatives gathered in early stage									X		
Enough time to conduct VM studies									X		
Open information system									X		
Dedicated personnel										X	
Prompt response among professionals during VM meetings									X		
Constant communication										X	
Adequate skills and training									X		

In your own opinion, is there any integration practice that has not been identified? Kindly indicate them and rate the impact on the performance of VM.

Variables	Rate 1-10

Q3: Kindly rate the impact of the following collaboration strategies among project stakeholders on the performance of VM in construction.

Collaboration refers to the cooperative effort of two or more distinct stakeholders involved in a construction project, working together to strategize and execute various operations within the construction value chain.

	Kindly rate the impact of the following collaborative practices on the performance of VM									
	No impact		Low impact		Medium impact		High impact		Very high impact	
	1	2	3	4	5	6	7	8	9	10
Dispute resolution techniques							X			

Partnership							X			
Client's support and participation								X		
Shared orientation							X			
Information sharing									X	
Equal contribution of participants										X
Resource sharing									X	
Decision alignment							X			
Teamwork								X		
Knowledge sharing								X		
Interaction among participants in each phase									X	
Group goal setting									X	
Risk sharing									X	
Coordination									X	

In your own opinion, is there any collaboration strategy adopted by construction project stakeholders that have not been addressed. Kindly indicate them and rate the impact on the performance of CVM.

Variables	Rate 1-10
Team building activities	8
Cooperation	8
Improved motivation	7

Q4: Kindly rate the impact of the following standardisation strategies on the performance of VM.

Standardisation is the process of implementing and developing technical standards based on the consensus of different parties that include firms, users, organisation and governments.

	Kindly rate the impact of the standardisation strategies on the performance of VM				
	No impact	Low impact	Medium impact	High impact	Very high impact

	1	2	3	4	5	6	7	8	9	10
Input of government and its agencies									X	
Mandatory VM training certification for all construction professionals									X	
Presence of VM policies and legal framework								X		
Government commitment to implement VM									X	
VM action plan for implementation										X
Inclusion of VM clause in procurement Act								X	X	
Attendance of policymakers on constant basis							X			
Presence of rule that encourage VM application								X		
Collaboration of government officials and professional bodies								X		
Regulation of VM activities								X		
Customizing VM for the Nigerian construction industry									X	
Active client's support and participation									X	

In your own opinion, is there any standardised practice that has not been identified? Kindly indicate them and rate the impact on the performance of VM.

	Rate 1-10

Q5 Kindly rate the impact of the following drivers for corporate culture on VM performance.

Corporate culture refers to the shared fundamental beliefs and practices that a stakeholder in a construction project has acquired as effective problem-solving methods. This study categorizes corporate culture into the following dimensions;

- **Clan Culture:** When a construction project stakeholder embraces clan culture, they prioritize building interpersonal relationships, fostering teamwork, providing mentorship, and forming partnerships within the organization.
- **Adhocracy Culture** Stakeholders adopting an adhocracy culture are inclined to promote innovation and take calculated risks within the organization.
- **Hierarchy Culture:** Stakeholders following a hierarchy culture emphasize establishing control, wielding power, and enforcing strict organizational structures within the construction project.
- **Market Culture:** Stakeholders who adopt a market culture focus on meeting the client’s needs, often prioritizing client satisfaction over the principles and opinions of other stakeholders in the construction project.

	Kindly rate the impact of the following corporate culture on the performance of CVM									
	No impact		Low impact		Medium impact		High impact		Very high impact	
	1	2	3	4	5	6	7	8	9	10
Clan culture										
Interpersonal relationship									X	
Teamwork									X	
Management commitment								X		
Continuous improvement								X		
Cooperation among stakeholders								X		
Participants satisfaction					X					
Motivation									X	
Regular communication									X	
Education and Training						X				
Skill development and acquisition								X		
Adhocracy culture										
Risk management								X		
Reward and incentive system								X		
Entrepreneurial development								X		
Creativity orientation								X		
Updated technology system									X	
Growth and development								X		

Availability of new resources								X		
High degree of flexibility								X		
Hierarchy culture										
Regulation of VM activities								X		
Assertion of policy within the value chain								X		
Control of other construction professionals`									X	
Efficiency among construction professionals								X		
Prediction of stakeholder's activity within the organisation								X		
Meeting targets with adherence to schedule								X		
Smooth operation of VM activities								X		
Market culture										
Goal accomplishment							X			
Result oriented									X	
Client satisfaction								X		
Competition among construction stakeholders						X				
Ensures large market size							X			
Focus on achievement irrespective of another stakeholders' opinion							X			

	Rate 1-10

Q6: Kindly rate the level of significance of the digital technologies in improving performance of VM process in the construction industry.

Digital technologies improves existing business processes and workforce efficiency in order to enhance clients' experience, launch business and product models and offer new opportunities to resolve issues of poor productivity and performance in the construction industry.

	Kindly rate the level of significance of digital technologies in improving the performance of VM process									
	No significance		Low significance		Moderately significant		Significant		Very significant	
	1	2	3	4	5	6	7	8	9	10
Knowledge of artificial intelligence							X			
Internet of things (IoT)							X			
Building information modelling (BIM)								X		
Augmented reality technologies (smart phones, video games, etc.)								X		
Mobile devices								X		
Digital twin									X	
Administrative tools (Microsoft suites, Primavera)										X
Virtual reality (sophisticated headsets, LCD displays, etc.)									X	
Knowledge of robotics								X		
Knowledge of the use of drones								X		
Cloud computing									X	
Electronic meeting tools (zoom, Microsoft teams, etc.)									X	
Knowledge of cybersecurity								X		
Advanced big data analytics									X	
Blockchain technology									X	

In your own opinion, is there any digital technology that has not been identified? Kindly indicate them and rate the impact on the performance of VM.

	Rate 1-10
Cryptocurrency	7
Engineering design (Computer-aided design)	9
Information technology and system control	8

Q8 Personal Information of Expert Panel Member

Title (Mr., Mrs., Dr., Prof.)	DR.
Highest Qualification	DOCTORATE
Professional Affiliation	CONSTRUCTION MANAGEMENT
Years of Experience	11 YEARS
Current Employer	HELZON CONSTRUCTION LTD.
Position	SITE ENGINEER
Any academic publications? (Journals, papers, books, etc).	YES
States Currently Residing	OYO

Thank you for participating in this initial survey round.

Should you have any inquiries regarding this survey or the research project as a whole, please feel free to reach out to me or my supervisor, Dr. Modupe Mewomo. Our contact details are provided below:

Contact details:

Comfort Iyiola, PhD candidate
 Durban University of Technology
 Faculty of Engineering and the Built Environment
 Email: iyiolacomfort27@gmail.com

Supervisor

Dr. Modupe Mewomo., PhD.
 PG Coordinator & DRC Chair:
 Department of Construction Management

and Quantity Surveying, Durban University of Technology,
Steve Biko Campus, Durban, South Africa
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APPENDIX D

DELPHI INSTRUCTIONS FOR ROUND 2

Thank you for your dedication in completing Round 1 of the Delphi survey. We understand that this survey demanded a significant amount of your time and thoughtful consideration, and we sincerely appreciate your commitment.

Round 2 of the survey marks the continuation of the Delphi process for this study. The main objective of Round 2 is to offer you the opportunity to modify your previous responses, should you choose to do so, based on the median group response for each question and variable.

This second round survey is expected to take approximately 30 minutes, as it solely involves reviewing your initial responses in light of the collective group median. Once you have completed all the questions, kindly send your updated responses to iyiolacomfort27@gmail.com. Your participation and input are invaluable to this research.

INSTRUCTIONS

For each element, you will find two values: your initial response from the Round 1 survey (highlighted in yellow) and the group median from the Round 1 survey located in the rightmost column of each table.

Please take one of the following three actions for each category:

1. Accept the group median response by leaving the field unchanged.
2. Provide a new response by marking it with an 'X' in the appropriate field.
3. Indicate a new response by placing an 'X' in the appropriate field.

Please note: If your response deviates by more than ten percent (one unit) from the group median, kindly explain your reasoning for the differing response in the 'comment' field, which is provided.

Additionally, any new issues identified from the Round 1 survey are highlighted in green for your review and response.

Q1 MAIN VM DIMENSIONS: To determine the various dimensions that enhances value management performance in the construction industry.

	Kindly rate the impact of the following attributes on ensuring effective VM practice in the construction industry										Media n
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	
Integration											7

Collaboration												9
Standardisation												8
Corporate culture												10
Digital technologies												9

Q2: Kindly rate the impact of the following integration practices on the performance of VM in the construction industry.

	Kindly rate the impact of the following integration practices on the performance of VM											Median
	No impact		Low impact		Medium impact		High impact		Very high impact		9	
	1	2	3	4	5	6	7	8	9	10		
Knowledge about VM												9
Regular workshop meetings												9
Commitment of participants												9
Early goal definition												8
Clear objectives of workshop												9
Experienced VM facilitator												8
Efficient project execution												7
Availability of resources												8
Involvement of decision makers and other key partners in VM workshop												8
Accelerated decision making												8
Efficient ideas and alternatives gathered in early stage												8
Enough time to conduct VM studies												8
Open information system												9
Dedicated personnel												8
Prompt response among professionals during VM meetings												9
Constant communication												8

Adequate skills and training												9
Comments												

Q3: Kindly rate the impact of the following collaboration strategies among project stakeholders on the performance of VM in construction.

	Kindly rate the impact of the following collaborative practices on the performance of VM											Median
	No impact		Low impact		Medium impact		High impact		Very high impact		9	
	1	2	3	4	5	6	7	8	9	10		
Dispute resolution techniques												8
Partnership												9
Client's support and participation												9
Shared orientation												9
Information sharing												8
Equal contribution of participants												8
Resource sharing												8
Decision alignment												9
Teamwork												9
Knowledge sharing												9
Interaction among participants in each phase												9
Group goal setting												8
Risk sharing												9
Coordination												9
Team building activities												9
Cooperation												8
Improved motivation												9
Comments												

Q4: Kindly rate the impact of the following standardisation strategies on the performance of VM.

	Kindly rate the impact of the standardisation strategies on the performance of VM										
	No impact		Low impact		Medium impact		High impact		Very high impact		Median
	1	2	3	4	5	6	7	8	9	10	
Input of government and its agencies											9
Mandatory VM training certification for all construction professionals											9
Presence of VM policies and legal framework											9
Government commitment to implement VM											8
VM action plan for implementation											8
Inclusion of VM clause in procurement Act											8
Attendance of policymakers on constant basis											8
Presence of rule that encourage VM application											7
Collaboration of government officials and professional bodies											7
Regulation of VM activities											8
Customizing VM for the Nigerian construction industry											9
Active client's support and participation											8
Comments											

Q5 Kindly rate the impact of the following drivers for corporate culture on VM performance.

	Kindly rate the impact of the following corporate culture on the performance of CVM										
	No impact		Low impact		Medium impact		High impact		Very high impact		Median
	1	2	3	4	5	6	7	8	9	10	

Clan culture											9
Interpersonal relationship											9
Teamwork											8
Management commitment											8
Continuous improvement											8
Cooperation among stakeholders											5
Participants satisfaction											9
Motivation											9
Regular communication											6
Education and Training											8
Skill development and acquisition											9
Adhocracy culture											
Risk management											8
Reward and incentive system											8
Entrepreneurial development											7
Creativity orientation											7
Updated technology system											9
Growth and development											8
Availability of new resources											8
High degree of flexibility											8
Hierarchy culture											
Regulation of VM activities											8
Assertion of policy within the value chain											8
Control of other construction professionals`											9
Efficiency among construction professionals											8
Prediction of stakeholder's activity within the organisation											8
Meeting targets with adherence to schedule											8
Smooth operation of VM activities											8
Market culture											
Goal accomplishment											7

Result oriented											9
Client satisfaction											8
Competition among construction stakeholders											6
Ensures large market size											7
Focus on achievement irrespective of another stakeholders' opinion											7
Comments											

Q6: Kindly rate the level of significance of the digital technologies in improving performance of VM process in the construction industry.

	Kindly rate the level of significance of digital technologies in improving the performance of VM process										Median	
	No significance		Low significance		Moderately significant		Significant		Very significant			
	1	2	3	4	5	6	7	8	9	10		
Knowledge of artificial intelligence												8
Internet of things (IoT)												9
Building information modelling (BIM)												9
Augmented reality technologies (smart phones, video games, etc.)												8
Mobile devices												8
Digital twin												9
Administrative tools (Microsoft suites, Primavera)												9
Virtual reality (sophisticated headsets, LCD displays, etc.)												8
Knowledge of robotics												8
Knowledge of the use of drones												8
Cloud computing												9

Electronic meeting tools (zoom, Microsoft teams, etc.)											9
Knowledge of cybersecurity											8
Advanced big data analytics											9
Blockchain technology											8
Cryptocurrency											7
Engineering design (Computer-aided design)											9
Information technology and system control											8
Comments											

Thank you for completing this second round of the survey.

If you have any questions regarding this survey or the research project in general, please don't hesitate to reach out to me or my supervisor, Dr. Modupe Mewomo. Our contact details are provided below:

Contact details:

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Supervisor

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PG Coordinator & DRC Chair: Department of Construction Management
and Quantity Surveying, Durban University of Technology,
Steve Biko Campus, Durban, South Africa
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APPENDIX E

INVITATION LETTER TO PARTICIPATE IN A FIELD SURVEY

Durban University of Technology,
Faculty of Engineering and the Built Environment,
Department of Construction Management and Quantity Surveying,
Steve Biko Campus,
4001

Dear sir/ma,

LETTER OF INVITATION FOR RESEARCH SURVEY

The Department of Construction Management and Quantity Surveying at Durban University of Technology is currently conducting research aimed at developing an integrated model to enhance the performance of value management in South Africa.

We kindly request your participation in the following brief questionnaire, which should require no more than 15 to 20 minutes of your time. Your thorough completion and submission of the questionnaire would be greatly appreciated. To ensure your anonymity, please refrain from including your name or contact information on the questionnaire. A summary of the study's results will be accessible through the Department of Construction Management and Quantity Surveying.

This research is supervised by Dr. M.C. Mewomo. If you have any questions or require further information, please do not hesitate to reach out to me on

Email: iyiolacomfort27@gmail.com

Thank you for your participation.

Comfort Iyiola

APPENDIX F
FIELD SURVEY QUESTIONNAIRE

INSTRUCTIONS

Please answer the following questions by crossing (x) in the relevant block or writing down your answer in the space provided.

SECTION A: PERSONAL INFORMATION

1. Indicate your gender.

Male	1
Female	2

2. Indicate your highest level of education

OND (Ordinary National Diploma)	1
HND (Higher National Diploma)	2
Bachelor's degree (BSc./Btech)	3
Master's degree (MSc./Mtech)	4
Doctorate (PhD)	5

3. What is your professional qualification?

Architect	1
Construction Manager/Builder	2
Project Manager	3
Engineer	4
Quantity Surveyor	5

4. How many years of experience do you have in the construction industry?

1-5 years	
6-10years	
16-20years	
More than 20 years	

5. How many number of projects have you been involved in the past year?

None	
1-2	
3-4	
5-6	
7-8	
9-10	
More than 10	

6. How often do you obtain projects from the following types of clients?

Please rate on a scale of; 1 – never 2. Rarely, 3. Sometimes, 4. Often, 5 always

	1	2	3	4	5
Government					
Individuals					
Corporate Bodies					

SECTION B

Attributes for Enhancing the Performance of Value Management in Construction

INTEGRATION FACTORS

Please, kindly rate the extent in which the following integration factors have an impact on value management performance in your organisation using the following point rating scale; 1 (No extent), 2 (Small extent), 3 (Moderate extent), 4 (High extent), 5 (Very high extent)

	Integration factors	No impact	Low impact	Medium impact	High impact	Very high impact
1	Knowledge about VM					
2.	Regular workshop meetings					
3.	Commitment of participants					
4.	Early goal definition					

5.	Clear objectives of workshop					
6.	Experienced VM facilitator					
7.	Availability of resources					
8.	Accelerated decision making					
9.	Efficient ideas and alternatives gathered in early stage					
10.	Enough time to conduct VM studies					
11.	Open information system					
12.	Prompt response among professionals during VM meetings					
13.	Equal contribution of participants					
14.	Constant communication					

COLLABORATION FACTORS

Please, kindly rate the extent in which the following collaboration factors have an impact on value management performance in your organisation using the following point rating scale; 1 (No extent), 2 (Small extent), 3 (Moderate extent), 4 (High extent), 5 (Very high extent).

	Collaboration Factors	No impact	Low impact	Medium impact	High impact	Very high impact
1.	Information Sharing					
2.	Resource sharing					
3.	Partnership					
4.	Decision Alignment					
5.	Teamwork					
6.	Knowledge sharing					
7.	Shared orientation					
8.	Coordination					
9.	Interaction among participants in each phase					
10.	Dispute resolution techniques					
11.	Client's support and participation					
12.	Group goal setting					
13.	Risk sharing					

14.	Cooperation					
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STANDARDISATION FACTORS

Please, kindly rate the extent in which the following standardisation factors have an impact on value management performance in your organisation using the following point rating scale; 1 (No extent), 2 (Small extent), 3 (Moderate extent), 4 (High extent), 5 (Very high extent).

	Standardisation factors	No impact	Low impact	Medium impact	High impact	Very high impact
1.	Input of government and its agencies					
2.	Mandatory VM training certification for all construction professionals					
3.	Presence of VM guidelines and legal framework					
4.	Government commitment to implement VM					
5.	Inclusion of VM clause in procurement act					
6.	Attendance of policymakers on constant basis					
7.	Regulation of VM activities					
8.	Collaboration of government officials and professional bodies					
9.	Customising VM for the Nigerian construction industry					
10.	Active client's support and participation					
11.	VM action plan for implementation					
12.	Clients' capacity to convey demands to the design team					

DIGITAL TECHNOLOGIES FACTORS

Please, kindly rate the extent in which the following digital technologies have an impact on value management performance in your organisation using the following point rating scale; 1 (No extent), 2 (Small extent), 3 (Moderate extent), 4 (High extent), 5 (Very high extent).

	Digital technologies	No impact	Low impact	Medium impact	High impact	Very high impact
1.	Internet of Things (IoT)					
2.	Electronic meeting tools					
3.	Knowledge of cybersecurity					
4.	Advanced big data analytics					
5.	Engineering design					
6.	Building Information Modelling					
7.	Augmented reality technologies					
8.	Mobile devices					
9.	Digital twin					
10.	Knowledge of administrative tools					
11.	Virtual reality					
12.	Cloud computing					
13.	Blockchain technology					

CORPORATE CULTURE FACTORS

Please, kindly rate the extent in which the following corporate culture factors have an influence on the performance of value management in your organisation using the following point rating scale; 1 (No extent), 2 (Small extent), 3 (Moderate extent), 4 (High extent), 5 (Very high extent).

	Corporate Culture	No impact	Low impact	Medium impact	High impact	Very high impact
1.	Interpersonal relationship					
2.	Teamwork					
3.	Management commitment					
4.	Cooperation among stakeholders					
5.	Motivation					
6.	Education and Training					
7.	Skill development and acquisition					
8.	Risk management					
9.	Reward and incentive system					

10.	Creativity orientation					
11.	Innovativeness					
12.	Updated technological system					
13	High degree of flexibility					
14	Regulation of VM activities					
15	Assertion of policy within the value chain					
16	Control of other construction professionals					
17	Smooth operation of VM activities					
18	Meeting targets with adherence to schedule					
19	Client satisfaction					
20	Result oriented					
21	Goal accomplishment					
22	Ensuring large market size					

SECTION C

OUTCOME OF EFFECTIVE VALUE MANAGEMENT PERFORMANCE

Based on your knowledge or experience, to what extent can each of the following outcomes be achieved if the above variables in section B are enhanced in the built environment? Please, rate according to the scale; 1 (No extent), 2 (Small extent), 3 (Moderate extent), 4 (High extent), 5 (Very high extent).

		No impact	Low impact	Medium impact	High impact	Very high impact
1.	Cost saving practice					
2.	Material management					
3.	Time management					
4.	Risk management					
5.	Whole life asset management					
6.	Conflict management					
7.	Long-term planning					
8.	Quality management system					
9.	Waste reduction					

10.	Improved project management					
11.	Elimination of delay					
12.	Efficient project delivery					
13.	Better quality system and performance					
14.	Innovative designs					
15.	Optimisation of value					
16.	Increased efficiency in achieving tasks					
17.	Better collaboration among professionals					
18.	Enhanced project functionality					
19.	Sustainability					

Thank you for your contribution. We really value your contribution and time spent on completing this questionnaire. If you have any queries, please do not hesitate to contact the undersigned.

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