Evaluating the Impact of Value Management Phases on Project Success in Construction Projects: An Empirical Study Using PLS-SEM and IPMA

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Abstract

The construction industry faces recurring challenges of cost overruns, schedule delays, and unsatisfactory quality outcomes. Value Management (VM) has emerged as an effective methodology to maximize value for money by systematically analyzing project functions and aligning them with client requirements. This study aims to evaluate the impact of VM Implementation described by seven phases (Pre-workshop, Information, Function, Creativity, Evaluation, Development & Presentation, and Post-workshop Implementation) on Project Success represented by five reflective dimensions (Time, Scope, Quality, Cost, Risk) through an empirical approach. A mixed-method research design was adopted, combining a structured questionnaire with advanced statistical analyses including Partial Least Squares Structural Equation Modeling (PLS-SEM) and Importance-Performance Matrix Analysis (IPMA). Valid responses were collected from 303 construction professionals, including consultants, contractors, and project owners. The results show that all seven VM phases significantly contribute to the latent construct VM implementation, The results show that VM phases explain 60% of the variance in Project Success, with a strong direct positive effect ($\beta = 0.781$, $p < 0.001$). Among VM phases, the Information Phase was identified as the most influential factor, followed by Function Analysis and Creative phases. The study contributes to both academia and practice by providing empirical evidence on the role of VM in enhancing project outcomes. Recommendations are provided for integrating VM from early project stages and conducting structured workshops to optimize project performance.

Keywords: Value Management, Project Success, PLS-SEM, IPMA, Construction Projects

1- Introduction: The construction sector is one of the most dynamic and complex industries, characterized by high capital investments, multidisciplinary collaboration, and multiple stakeholders (Abdelalim et al., 2025). Despite

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its importance, the sector continues to suffer from chronic problems such as delays, budget overruns, inadequate quality standards (Kineber et al., 2021, 2023) and a range of delivery related risks (Abdelalim, 2019) These issues negatively affect client satisfaction and project sustainability. In response, Value Management (VM) has been introduced as a systematic approach to optimize project performance by balancing cost, function, quality, and time.

These recurring problems have intensified the search for management approaches that can optimize project outcomes and ensure better value for stakeholders (Kineber et al., 2023; Osman et al., 2023; Waqar et al., 2023). Value Management (VM) has emerged as one such approach, offering a structured and systematic process to achieve “value for money” by balancing function, quality, and cost (Kelly et al., 2015). VM is widely recognized for its potential to reduce unnecessary costs, improve design efficiency, and enhance stakeholder engagement, especially when applied in the early phases of project development(Abd elalim et al., 2025; Ellis et al., 2005; Khodeir & El Ghandour, 2019). Several studies across developed and developing countries have demonstrated its effectiveness in optimizing project performance, with reported savings of 10 – 40% without compromising quality (Atabay & Galipogullari, 2013). Beyond financial benefits, VM also supports innovation, risk management, and sustainability by encouraging multidisciplinary collaboration and structured evaluation of project (Al Amri & Marey-Pérez, 2020; Osman et al., 2023).

Despite its proven advantages, the adoption of VM remains uneven across regions, with limited empirical evidence from developing economies, particularly in the Middle East (Khodeir & El Ghandour, 2019; Olawumi et al., 2016; Omran & Soliman, 2017).

In Egypt Arabia, the construction sector plays a central role in economic diversification under Vision 2030, yet it faces challenges related to efficiency, stakeholder coordination, and sustainable delivery ((A. Abdelalim et al., 2021; Khodeir & El Ghandour, 2019). This context provides a unique opportunity to evaluate the role of VM in improving project outcomes.

The purpose of this study is to provide empirical evidence that demonstrates how structured VM practices contribute to the success of construction projects. The aim is to examine whether the implementation of Value Management contributes to improving overall project success, and to provide evidence on how adopting Value Management practices can enhance project outcomes in terms of performance, cost efficiency, and stakeholder satisfaction. Accordingly, this study investigates the impact of VM implementation on project success in the construction sector. Project success is examined through five key dimensions-scope, time, cost, quality, and risk-while VM implementation is captured through seven structured phases, from pre-workshop preparation to post-workshop implementation, Figure 1 and Figure 2. By applying a quantitative approach and structural equation modeling, this research contributes empirical evidence on how VM enhances project performance and offers practical insights for improving construction management practices in Egypt.

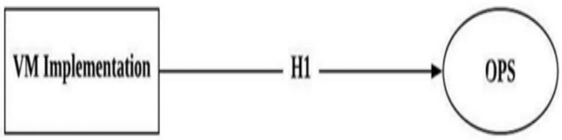

Figure1: The Research Hypothesis

2- Literature Review

2-1- Value Management in Construction :

Value Management (VM) is not limited to cost-cutting measures but is aimed at achieving the best possible value by ensuring that project functions are defined, analyzed, and delivered efficiently. The methodology involves structured phases, often referred to as the VM Job Plan: Information, Function Analysis, Creative, Evaluation, and Development/Presentation. Although the theoretical foundations of VM are well established, empirical research on its impact on project success-particularly in developing economies-is limited.

VM is a multidisciplinary methodology developed to maximize value by focusing on project functions rather than simply cost reduction. Initially developed during World War II in the United States as Value Engineering (VE), it has since evolved into VM to address broader strategic and operational goals. The core principle is to achieve client requirements at the lowest life-cycle cost without compromising essential functions. VM is widely applied in Europe, Asia, and the Middle East, often mandated in public sector projects to improve accountability and transparency. The benefits of VM include improved communication among stakeholders, enhanced creativity in solution generation, and better alignment of project deliverables with client expectations.

Value Management (VM), also referred to as Management of Value (MoV®), is a structured approach designed to maximize the value of investments by balancing benefits, costs, and risks while addressing the diverse needs of stakeholders. VM emphasizes efficiency in resource use, clear definition of objectives and scope, effective stakeholder engagement, sustainable decision-making, and innovation aligned with organizational goals. It is delivered through seven interrelated processes: framing the project, gathering and analyzing information, generating and evaluating proposals, developing recommendations, and implementing and sharing outputs for continuous improvement. To support these processes, VM applies a range of tools and techniques, including function analysis through FAST diagrams and value trees, function cost analysis to compare cost and worth, and value engineering analysis to generate alternatives that improve value without compromising quality. Collectively, these processes and tools provide a systematic framework for enhancing project outcomes by integrating both monetary and non-monetary factors into decision-making (Office of Government Commerce, 2010; Kelly, et al., 2014).

VM is widely applied in construction to maximize value for money by reducing costs or improving functionality. The greatest impact of VM occurs during the early project stages, particularly in strategy, feasibility, and design, when alternative options can still be explored. VM studies typically involve structured workshops where multidisciplinary teams, including stakeholders and project contributors, brainstorm to identify high-cost elements, clarify their functions, and generate innovative alternatives. Effective facilitation is essential to ensure independence, encourage participation, and balance idea generation with evaluation. Timing is also critical: VM should not be applied too early, before project requirements are clear, nor too late, after decisions are fixed; feasibility and pre-construction stages are generally considered most effective. Key success factors include reliable cost data, stakeholder engagement, and alignment with corporate policy and project-specific objectives such as environmental performance, utility, and risk. Integrating VM with risk management allows project teams to consider trade-offs between value improvement and risk exposure, supporting decisions that optimize long-term outcomes (CIOB, 2014; Rangelova & Traykova, 2014; Olawumi et al., 2016).

2-2- Project Success : The successful completion of projects has become a universal requirement in the building and construction sector. For this reason, it is crucial for all stakeholders - including clients, designers, and consultants - to have a clear understanding of what defines a successful project (Abdelalim, Salem, Al- Sabah, et al., 2025). Projects vary in complexity, size, value, duration, and type, leading to different views on what constitutes success and how it should be measured. There is no universally accepted concept of project success, and various models and frameworks have been developed to address this diversity (Lalic et al., 2022).

Initially, Success Was Measured Using The Traditional “Iron Triangle” Of Time, Cost, And Scope, Which Focuses On Efficiency (Atkinson, 1999; Carvalho Et Al., 2015). Traditionally, Cost, Quality, And Timeliness Have Been Regarded As The Primary Goals Of Construction Projects. Waqar Et Al. (2023) Proposed A Hierarchical Model That Emphasizes These Three Factors As The Core Objectives Of Productive Project Delivery. This Model Highlights How Time, Cost, And Quality Form The Ultimate Benchmarks Of Success In Construction Projects, Reflecting Their Central Role In Project Life Cycles And Outcomes. While The Traditional Criteria Remain Fundamental, Broader Considerations Also Shape Project Outcomes. The Concept Of

Project Success Has Evolved Into A Multidimensional Construct That Includes Long-Term Effectiveness, Organizational Impact, And Customer Satisfaction (Lalic Et Al., 2022). While The Short-Term Efficiency Measures Remain Relevant, Stakeholders Often Prioritize Broader Outcomes Such As Value Creation And Strategic Alignment. Success Is Therefore Subjective, Depending On The Stakeholder's Perspective, The Type Of Project, And Its Context (Müller & Jugdev, 2012; Nara Et Al., 2015). To Address This, Shenhar Et Al. (1997) Proposed A Multidimensional Framework That Evaluates Success Across Both Short- And Long-Term Objectives. This Framework, Widely Applied In Project Management Research, Highlights That Projects Should Be Assessed Not Only On Immediate Outputs But Also On Their Strategic Contribution And Long-Term Benefits (Lalic Et Al., 2022). Since Huge Projects Should Be Stayed Focus Within A Specific Scope And Usually Are Exposed To Various Risks (Hassanen & Abdelalim, 2022), Project Success Should Be Assessed In Terms Of Scope And Risks.

Accordingly, for the current study, Success should not only be measured by meeting predefined constraints but also by delivering value to stakeholders and ensuring long-term functionality. For the current study, project success is a multidimensional construct encompassing the traditional "iron triangle" (time, cost, and quality) as well as scope fulfillment and risk management.

2-3- VM and Project Success : Research into VM implementation across global construction industries has consistently highlighted its potential to enhance project outcomes, though challenges remain in practice. In the UK, Ahmed et al. (2019) demonstrated that stakeholder involvement through multidisciplinary VM workshops fosters collaboration, ownership, and cost efficiency. However, the study also noted that the lack of shared understanding of cost undermines collaborative practices. Similarly, in Canada, BuHamdan et al. (2019) explored value-adding frameworks and emphasized the need for a unified approach to overcome knowledge discontinuities and maximize project outcomes.

Studies in the MENA region reveal both the promise and limitations of VM adoption (Abdelalim et al., 2024). In Egypt, Khodeir and El Ghandour (2019) reported significant cost savings of up to 40% through early VM application in residential projects, stressing that implementation at the design stage delivers the greatest benefits. Complementary studies in Egypt further demonstrated the integration of VM with risk management and innovative housing design (Kh. Ma, 2018; Heiza et al., 2016). In Libya, Omran and Soliman (2017) found that VM was recognized mainly for cost reduction and efficiency, yet late initiation, lack of expertise, and cultural resistance limited its impact. Comparable challenges were reported in Gaza, where Alkheribi and Hasan (2017) proposed a BIM-integrated framework to overcome fragmented VM practices.

In the GCC, the focus has been on linking VM with broader development goals. Al Amri and Marey-Pérez (2020) stressed its role in promoting sustainability within Oman's construction sector, while Alkaabi (2019) in Bahrain identified key enablers of VM success such as project characteristics, contractual flexibility, and management support. Similar findings emerged in Africa: Tanko et al. (2018, 2019) in Nigeria identified both success factors and barriers, including lack of awareness, poor facilitation skills, and limited guidelines, while Kissi et al. (2017) in Ghana emphasized the need for legal and institutional support to mainstream VM into public projects. In Sri Lanka, Madushika et al. (2020) confirmed that VM is most effective at the design stage, underlining key performance indicators linked to project efficiency and stakeholder satisfaction.

Asian research has also investigated the integration of VM with sustainability agendas. Yu et al. (2018) in Hong Kong showed that VM enables multidisciplinary collaboration to address environmental and social considerations, but a shortage of expertise and training remains a constraint. Similar challenges were echoed in Saudi Arabia by Alshehri (2020), who pointed to limited adoption due to knowledge gaps and resource constraints.

Taken together, these studies establish a clear link between VM practices and improved cost, quality, and stakeholder engagement in construction projects. However, they also reveal persistent barriers such as lack of expertise, limited awareness, and late-stage implementation. While many studies highlight VM's potential benefits, few have empirically tested its direct impact on overall project success across multiple dimensions such as cost, time, quality, risk, and scope. Addressing this gap is the core motivation of the present study.

Several studies have indicated positive correlations between VM practices and project outcomes. VM workshops are found to reduce unnecessary costs, encourage innovation, and improve decision-making. However, gaps remain in empirically measuring the contribution of each VM phase to project success. This study addresses this gap by linking VM activities directly to project performance metrics.

Accordingly, it is hypothesized that:

H1: Value Management (VM) implementation positively influences project success in the construction sector.

3- Research Methodology : The present study adopts a quantitative research approach, as this design is considered suitable for testing relationships between variables and ensuring objectivity through statistical analysis. A structured questionnaire was developed as the primary instrument for data collection, enabling the systematic assessment of perceptions regarding Value Management (VM) activities and their impact on overall project success.

The questionnaire was structured into three main sections. The first section focused on collecting demographic information about the respondents, including factors such as age, educational background, professional role, and years of experience in project management. This information was essential to contextualize the responses and ensure the representativeness of the sample. The second section measured the extent of Value Management implementation across its key dimensions. These dimensions, derived from established VM practices, included

1) Pre-workshop activities – preparation and planning prior to VM sessions,

2) Information phase – gathering and analyzing project information,

3) Function analysis – defining and clarifying the functions of the project,

4) Creativity phase – generating alternative solutions to improve value,

5) Evaluation phase – assessing and prioritizing the proposed alternatives,

6) Development and presentation – refining selected ideas and presenting recommendations., and

7) Post-workshop implementation – applying the outcomes of the VM process in practice. The third section assessed project success, measured across five critical performance dimensions commonly used in project management literature: scope, time, cost, quality, and risk management. These dimensions reflect the holistic nature of project success, extending beyond the traditional iron triangle to incorporate broader performance factors. The questionnaire included 30 items covering five VM phases and five project success dimensions. A five-point Likert scale was used (1 = strongly disagree, 5 = strongly agree). Validity and reliability were ensured through pilot testing, Cronbach's alpha, and factor analysis. This scale facilitated the quantification of perceptions and enabled the statistical testing of hypothesized relationships between VM implementation and project success.

Data was collected through the distribution of the questionnaire to professionals involved in project management and related fields. Purposive and snowball sampling were used to distribute the questionnaire. Purposive sampling allowed the selection of participants who could provide valuable insights (Etikan et al., 2016). The questionnaire was built on Qualtrics.com and the link was distributed to 300 construction professionals across contractors, consultants, and owners. The response rate was 59%, where a total of 178 valid responses were received from VM practitioners, project managers, developers, engineers, interior designers, and services consultants. The respondents represented a diverse range of projects including residential, commercial, and infrastructure.

To ensure the reliability and validity of the questionnaire, several steps were undertaken during its development. In the **Pretest phase**, a preliminary version of the questionnaire was initially pretested with a small group of respondents (e.g., 5–10 professionals) from the target population. The purpose of this pretest was to identify potential issues related to clarity, wording, and sequencing of the items. Feedback from this stage informed minor revisions to improve the readability and flow of the questionnaire.

Face and Content Validity tests were conducted after the pretest phase. Face validity refers to the extent to which an instrument appears, on the surface, to measure what it intends to measure. To achieve this, the instrument was reviewed by a panel of experts in project management and academic researchers familiar with VM. The experts confirmed that the items were generally appropriate, understandable, and reflective of the constructs under study. In addition to face validity, content validity was examined to ensure comprehensive coverage of the constructs. **Content validity** involves determining whether the instrument adequately represents the theoretical dimensions of VM activities and project success. The expert panel evaluated each item in terms of relevance, clarity, and representativeness of the domain being measured. Based on their suggestions, several items were refined, reworded, or removed to improve alignment with the study objectives. After revisions, a **pilot study** was conducted with a sample 30 respondents (Browne, 1995) drawn from the target population but not included in the final dataset (Walliman, 2022). The pilot study aimed to test the reliability of the scales and the feasibility of the data collection process (Saunders & Tosey, 2013). Statistical analyses, including Cronbach's alpha, were performed to assess the internal consistency of the constructs. The pilot study results demonstrated acceptable reliability levels ($\alpha \geq 0.70$), confirming that the questionnaire was suitable for use in the main study with minor adjustments applied.

4 - Data analysis and Results :

The demographic profile, Table 1, shows a diverse sample of respondents. Most participants hold a bachelor's (46.2%) or master's degree (42.2%), reflecting strong educational backgrounds. A large share has significant industry experience, with 35.6% having 15–20 years and 33% more than 20 years. The majority work in contracting (42.9%) or consultancy (38%), mainly on governmental/public sector projects (47.9%). Most organizations handle large-scale projects, with 78.5% exceeding $5 million in value. Familiarity with value management/value engineering (VM/VE) is generally high, as 71% reported being familiar or totally familiar. Moreover, 59.4% perceive VM/VE as a methodology, and most rated their own knowledge as good or very good (69%). Job titles indicate balanced representation across managerial and technical roles, with managers forming the largest group (31.4%).

Table 1: The demographic data analysis

Category	Level	Frequency	Percent
Education	Bachelor's degree	140	46.2
	Diploma, Higher studies	20	6.6
	Master's degree	128	42.2
	PhD	10	3.3
	Other (DBA/Professional Doctorate)	5	1.7
Years of Experience	Less than 5	25	8.3
	5–10 years	20	6.6
	10–15 years	50	16.5
	15–20 years	108	35.6
	More than 20 years	100	33.0
Organization Function	Client/Developer or PMO	30	9.9
	Consultant	115	38.0
	Contractor	130	42.9
	Vendor/Supplier	15	5.0
	Other	13	4.3
Types of Projects	Governmental/Public sector	145	47.9
	Private sector	115	38.0
	Other	43	14.2
Project Size (Last 5 Years)	Less than $1M	35	11.6
	$1M–$3M	10	3.3
	$3M–$5M	20	6.6
	More than $5M	238	78.5
VM/VE Familiarity	Totally Familiar	75	24.8
	Familiar	140	46.2
	Moderately Familiar	70	23.1
	Not Familiar	13	4.3
	Totally not Familiar	5	1.7
Perception of VM/VE	It is a technique	25	8.3
	It is a concept	35	11.6
	It is a profession	45	14.9
	It is a tool	15	5.0
	It is a methodology	180	59.4
	Other	5	1.7
Self-Assessment in VM/VE	Very Good	85	27.9
	Good	125	41.0
	Fair	70	23.0
	Poor	20	6.6
	Very Poor	5	1.6
Job Title	Director	15	5.0
	Senior Manager	25	8.3
	Department Head	55	18.2
	Manager	95	31.4
	Design Engineer	40	13.2
	Design Manager	15	5.0
	Quantity Surveyor	10	3.3
	Other	48	15.8

4-1- Measurement Model : The outer loading results, Figure 2, show that most items exceed the recommended threshold of 0.70, confirming strong indicator reliability. One item (VM.CP1#1_7) reported a very low loading (0.256) and was therefore removed from the model. All other items, even those slightly below the ideal cutoff, were retained because the construct reliability (CR) and average variance extracted (AVE) values, Table 2, remained within acceptable levels. This ensures both reliability and validity of the measurement model.

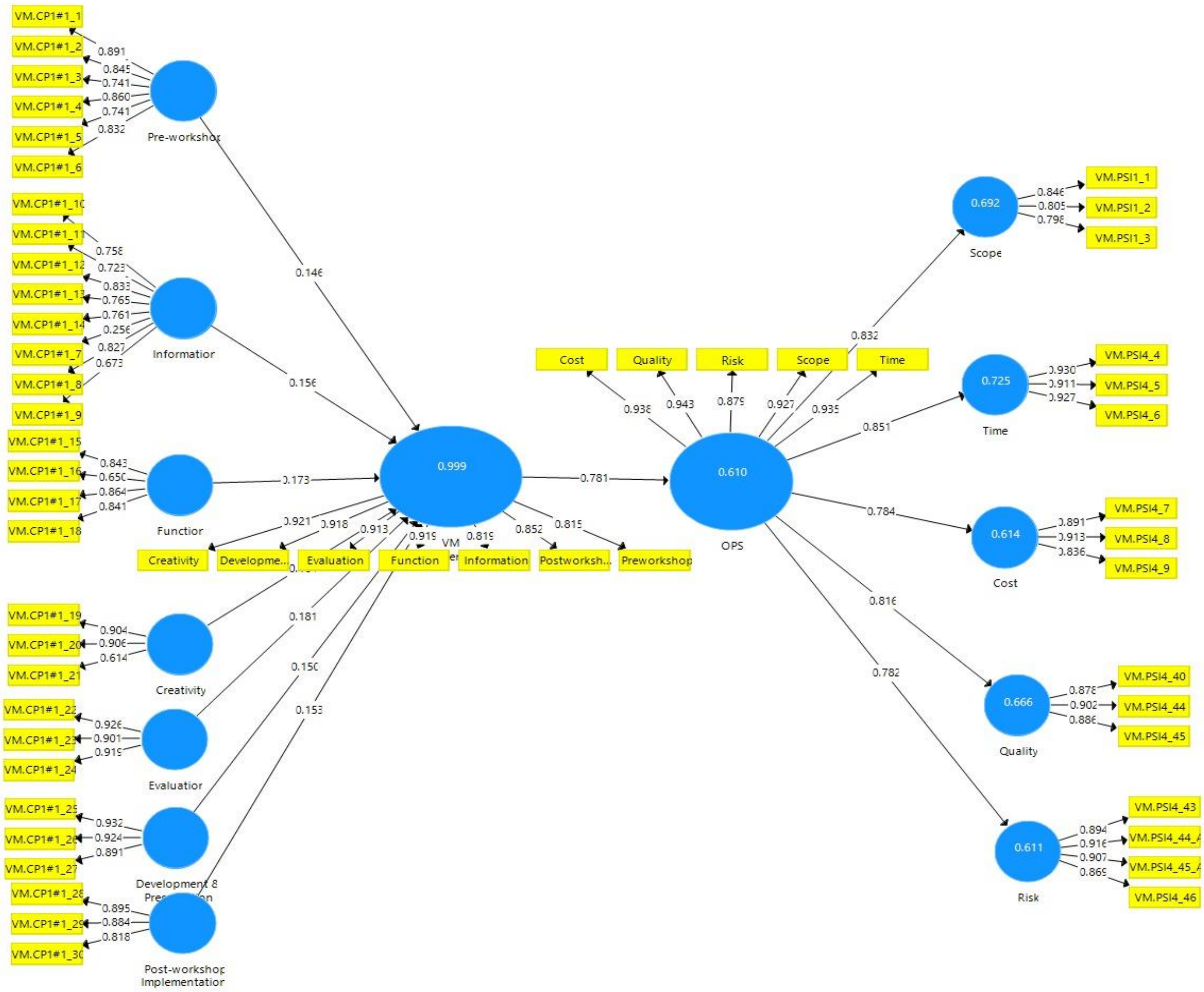

Figure 2: The Measurement Model

The composite reliability (CR) values for all constructs range between 0.856 and 0.967, Table 2, which are well above the recommended threshold of 0.70, which indicates high internal consistency. Similarly, the average variance extracted (AVE) values are mostly above the acceptable level of 0.50, confirming convergent validity. The lowest AVE is observed for Information (0.520), yet it still meets the minimum threshold, suggesting adequate explanatory power.

Table 2: Composite reliability, AVE, VIF

	Items	Composite reliability	AVE
Cost	3	0.912	0.776
Creativity	3	0.856	0.671
Development &_Presentation	3	0.940	0.839
Evaluation	3	0.939	0.838
Function	4	0.878	0.646
Information	8	0.891	0.520
OPS	5	0.967	0.855
Post-workshop_Implementation	3	0.900	0.751
Pre-workshop	6	0.925	0.673
Quality	3	0.919	0.790
Risk	3	0.943	0.804
Scope	3	0.857	0.667
Time	3	0.945	0.851
VM_Implementation	7	0.960	0.776

To evaluate the discriminating validity, Table 3, the AVE square root of each construct is set against to the correlations of one construct with any other constructs consecutively. The AVE square root must be greater than the correlation between the latent variables. As Fornell and Larcker (1981) recommended, the obtained outputs ensure the discriminant validity of the measurement model. Most constructs (e.g., Cost, Time, Quality, Risk, VM Implementation) show strong discriminant validity, with diagonal values well above their correlations. However, some constructs such as Creativity, Function, and Information display relatively high correlations with other constructs (e.g., Function–Creativity = 0.877; Information–Function = 0.783), which suggests conceptual closeness. Despite this, the diagonal values still exceed the off-diagonal values, satisfying the criterion.

Table 3: Fornell and Larcker Discriminant Validity Test

Construct	Cost	Creat.	Dev.& Pres.	Eval.	Func.	Info.	OPS	Post-WI	Pre-WI	Qual.	Risk	Scope	Time	VM Impl.
Cost	0.881													
Creativity	0.760	0.819												
Dev.&Pres.	0.776	0.839	0.916											
Evaluation	0.795	0.868	0.870	0.915										
Function	0.814	0.877	0.829	0.840	0.804									
Information	0.699	0.713	0.632	0.690	0.783	0.721								
OPS	0.784	0.753	0.714	0.754	0.755	0.612	0.925							
Post-WI	0.734	0.738	0.804	0.735	0.748	0.657	0.626	0.866						
Pre-WI	0.729	0.667	0.738	0.656	0.727	0.709	0.629	0.710	0.820					
Quality	0.867	0.791	0.738	0.764	0.805	0.677	0.816	0.658	0.686	0.889				
Risk	0.777	0.730	0.714	0.680	0.693	0.600	0.782	0.624	0.706	0.892	0.897			
Scope	0.852	0.815	0.764	0.793	0.859	0.743	0.832	0.728	0.734	0.845	0.738	0.817		
Time	0.873	0.794	0.807	0.799	0.822	0.673	0.851	0.749	0.697	0.825	0.749	0.893	0.923	
VM Impl.	0.853	0.920	0.918	0.915	0.936	0.832	0.781	0.863	0.830	0.822	0.761	0.875	0.861	0.881

As Table 4 illustrates, Variance Inflation Factor (VIF) was assessed to examine potential multicollinearity. Testing VIF is essential for formative constructs because their indicators are expected to contribute uniquely to the construct rather than reflect a common underlying dimension. High multicollinearity among formative indicators means that two or more dimensions overlap excessively, making it difficult to determine their individual contribution. By ensuring that VIF values remain within acceptable thresholds, researchers can confirm that each formative indicator provides distinct and meaningful information to the construct. This test ensures that the indicators are not excessively correlated, which could distort the results and weaken the construct's validity. VIF values below the common threshold of 5 (Hair et al., 2019) indicate acceptable levels of collinearity, while values between 5 and 10 suggest moderate but manageable collinearity.

The results show that Information (3.123), Post-workshop Implementation (3.113), and Pre-workshop (2.787) are well below the common thresholds (5.0 or stricter 3.3), indicating no multicollinearity issue. However, Creativity (6.109), Development & Presentation (6.876), Evaluation (6.145), and Function (5.552) exceed the recommended cutoff of 5.0 and even the more conservative 3.3. This suggests potential collinearity among these formative dimensions, which may bias the estimation of weights in the formative construct of VM Implementation.

Table 4 : Variance Inflation Factor

Dimension	VIF
Creativity	6.109
Development Presentation	6.876
Evaluation	6.145
Function	5.552
Information	3.123
PostworkshopImplementation	3.113
Preworkshop	2.787
Cost	6.275
Creativity	6.109
DevelopmentPresentation	6.876
Evaluation	6.145
Function	5.552

For the reflective construct, Project Success, VIF is assessed to ensure that multicollinearity among the indicators is not excessive. Since reflective indicators are expected to be correlated, some degree of collinearity is normal; however, very high VIF values may indicate redundancy and the risk of distorted measurement results. In line with common guidelines, VIF values below 5 suggest that collinearity is not a major concern. Therefore, examining VIF alongside loadings, CR, and AVE provides further support for the validity of the reflective measurement model.

4-2- Structural Equation Modelling According to Hair et al. (2021), evaluation of Structural Equation Model allows us to determine the model's capacity for predicting one or more variables. As displayed in Table 5, the results indicate that multiple formative dimensions significantly contribute to VM implementation. Specifically, Creativity ($\beta = 0.164$, $p < 0.05$), Development & Presentation ($\beta = 0.150$, $p < 0.05$), Evaluation ($\beta = 0.181$, $p < 0.01$), Function ($\beta = 0.173$, $p < 0.01$), Information ($\beta = 0.156$, $p < 0.05$), Pre-workshop ($\beta = 0.146$, $p < 0.05$), and Post-workshop Implementation ($\beta = 0.153$, $p < 0.05$) all exhibit positive and significant path coefficients, confirming their importance in shaping VM implementation. Among these, Evaluation and Function stand out as relatively stronger predictors due to their higher coefficients and stronger significance levels.

In turn, VM implementation strongly predicts Overall Project Success (OPS) ($\beta = 0.781$, $p < 0.001$). This highlights that effective application of VM practices substantially enhances project performance. Finally, the reflective dimensions of OPS show very strong and significant loadings: Cost (β = 0.784, $p < 0.001$), Quality (β = 0.816, $p < 0.001$), Risk (β = 0.782, $p < 0.001$), Scope (β = 0.832, $p < 0.001$), and Time (β = 0.851, $p < 0.001$). These results confirm that OPS is comprehensively defined by its core performance dimensions, with Time and Scope emerging as the strongest indicators.

Overall, the hypothesis that VM implementation positively influences project success is fully supported. The findings suggest a two-step relationship: first, VM implementation is shaped by key formative inputs, and second, it directly drives project success across its critical dimensions.

Table 5: Path Coefficient and P-Values

Dimension	Path Coefficient	P-Value
Creativity -VM Imp	**0.164**	**0.012 ($p < 0.05$)**
Development & Presentation -VM Imp	**0.150**	**0.021 ($p < 0.05$)**
Evaluation- VM Imp	**0.181**	**0.003 ($p < 0.01$)**
Function- VM Imp	**0.173**	**0.008 ($p < 0.01$)**
Information- VM Imp	**0.156**	**0.034 ($p < 0.05$)**
VM Imp-OPS	**0.781**	**0.000 ($p < 0.001$)**
Post-workshop Implementation- VM Imp	**0.153**	**0.028 ($p < 0.05$)**
Pre-workshop	**0.146**	**0.045 ($p < 0.05$)**
OPS - Cost	**0.784**	**0.000 ($p < 0.001$)**
OPS- Quality	**0.816**	**0.000 ($p < 0.001$)**
OPS -Risk	**0.782**	**0.000 ($p < 0.001$)**
OPS -Scope	**0.832**	**0.000 ($p < 0.001$)**
OPS- Time	**0.851**	**0.000 ($p < 0.001$)**

As displayed in Table6, the R^2 value for OPS is 0.601, indicating that 60.1% of the variance in overall project success is explained by VM implementation. This reflects a substantial level of explanatory power according to Hair et al. (2019). The Q^2 value is 0.300, which is above the recommended threshold of 0.00. This confirms that the model has good predictive relevance for OPS

Table 6: Explanatory and predictive power of the model

Dependent variable		
	R^2	Q^2
OPS	0.601	0.3

VMImp is the independent variable

Taken together, these results suggest that the model not only explains a significant proportion of project success but also demonstrates strong predictive capability.

4-3- Importance-Performance Matrix Analysis (IPMA)

IPMA was conducted to identify priority areas for improvement. The Importance-Performance Matrix Analysis (IPMA) extends the results of PLS-SEM by not only examining the relative importance of independent variables in explaining a dependent variable but also by assessing their performance. Importance reflects the total effect of a construct on the outcome, while performance indicates the average score of that construct based on the latent variable scale. Combining these two perspectives allows researchers and practitioners to identify areas that exert a strong influence yet show lower levels of performance, thereby highlighting where managerial attention and improvement efforts should be directed. In this study, IPMA was applied with VM implementation as the dependent variable to evaluate which dimensions of VM activities contribute most significantly to project success and to determine how effectively these dimensions are currently performing.

IPMA highlighted the **Information Phase** as having both high importance and moderate performance, indicating a priority area for improvement. Function Analysis and Creative phases also showed significant importance but relatively lower performance. Evaluation and Development/Presentation phases, while contributing positively, were less critical compared to the others.

5 – Discussion

The findings confirm the significant role of VM in enhancing project success.

The results show that all seven VM phases - Pre-workshop, Information, Function, Creativity, Evaluation, Development & Presentation, and Post-workshop Implementation - significantly contribute to the latent construct VM implementation, with Evaluation and Function among the relatively stronger predictors. VM implementation in turn has a strong positive effect on Overall Project Success (OPS) ($\beta = 0.781$) and OPS is well represented by its reflective dimensions (Time, Scope, Quality, Cost, Risk). The model explains a substantial share of OPS variance ($R^2 \approx 0.60$) and exhibits acceptable predictive relevance ($Q^2 = 0.30$).

These findings align closely with prior literature in several ways. First, multiple case and survey studies emphasize that VM is most effective when applied early and through structured phases: gathering information, analysing functions, and evaluating alternatives (BuHamdan et al., 2019; Khodeir & El Ghandour, 2019). The significant Pre-workshop and Information (β =146 and 156 respectively) effects support those recommendations: early, information-rich preparation strengthens VM implementation and allows meaningful option generation, as reported in the reviewed studies.

Second, the prominence of Function and Evaluation in the obtained results echoes the centrality of function-analysis (FAST/value-trees) and rigorous evaluation in the VM/VE literature. Several of the reviewed studies highlight FAST and function-cost analysis as core to identifying high-value opportunities and focusing efforts on the small set of functions that drive most cost and value (Kineber et al., 2021, 2023; Osman et al., 2023) . The findings empirically confirm that function analysis and evaluation are key levers within VM implementation.

Third, the measurable downstream effect - a strong VM → OPS path and high loadings of OPS dimensions (Time, Scope, Quality, Cost, Risk) — is consistent with empirical reports of VM reducing duration and costs and improving quality when applied properly (e.g., Khodeir & El Ghandour, 2019; Osman et al., 2023). The R^2 (≈0.60) is similar to other PLS-SEM studies that found VM and its CSFs explain a large portion of OPS variance (Kineber et al., 2023), reinforcing the idea that VM is not merely a cost tool but a broad project success mechanism .

Fourth, the literature about sustainability and VE (Osman et al., 2023; Yu et al., 2018) complements the current results by showing that VM/VE can extend beyond cost and schedule to environmental and lifecycle value. The OPS construct's strong multi-dimensional loadings (including quality and risk) indicate VM's contribution to wider project objectives, which supports calls to integrate VM with sustainability and lifecycle thinking.

The strong relationship between VM activities and the overall project success underscores the importance of adopting structured VM practices. Specifically, the Information Phase is vital (according to the IPMA analysis), as accurate data collection and requirement definition form the foundation for subsequent phases. The results align with previous studies that emphasizes the role of information building (Waqar et al., 2023) but provide additional empirical evidence using advanced statistical tools.

The use of PLS-SEM and IPMA adds methodological rigor, enabling researchers and practitioners to quantify both the effect size and the performance gaps. The findings suggest that improving performance in the Information and Function Analysis phases could yield substantial improvements in overall project outcomes.

6 - Conclusion and Recommendations : This study set out to examine the impact of Value Management implementation across its various phases on overall project success within the construction sector. Using a quantitative approach and PLS-SEM analysis, the findings provide strong empirical evidence that Value Management implementation significantly enhances project outcomes. All seven VM phases—Pre-workshop, Information, Function, Creativity, Evaluation, Development & Presentation, and Post-workshop Implementation—were found to contribute meaningfully to VM implementation, with Function and Evaluation emerging as the strongest drivers. VM implementation was shown to have a substantial positive effect on Overall Project Success (OPS), which was measured through scope, time, cost, quality, and risk. The high explanatory power ($R^2 = 0.601$) and predictive relevance ($Q^2 = 0.300$) confirm that VM implementation is not only a cost-control mechanism but a holistic management approach that improves efficiency, promotes innovation, and aligns project outcomes with stakeholder expectations. These results reinforce prior studies that highlight VM's role in reducing unnecessary costs, shortening project duration, and enhancing quality without compromising essential functions.

Accordingly, it is recommended to strengthen early phases (pre-workshop and information gathering) for effective preparation; focus on function analysis and evaluation as the key drivers of VM success; ensure workshop outputs are implemented through follow-up and monitoring; and promote wider stakeholder engagement to build ownership and reduce resistance. Future studies should expand to other sectors and regions, use longitudinal designs to track long-term VM benefits, and explore links between VM and sustainability. Researchers may also test mediating or moderating factors such as project complexity, organizational culture, and governance structures to refine understanding of the VM–success relationship.

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