An Extensive Literature Review on Value Engineering/Management in the Construction Industry of Saudi Arabia: Identifying Future Research Directions

Abdulrahman Bageis[1]

[1] Architectural Engineering Department - College of Engineering - Taibah University P.O.Box 344, Saudi Arabia,

asbageis@taibahu.edu.sa

Abstract

Analysing value engineering/management in Construction, addressing research gaps, and identifying unexplored areas are crucial to enhancing project efficiency and saving costs. This research paper presents a comprehensive review of the value engineering/management literature, specifically focusing on its application and significance in the context of the Saudi Construction Industry. The study aims to identify recommendations for further research applicable to the Saudi construction industry to enhance project efficiency and achieve cost savings. This research addresses gaps in the existing literature on value engineering/management, particularly within the Saudi construction industry. By examining the current state of research, the study seeks to answer the research question: "What subjects of value engineering/management have not been researched within the Saudi Construction industry yet?". This research paper identifies the key themes, theoretical frameworks, methodologies, and findings in value engineering through a systematic review of relevant scholarly articles, books, and industry reports. The findings of this study contribute to a deeper understanding of value engineering/management practices in the Saudi Construction Industry and highlight areas that have not yet been extensively explored.

The research paper concludes by providing recommendations for future research directions, suggesting potential value engineering/management subjects that justify further investigation within the Saudi construction industry. The findings of this study can serve as a valuable resource for researchers, practitioners, and decision-makers in the construction industry by identifying untapped opportunities for improving project efficiency and achieving cost savings by applying value engineering principles.

Keywords

Cost Savings, Project Efficiency, Value Engineering, Value Management

1. Introduction

The introduction provides an overview of value engineering/management and its importance in construction. It highlights the significance of the Saudi Construction Industry and the need for effective value engineering practices to enhance project outcomes and contribute to the Kingdom's Vision 2030 objectives. "Value Engineering" and "Value Management" are often used interchangeably, but they can have slightly different connotations depending on the context. While the objectives of value engineering are dominated by cost reduction, value management aims to develop a shared understanding of the design problem and explicitly identify an agreed statement of design objectives by the project stakeholders (Green, 1994). The general differences between the two terms are as follows:

Definition: "Value Engineering" is a systematic and structured approach to analysing and improving the value of products, services, or processes. It identifies and eliminates unnecessary costs while maintaining or enhancing the desired functions and quality. "Value Management" encompasses a broader scope and includes both value analysis

(analysing the functions and costs) and value planning (strategic decision-making to maximise value throughout the life cycle of a project or organisation).

Scope: Value Engineering is often associated with specific projects or processes and is commonly used in engineering, construction, and manufacturing industries. It aims to optimise value within a defined system or project. Value Management, on the other hand, has a broader scope and can be applied to organisations, programs, or portfolios. It involves strategic decision-making and considers long-term value creation and management.

Application: Value Engineering is typically applied during a project or process's design and development stages, where it focuses on identifying opportunities for cost reduction and value enhancement. It often involves cross-functional collaboration and the application of specific methodologies and tools. Value Management, on the other hand, can be applied throughout the entire life cycle of a project or organisation. It includes strategic planning, value analysis, monitoring, and control.

Perspective: Value Engineering often takes a more technical and analytical perspective, emphasising the identification and optimisation of functions, costs, and performance. It aims to achieve value improvements through systematically analysing the project or system. Value Management also incorporates analytical aspects and takes a broader view, including strategic decision-making, stakeholder engagement, and the overall organisational context.

Emphasis: Value Engineering strongly emphasises cost optimisation and efficiency. It focuses on identifying cost-saving opportunities while maintaining or enhancing the desired functions and quality. Value Management, while considering cost optimisation, emphasises strategic value creation, stakeholder satisfaction, and long-term value maximisation.

It is important to note that these terms' specific usage and interpretation can vary across industries and contexts. The key is understanding that Value Engineering and Value Management share the goal of maximising value. However, Value Management has a broader scope and includes strategic decision-making aspects beyond the technical analysis provided by Value Engineering.

The following sections delve into the historical background of value engineering and its evolution over time. They explore the development and adoption of value engineering practices in the global construction industry and their subsequent introduction to the Saudi Arabian context.

1.1. Historical Perspective of Value Engineering/Management

Value Engineering is described in the Value Standard and Body of Knowledge published by SAVE International, the Society for Value Engineering, as “the application of a value methodology to a planned or conceptual project or service to achieve value improvement.” (SAVE International, 2007). It is essential to acknowledge that every project, regardless of its purpose, is ultimately intended to deliver value to its stakeholders. In this regard, value engineering is a valuable methodological approach to analyse product functions and value systematically. This holds true even in cases where a project is initiated with the sole objective of identifying and deriving value. By leveraging the principles and processes of value engineering, stakeholders can ensure that product value optimisation is at the forefront of project planning and execution (Merla, 2010).

Value engineering, also known as value analysis, is a systematic approach used to improve the value of a product, system, or process by examining its functions and reducing costs while maintaining or improving its performance. The technique was first applied and explored in the late 1940s. Lawrence D. Miles, an American engineer working for General Electric (GE), initially developed value engineering during World War II. In 1945, Lawrence Miles introduced the Value Analysis technique to facilitate cost-reduction efforts by linking the cost of individual components to their functional impact. He proposed using an actionable verb and a quantifiable noun to accurately convey the purpose of each component and pinpoint areas for value enhancement and cost reduction. Since then, Value Engineering has advanced to encompass a range of tools, techniques, and processes for optimising value (Merla, 2010). In 1947, Miles introduced the concept of "value analysis" at GE as a means to address the rising costs of military projects. The approach gained significant attention and success within GE, leading to its widespread adoption in other industries (Gordian, n.d.).

The European Community's SPRINT programme (Strategic Programme for Innovation and Technology) adopted ‘value management’ as the official term. It described the same philosophical concept but in terms that were more in keeping with European management styles. The term 'value management' was also applied as a broad, high-order description encompassing all value techniques, whether applied at a strategic or tactical level (The Chartered Institute of Building (CIOP), 2022). Value engineering, also known as value-driven design (VDD), finds its roots in systems engineering (Bertoni, Bertoni, Panarotto, & Johansson, 2016). This approach emphasises methodological guidance and decision-support tools for product-service system development. Maintaining project objectives and requirements is essential while implementing value engineering methodologies (Kwok, P. M. Anderson, & S. H. S. Ng., 2009). Furthermore, the principles of value engineering have been observed to significantly impact the competitiveness of

the value chain in industries reliant on supplier performance, particularly in terms of cost, quality, and on-time delivery. VE has been applied in various fields, such as sustainability, which has been integrated into value models to support design decision-making (Bertoni M. , 2017). The competitiveness of the value chain in industries heavily reliant on supplier performance is also influenced by the principles of value engineering (Quesada, Syamil, & Doll, 2006). These references collectively support the origin and application of value engineering in different domains, highlighting its significance in decision-making processes and project management. Value engineering spread to various sectors in the following years, including construction, manufacturing, and government projects. The Society of American Value Engineers (SAVE International) was formed. In 1959, the contractual requirement for VE was added to the Armed Services Procurement Regulation, the forerunner of today's Federal Acquisition Regulation FAR. VE was initially used only with command approval. However, in June 1962, the Defense Department procurement regulations were modified to establish VE as a mandatory program for the department and its contractors (INSTITUTE FOR DEFENSE ANALYSES ALEXANDRIA VA, 2006). Today, value engineering is recognised as a valuable technique for optimising costs, improving efficiency, and maximising value in a wide range of industries and applications.

Value engineering is an interesting management technique that analyses alternative solutions and identifies the best possible option (Asif, Muneer, & Kubie, 2005). It is not about short-term cost cutting but providing the most cost-effective long-term project solution (Asif, Muneer, & Kubie, 2005). Also known as value analysis, it is a systematic and organised approach to providing necessary functions in a project at the lowest cost (Ismail, Aminzadeh, Aram, & Arshad, 2010). Value engineering methodology evolved in the forties when the transition was made from searching for alternatives to searching for means of fulfilling the functions of an alternative. It was observed that function-oriented alterations in working methods often improve quality and eliminate unnecessary costs (Marzouk, 2011). Furthermore, it is a committed approach to improving and adding value to a product for every resource spent (Kalani, Kazemzadeh, & Kamrani, 2017). It involves searching for and eliminating unnecessary costs while maintaining or increasing the structure's assumed functionality and quality per the investor's requirements (Leśniak & Lendo-Siwicka, 2018). The value engineering approach is innovative and efficient, utilised for breaking down functional necessities of a project at the lowest total expense over the project's life expectancy (Sheikh, Dar, Khan, & Wani, 2022).

Value engineering is a methodical process that examines the functions of diverse components and materials to reduce the cost of goods, products, and services while preserving or enhancing their performance. This approach is built upon the principle that a product's fundamental functions must be safeguarded and that cost-cutting measures should not compromise them. Value engineering has evolved into a crucial practice in diverse fields, such as project management, industrial engineering, and architecture.

1.2. Global Adoption of Value Engineering/Management:

The practice of value engineering is widely embraced in the global construction industry. Despite being one of the largest sectors in the world, the construction industry is trailing behind other industries in terms of technology adoption. The widespread adoption of Value Engineering and its seamless integration into the global construction industry. It delves into the distribution of VE practices beyond the United States, as countries such as Japan, the United Kingdom, Australia and Saudi Arabia have embraced VE principles and established their professional associations, thus providing a comprehensive overview of the current state of affairs in this domain. Introducing new technologies has proven to be a challenge, leading to a delay in the digitalisation of the industry. More than 70% of construction companies worldwide face difficulties implementing technology. Nonetheless, 97% of construction professionals anticipate an increase in digital investment in the next three years, especially in construction project management software (Mitchell, 2023). However, there is a growing trend towards digitalisation and technology adoption in construction. For instance, KPMG's 2023 Global Construction Survey revealed that 83% of engineering and construction firms reported adopting or starting to adopt project management information systems (PMIS) (KPMG, 2023). The construction industry is currently demonstrating a trend towards embracing technology. A valuable methodology being utilised is value engineering, which analyses the function of goods and services to deliver the required user functions at the lowest total cost without compromising on essential performance quality. It is common for Value Engineering to be mistaken for cost-cutting practices within the construction industry. However, the key difference between conventional cost-cutting and VE is that VE focuses on improving functionality through reduced energy consumption of manpower, materials, and machines. Initially, VE was utilised by production engineers to lower manufacturing costs. Nevertheless, it was discovered that this approach yielded even more significant benefits when multidisciplinary teams of engineers were involved. This involvement also extends to the design team, typically the construction case (Ilayaraja & Eqyaabal, 2015).

1.3. Standardization and Guidelines:

The review explores the development of standards and guidelines for VE implementation. It illustrates the contributions of organisations such as SAVE International in developing standard definitions, methodologies, and best practices for VE. The "Value Methodology Standard" development by SAVE International in 2007 is highlighted as a significant milestone in standardising VE practices. The International Organization for Standardization (ISO) develops and publishes various international standards across various industries. While no specific ISO standard is dedicated to value engineering, standards are related to related fields or aspects. For example, ISO 9001 (Quality Management Systems) and ISO 14001 (Environmental Management Systems) emphasise the importance of continuous improvement and cost-effectiveness, which align with value engineering principles. ISO developed the ISO 15686-10 standard titled "Buildings and Constructed Assets - Service Life Planning - Part 10: Whole-Life Value Management." While not specific to value engineering, these standard guides incorporate value management principles throughout the life cycle of constructed assets, including considering costs, benefits, and risks.

In the United States, government contracts often include a value engineering clause as part of the Federal Acquisition Regulation (FAR). This clause requires contractors to establish and maintain a formal Value Engineering program to identify cost savings, innovation, and performance improvement opportunities. The Construction Industry Institute (CII), a research organisation within the University of Texas at Austin, has published several guidelines and best practices for value engineering in the construction industry. These guidelines provide recommendations for implementing value engineering processes, conducting workshops, and measuring the effectiveness of value engineering efforts. International Value Engineering Standard (INVEST) is an international standard developed by a consortium of value engineering organisations from different countries, including the United States, Canada, the United Kingdom, Australia, and others. It provides a common framework for the practice of value engineering across different regions and industries. INVEST sets up guidelines for value engineering processes, terminology, documentation, and reporting, ensuring consistency and compatibility in value engineering practices worldwide.

Industry-Specific Guidelines: various industries have developed guidelines and best practices for value engineering. For example, the American Association of State Highway and Transportation Officials (AASHTO) has published guidelines for value engineering in transportation projects. These industry-specific guidelines consider different sectors' unique challenges and considerations and provide tailored approaches for value engineering implementation. Nevertheless, many government agencies and organisations have incorporated value engineering requirements into their procurement regulations. The Gulf Chapter of Value Engineering published a Guide for VE implementation in the Gulf region in 2017. Regarding Saudi public projects, the Saudi Ministry of Finance has published a Circular No. 10/2/35269 dated 20/7/1422 (21 October 2001) according to paragraph (6) of Article (2) of the decision of Saudi Supreme Economic Council No. 8/21 dated 7/9/1421 (3 October 2000) that to compulsory adapt value engineering studies for all projects exceed 20 million SAR, and for all prototype projects exceed 5 million SAR. Given that some government agencies did not adhere to the decision of the Ministry of Finance and the directive of the Supreme Economic Council, a Royal Decree was issued in June 2015 by forming a ministerial committee to investigate the facts and examine the issue in all its aspects. Later, On February 23, 2021, a Cabinet decision Under Resolution No (389), Saudi Arabia created the Expenditure Efficiency & Project Authority (EXPRO). EXPRO's main aim is to improve government agencies' spending efficiency while enhancing the quality of their projects, assets, facilities, and infrastructure planning. Additionally, the program aims to monitor the implementation of these initiatives and programs to ensure that the state's general budget is being used effectively and efficiently. It is worth noting that standards and guidelines for value engineering are continuously evolving as new practices, methodologies, and technologies emerge.

2. Methodology

This review paper on value engineering/management in the construction industry was conducted systematically. This research aims to address the gaps in the existing literature related to value engineering/management, focusing on the Saudi construction industry. Instead of detailing all the relevant literature on a subject or sub-subject related to value engineering/management, it has been chosen to highlight the most relevant ones. Therefore, the study stopped searching for additional publications on the selected topic once it had found sufficient coverage in scientific publications. Employing this methodology answers the research question, “What subjects of value engineering/management have not been researched within the Saudi Construction industry?”. The methodology employed included utilising various Artificial Intelligence (AI) websites to gather relevant value engineering/management literature. One of the websites used was Scite.ai's "Assistant," a conversational tool providing answers supported by current and reliable scientific references. Scite.ai is an award-winning platform that provides a unique approach to discovering and evaluating scientific articles through a feature called Smart Citations.

Smart Citations allow users to see how a publication has been cited by providing the context of the citation and a classification describing whether it provides supporting or contrasting evidence for the cited claim. Additionally, Perplexity.ai, an alternative to conventional search engines, was employed. Perplexity.ai allows users to pose questions directly and receive succinct and accurate answers supported by a curated collection of sources. Moreover, the Consensus.app is a search engine that uses language models to surface papers and synthesise insights from academic research papers. Consensus is not a chatbot, but it uses the same technology throughout the product to help make the research process more efficient.

These AI platforms and applications leverage advanced models such as OpenAI's GPT-4 and Claude 2. Moreover, significant databases, such as the American Society of Civil Engineers (ASCE), ScienceDirect, Emerald, Web of Science, and others, were utilised to find related publications to the subject matter. The Google Scholar website was also used to find the publication, access it, and double-check the accuracy of the reference. The following steps were implemented as part of the methodology:

1. **Definition of Research Scope**: The scope of the review paper was defined to focus specifically on value engineering/management in the construction industry.
2. **Identification of Relevant Publications**: A search was conducted for scientific publications addressing value engineering/management research in the construction industry.
3. **Utilization of AI Assistant**: The Assistant feature of Scite.ai and Perplexity.ai was employed to search for and retrieve relevant publications on value engineering/management. This tool allows users to ask questions in simple language and obtain answers supported by accurate, up-to-date references.
4. **Adaptation of Selection Methodology**: The method used to select appropriate search outputs for review was adapted from previous studies.
5. **Screening and Evaluation**: The retrieved publications were screened and evaluated based on their relevance to value engineering/management in the construction industry. Only papers related to the research topic were considered for inclusion in the review. The publication was searched and accessed, and the reference accuracy was double-checked using the Google Scholar website.
6. **Data Extraction and Synthesis**: Relevant information, findings, and insights from the selected publications were extracted and synthesised to form a comprehensive review of value engineering/management in the construction industry.

This review paper employs a systematic approach incorporating AI's Assistant and adapts the selection methodology from previous studies. It aims to provide an in-depth analysis of value engineering/management in the construction industry based on reliable and up-to-date scientific literature.

3. Results and Discussion

3.1. Scientific Publication Considered Value Engineering/Management:

The dissemination of research findings, innovative methodologies, and case studies through scientific publications is crucial in advancing the field of Value Engineering/Management. These publications provide a platform for researchers, practitioners, and academics to exchange knowledge, contribute to the existing knowledge base, and promote evidence-based practices. Also, some conferences and symposiums often focus on Value Engineering/Management, e.g., the International Conference on Value Engineering and Management (ICVEM), SAVE International Annual Conference, Construction Industry Institute (CII) Annual Conference, and International Cost Engineering Council (ICEC) World Congress. The key considerations regarding scientific publications within the discipline of Value Engineering:

Journals: Several journals focus on value engineering as a subject area or include relevant articles. These journals may cover various topics related to Value Engineering, including methodologies, case studies, cost analysis, risk management, sustainability, and innovation. Examples of journals that publish articles on Value Engineering include but are not limited to the Journal of Construction Engineering and Management, the Journal of Value Inquiry, the Journal of Value Studies, the Journal of Advanced Value Engineering, and the International Journal of Value Chain Management.

Research Methods: Scientific publications on Value Engineering often employ rigorous research methods and techniques. These may include quantitative analysis, statistical modelling, cost-benefit analysis, simulation,

optimisation, and case study research. By utilising robust research methods, these publications aim to generate reliable and valid results that contribute to the understanding and advancement of Value Engineering.

Innovation and New Methodologies: Scientific publications in Value Engineering often focus on developing and applying innovative methodologies and techniques. Researchers and practitioners continuously seek to improve existing Value Engineering approaches or propose new frameworks to address emerging challenges. These publications may introduce novel ways of conducting value analysis, function analysis, decision-making, or performance measurement within the context of Value Engineering.

Case Studies and Real-World Applications: Scientific publications commonly feature case studies showcasing the application of Value Engineering in real-world projects. These case studies provide insights into how Value Engineering has been implemented, the challenges faced, and the outcomes achieved in various industries such as construction, manufacturing, healthcare, and government projects. They are valuable references for practitioners looking to learn from successful Value Engineering implementations.

Integration with Other Disciplines: Value Engineering is a multidisciplinary field that intersects with various domains such as engineering, management, economics, and sustainability. Scientific publications often explore the integration of Value Engineering with other disciplines to address complex problems and achieve holistic solutions. These interdisciplinary studies contribute to the broader understanding of Value Engineering and its applications in different contexts.

3.2. Subjects that Considered Value Engineering/Management within the Construction Industry:

Scientific publications and conferences on Value Engineering/Management within the construction industry cover various subjects and titles. It is observed that the Geographic Location of studies considered value Engineering/management has a wide range of distribution. Although, Chen, et al. (2022), highlight that this distribution suggests a strong interest in value engineering within developing countries across Asia and the Middle East and countries where value engineering is a well-established and often a mandated requirement for certain projects. However, there is a lean towards more publications being generated from developing countries (Chen, et al., 2022). Key common subject areas and titles that are considered in the context of Value Engineering/Management are as follows:

3.2.1. History of Value Engineering and Review Articles:

Several publications have considered the history of value engineering and have conducted comprehensive reviews of the subject matter. Alshehri (2020) has explored the level of value management awareness among all construction industry players. That is using research and review papers from 30 studies for 18 years (2000-2018). The conclusion was that the construction industry needs to put forth efforts to maximise the awareness and applications of value management to enhance project outcomes (Alshehri, 2020). Chen, et al., (2022) have provided an in-depth quantitative and qualitative content analysis of the application of VE in construction projects. Concluded that over the past decade, new research has continuously improved the efficiency and productiveness of value engineering practices. Also, it concluded that the current work focuses on integrating value engineering with other disciplines, applying value engineering in diverse project domains, assessing value engineering performance, and developing new value engineering technologies (Chen, et al., 2022). Lin, X. et al. (2023) have examined the status of Value Management (VM) studies in specific construction projects by reviewing 104 relevant articles published from 2001 to 2021. The analysis indicates that the project type, project size, and research theme of VM studies conducted on various construction projects are all significantly correlated. Building and large-scale projects are identified as the most favoured subjects of VM studies to date. Meanwhile, researchers are keen to investigate the performance, impacts, and strategy of VM in different construction projects. The research trend observed indicates that interest in these projects is expected to continue growing (Lin, X., et al., 2023).

In the context of Saudi Arabia, The rise of Value Management in Saudi Arabia has been well-documented in the research papers of (Al-Yosfi, 2019) and (Alsolami, 2022). According to their findings, the practice gained popularity in the 1970s and soon caught the attention of the Saudi government. In 1975, the Military Works Directorate (GDMW) sent a team of engineers to attend a value management course in the United States. This led to Riyadh hosting its first value management training seminar in 1982, which saw attendance from 150 engineers. By 1988, Value Management was even added as a subject for undergraduate students at the College of Engineering (King Saud University). The Saudi Engineering Committee also conducted value management training programs in Riyadh, Jeddah, and Dammam, which helped to spread the knowledge of value management among Saudi engineers. As the importance of value management continued to grow, engineers began to request that it be made a mandatory criterion for assessing projects. In 1999, around 300 projects worth $1.5 billion covering various fields in Saudi Arabia were classified as value-

management-related. More than three thousand Saudi engineers have obtained professional certificates in value engineering. This is considered a distinguished achievement for the Gulf engineer, as the number of Gulf specialists represents about 30 % of specialists worldwide. Value studies have become applied to engineering projects (Operation and Maintenance programs) and administrative operations at a rate of 250 to 300 evaluation studies annually. Since its first application in the Gulf region in 1978, (15,000) studies have been conducted in which more than (200,000) people participated, resulting in an improvement in the quality of engineering projects while achieving financial savings exceeding fifty (50) billion US dollars. These successes were achieved even though they were not implemented on all Saudi construction projects and were applied only to 15-20% of them (Al-Yosfi, 2019). The secret behind the success of value engineering studies is the possibility of identifying unnecessary costs and improving quality and performance together (Al-Yosfi, 2019). There was a belief among some engineers that value engineering is a method and approach to reducing costs. Only, since the concept currently differs from that, value engineering is considered a method and/or a systematic approach to raising the value, quality and efficiency of the product (project, services, materials, etc.) by examining the project's functions and factors (Al-Yosfi, 2019).

3.2.2. Value Engineering/Management Concept Exploration:

Several publications have considered the Value Engineering/Management Concept Exploration within the construction industry. The first publication on the subject seems to be (Miles, 1962), which was titled "Techniques of value analysis and engineering". Later, in 1989, the first edition of the book "Techniques of Value Analysis and Engineering" was published by the author Lawrence D. Miles, which details the concept of value analysis and engineering. So, the concept of value engineering has existed for more than half a century, as discussed by (Xiaoyong & Wendi, 2012). The work of Xiaoyong and Wendi provides insights into the long-standing existence and relevance of value engineering in the construction industry. Furthermore, Patanakul and Shenhar (2009) illustrated the importance of delivering new value to stakeholders in engineering processes (Patanakul & Shenhar, 2009). This article delves into the concept of value creation in engineering processes. Ilayaraja and Eqyaabal (2015) illustrated the definition of value engineering/management and explored its concept (Ilayaraja & Eqyaabal, 2015). In their study, Alabd and Pandey (2016) sought to clarify the concept of value management as it applies to the construction industry. They offered a succinct summary of the worldwide knowledge base in this area and a thorough examination of the history of value engineering. Furthermore, they provided in-depth explanations of the commonly employed definitions and terminology (Alabd & Pandey, 2016). Leśniak & Lendo-Siwicka (2018) have presented the definition and assumptions of value management in construction projects and presented the results of surveys conducted among Polish engineers (Leśniak & Lendo-Siwicka, 2018). Hyderaly et al. (2019) explored the idea behind the term "value" through value engineering and manifested previously identified causes and mitigation strategies to enhance value engineering practices within Sri Lanka. A comprehensive literature review has been conducted to disclose facts and cues of value engineering identified globally and contextualise value engineering concepts within the Sri Lankan construction industry (Hyderaly, et al., 2019).

In the context of Saudi Arabia, Assaf, et al., (1996) have presented the concept of value engineering and illustrated ways of expanding the use of value engineering in Saudi Arabia are explored after a detailed survey had been carried out. (Assaf, et al., 1996). Several other publications considered the Saudi construction industry have presented the concept of value engineering as part of their research e.g. (Al-Yami, 2008; Al-Gahtani, et al., 2015; Aboelmagd & Mobarak, 2021; Alharbi, et al., 2022; Alsolami, 2022; Oke & Aigbavboa, 2022).

3.2.3. Value Engineering/Management Success Criteria and/or Critical Drivers:

Shen and Liu (2003) have identified key factors for value management success and distinguished them according to their degrees of importance to success (Shen & Liu, 2003). Oke and Aghimien, (2018) have determined the possible drivers of value management in the construction industry to provide better-quality construction and achieve value for money through its usage (Oke & Aghimien, 2018). Tanko, et al., (2018) established the requirements for the successful implementation of value management construction practices in the Nigerian construction industry and developed a framework for value management value management implementation (Tanko, et al., 2018). Ojo and Ogunsemi (2019) have assessed the drivers of value management in the Nigerian construction industry to identify the critical ones through the Delphi study (Ojo & Ogunsemi, 2019).

Kineber, et al., (2022) have assessed the influence of value management critical success factors on the implementation of value management activities in building projects to promote sustainability of construction industry in Egypt (Kineber, et al., 2022). Thneibat, et al., (2022) have laid the groundwork for the potential application of value management in construction projects, presented a critical review of the status of v in a developing country, and

highlighted the role of perceptions on critical success factors for the phases of value management studies, as the participants in the study should consider critical success factors tailored to the local context (Thneibat, et al., 2022).
Kineber, et al., (2023) have developed an overall project success model by investigating the mediation impact of value management implementation between value management critical success factors and overall project success model as well as the moderation impact of value management critical success factors between value management implementation and overall project success model (Kineber, et al., 2023). In the context of Saudi Arabia, Alsolami, (2022) has provided insight into critical success factors (CSFs) that enable value management adaptation in Saudi Arabia, which defined 25 CSFs that affect value management implementation in the Saudi construction industry (Alsolami, 2022)

3.2.4. Value Engineering/Management Performance Indicators:

Chen & Liao, (2010) have presented a model that can evaluate the performance of a Value Engineering Study (VES) for a construction project (Chen & Liao, 2010). Also, they highlighted that value engineering can reduce costs and enhance the value of projects. Currently, the acceptance rate of VES recommendations and total potential savings are considered the principal performance indicators of a VES. Lee, et al., (2010) have studied the performance measurement-based value engineering method, process, and case study applications (Lee, et al., 2010). They have found that the project can significantly save costs and improve the performance of project functions by using the appropriate VE process at the appropriate time. Chen, et al., (2010) applied factor analysis and the Analytic Hierarchy Process (AHP) to analyse a questionnaire survey distributed to experienced VE practitioners. (Chen, et al., 2010).
In the study of Lin, et al., (2011) 18 key performance indicators (KPIs) were identified for measuring the performance of value management studies in construction, divided into three groups: predicting indicators, process-related indicators, and outcome-related indicators (Lin, et al., 2011). Madushika, et al., (2018) have illustrated that value management enhances the value of construction projects. However, the study stated that "presently there is no tool available to measure the performance of VM". The research aimed to investigate the key performance indicators (KPIs) of value management in the construction industry in Sri Lanka. The scope was limited to probing only the KPIs of VM in the pre-construction stage (Madushika, et al., 2018). Wang, et al., (2019) the modern project value engineering theory system has been established, which includes three first-level indicators, ten second-level indicators and twenty-seven third-level indicators, effectively increases the value of modern engineering projects compared to traditional value engineering theory (Wang, et al., 2019).
In the context of Saudi Arabia, Al-Gahtani et al. (2015) have identified the key indicators for evaluating the performance of value management practices in the construction industry in Saudi Arabia. A list of 55 initial performance criteria classified into three main groups has been identified through literature and interviews with value management experts (Al-Gahtani, et al., 2015). Al-Ghamdi, (2023) has assessed 28 value engineering reports of studies conducted by third-party value engineering consultants on Saudi Aramco capital projects from January 2020 to August 2022. The findings indicate an inverse relationship between the accepted number of value engineering proposals and the size of the workshop review team (Al-Ghamdi, 2023).

3.2.5. Value Engineering/Management obstacles:

Kim, et al., (2016) have identified 18 factors hindering the application of value management in the construction industry (Kim, et al., 2016). (Aghimien, et al., 2018) have highlighted the possible barriers to adopting value management in Nigeria construction industry and provides ways to avoid these barriers to achieve better quality construction and value for money (Aghimien, et al., 2018). Tanko, et al., (2019) have evaluated the critical barriers to value management application in the Nigerian construction industry (Tanko, et al., 2019). Othman et al. (2021) have addressed barriers and obstacles to adopting value management in Egyptian building projects and established the current level of value management implementation in the Egyptian construction industry, which is the first research that appears at this level. The research was limited to the regions of Cairo and Giza, and clients, consultants, and contractors with sufficient experience in building construction management are the key participants (Othman, et al., 2021). Kineber, et al., (2022) have evaluated the value management implementation barriers in construction projects in India (Kineber, et al., 2022). Al-Gahtani (2022) presented a literature review of the main challenges of value engineering implementation in the construction industry (Al-Gahtani, 2022). Ojo, et al., (2023) have identified the critical barriers to adopting value management, along with recommendations to help construction stakeholders overcome the challenges and enjoy the benefits of value management (Ojo, et al., 2023). Kineber, et al., (2023) have examined the relationship between overcoming the value management implementation barriers and value management implementation in the Egyptian building sector. (Kineber, et al., 2023).

In the context of Saudi Arabia, Alharbi, et al., (2022) have discussed the value management methodology in Saudi Arabia to figure out the situation of value management and evaluate the current situation of value management in Saudi Arabia, measuring the awareness of value management and its applications in both public and private sector, identifying the challenges and obstacles of the value management implementation studies worldwide and especially in Saudi Arabia (Alharbi, et al., 2022).

3.2.6. Value Engineering/Management Impact:

Green, (1991) has described the current state -at that time- of development of value engineering in the UK construction industry and found that value engineering has significantly impacted the UK construction industry (Green, 1991). Ning, (2015) has illustrated that using value engineering methods to control cost in the most productive phase of value engineering—the design phase bears great practical significance and demonstrated that value engineering in construction design can improve product function and reduce costs, reducing construction time, waste, and improving quality (Ning, 2015). Khodeir & El Ghandour, (2019) have highlighted the value added from applying methodologies of value management, where it was observed that it could achieve 15–40% savings of the total project cost and illustrated that the most important goals that value engineering seek to reach are time and cost saving, quality improvement, mitigating unessential resource waste, accurate decision-making, and teamwork enhancement, without letting go of the performance enhancement factor (Khodeir & El Ghandour, 2019). Elbaz, et al., (2020) have studied hidden transaction cost in hotels construction in Egypt and an influential cost-saving variable while applying value engineering to achieve the cost-effectiveness during the project life cycle (Elbaz, et al., 2020). Yu, et al., (2020) have investigated the impact of traditional value engineering on the embodied greenhouse gas emissions in the Australian built environment and found that traditional value engineering can potentially provide environmental benefits through the dematerialisation of the building (Yu, et al., 2020). Oladigbolu, et al., (2023) have explored the significant impact of value engineering in the construction industry and found that value engineering in construction enhances project efficiency and cost-effectiveness by optimising resources, improving quality, and maximising value, leading to more sustainable and successful projects (Oladigbolu, et al., 2023). In the context of Saudi Arabia, Aboelmagd & Mobarak (2021) have investigated ordering the types of works in terms of effectiveness in cost-saving using the value engineering process for construction projects in Saudi Arabia (Aboelmagd & Mobarak, 2021).

3.2.7. Value Engineering/Management Implementation and Framework:

Aminzadeha, et al., (2011) have developed a value engineering model in construction transportation and achieved decrease time, cost and increase quality (Aminzadeha, et al., 2011). Dhayalkar & Ahire, (2016) have discussed the concept of value engineering and the effective implementation of it through a case study in Road Construction Project (Dhayalkar & Ahire, 2016). Senay Atabay & Niyazi Galipogullari (2016) have explained how the principles of value engineering are applied in construction projects by covering the Bregana-Zagreb-Dubrovnik Motorway construction in Croatia by BECHTEL – ENKA joint venture as the sample project, and practices of value engineering in this project are described. Approximately 43,000,000$ and 12 months were saved (Senay Atabay & Niyazi Galipogullari, 2016). Tanko, et al., (2018) have develop A framework that established the requirements for the successful implementation of VM construction practices in the Nigerian construction industry (Tanko, et al., 2018). Jadhav & Patil, (2019) have studied various cost-effective construction techniques such as “Gypsum Plastering”, “CLC brickwork” and the use of modern precast elements of buildings for residential and commercial buildings, It also includes comparison of various design approaches like “mivan shuttering”, and “conventional techniques”, study of alternative materials to minimize cost and specially time of project and simultaneously to improve value of project. (Jadhav & Patil, 2019). Kineber, et al., (2020) examined value management diffusion between residential building entities in the Egyptian residential building industry. The results constitute activities for the adoption of value management in Egypt. Its guidelines will dramatically enhance the implementation of value management in Egypt and other developing countries where similar projects are conducted. (Kineber, et al., 2020).

Saleh, (2021) has assessed the value engineering factors' implementation on construction projects' design management performance and identify the ranking of each factor's effective weights and its impact on the design management performance (Saleh, 2021). McKendry, et al., (2022) have presented the first ever framework for implementing Product Lifecycle Management within high value Engineering to Order programmes (McKendry, et al., 2022). Anuradha, et al., (2022) have identified the challenges that affect the implementation of Value Engineering for the public sector construction projects in Sri Lanka (Anuradha, et al., 2022). In the study of (Elfargani, 2023) the values engineering principles are applied and the study of the constructor project defines value engineering practices in this project.

In the context of Saudi Arabia, (Oke & Aigbavboa, 2022) have Identified roles of a value manager that oversees value management give the avenue to comprehend what it takes to be ensued with the value management tasks, which later

drafted the history of value management in the Saudi Arabian construction industry. Other chapters of this study include its application, phases, factors to be considered, reasons for implementing value management practice, barriers in implementation with solutions to some of the barriers and the concluding part summarising the perceptions inferred from the value management task through the study. (Oke & Aigbavboa, 2022).

3.2.8. Value Engineering/Management Applications and Integrations:

3.2.8.1. Sustainability Applications and Integrations:

Tahir, et al., (2016) have presented the concept and the application of value management approach and potential to improve energy efficiency within pre-construction process and contribute to better optimize the energy consumption in a building by seeking the best value energy efficiency through the design and construction process (Tahir, et al., 2016). ABD-KARIM, et al., (2017) have investigated the practicability of the value management-sustainable building integration in the Malaysia construction industry and explored the development and practices of value management-sustainable building concept as well as assessing the performance criteria of integrating value management in sustainable building projects (ABD-KARIM, et al., 2017). Yu, et al., (2018) have investigated the strengths, weaknesses, opportunities and threats (SWOT) for integrating sustainability into the VM process in Hong Kong (Yu, et al., 2018). Gunarathne, et al., (2020) have developed a framework that integrates value engineering and sustainability concepts in the construction industry in Sri Lanka to improve project values (Gunarathne, et al., 2020). Sheikh, et al., (2022) have audited value engineering and sustainable advancement as important constructs for accomplishing best value in construction venture for an amazing duration. It covered various phases of significant value engineering and relationship with sustainable construction and explored calculated linkage between construction designing and feasible construction (Sheikh, et al., 2022).

In Saudi Arabia, Al-Yami & Price (2006) have proposed a theoretical framework to implement sustainable construction principles in briefing process. It integrates Soft Value Management to sustainable construction to enable the client and project team to implement sustainability principles in the briefing process (Al-Yami & Price, 2006). Al-Saleh & Taleb, (2010) have investigated the Integration of sustainability within value management practices (Al-Saleh & Taleb, 2010). Alattyih, et al., (2019) have proposed a framework to develop a set of the most important value creation drivers (VCDs) for green buildings. (Alattyih, et al., 2019). Muhammad, et al., (2019) have developed an integrated approach to value management and sustainable Construction during strategic briefing in Saudi construction projects (Muhammad, et al., 2019). ALshabanat & Omer, (2023) have proposed a multi-objective evaluation of the potential green engineering solutions to conserve energy by using a building within the ROSHN housing project in Saudi Arabia as a case study for this paper with the aid of simulation software. These green engineering solutions were used to simplify a comprehensive design, considering the context of the sustainability concept and making them more applicable and understandable in terms of energy consumption (ALshabanat & Omer, 2023).

3.2.8.2. BIM Applications and Integrations:

Usman, et al., (2018) have presented a review of the implementation of BIM in construction industry. The factors that triggered and hinder the implementation of VE and BIM in the current industry and a case study of the application of VE using BIM for cost optimization of renovation works are also discussed (Usman, et al., 2018). Li, et al., (2021) have determine how BIM can be integrated with value engineering and illustrate the benefits of this integration. The study proposed a framework based on the analytic hierarchy process (AHP) and the entropy method to calculate the weight and coefficient (Li, et al., 2021). Baarimah, et al., (2021) have carried out a bibliometric analysis of the available BIM and value engineering literature to provide a picture of the research status from 2007 to September 2021. There were 46 documents extracted from the database of Scopus. (Baarimah, et al., 2021).

In the context of Saudi Arabia, Alrashed & Kantamaneni, (2018) have assessed and compared existing flat design vs. mid-terrace housing through cost estimation and design criteria that considers family privacy and meets the needs of Saudi Arabian families – while the study did not mention value engineering directly. However, it can be figure out that this is a kind of value engineering study, hawever, a 5D (3D + Time + Cost) Building Information Modelling (BIM) is proposed for cost benefiting houses (Alrashed & Kantamaneni, 2018) . Al-Ghamdi & Al-Gahtani, (2022) have developed a systematic model for selecting HVAC systems based on the value engineering (VE) concept and a complete model was developed to enhance the selection process, programmed within the building information modeling (BIM) environment platform (Al-Ghamdi & Al-Gahtani, 2022). Saud, et al., (2022) have proposed a framework for automating the value engineering process and integrating it with the decision-making process for building material selection and established a programmed framework with BIM as a great aid to the decision-maker to select the most valuable materials during the design stage (Saud, et al., 2022). Al-Gahtani, (2022) has reviewed the recent value engineering studies more comprehensively to answer two objectives. The first objective is identifying the

most rote limiting value engineering application challenges in the construction industry. The second objective is finding the existing value engineering automation knowledge gap such as BIM (Al-Gahtani, 2022).

3.2.8.3. Architectural Design Processes Applications and Integrations:

Omigbodun, (2001) has examined how value engineering contributes to obtaining an optimal solution to the design problem for a building project (Omigbodun, 2001). Feng & Ding, (2011) have applied value engineering to compare the technical economy of design schemes of highway engineering, comprehensive analysis the conditions of function and cost to optimize the optimal scheme, and verified the reliability of application value engineering in optimizing design scheme of highway engineering by actual engineering example (Feng & Ding, 2011). Ranjbaran & Moselhi, (2014) have presented an automated model for design professionals, owners, and members of value engineering teams to evaluate and compare different design alternatives of project components using multiattributed criteria, as well as integrating that model with visualization capabilities to assist designers and stakeholders in making related decisions. (Ranjbaran & Moselhi, 2014). Papageorgiou, et al., (2016) have presented culminates in the development of a value model used in the conceptual phase of engineering design, with the preferences of more than one stakeholder addressed in the multi-stakeholder and multi-objective optimisation (Papageorgiou, et al., 2016). Giménez, et al., (2020) have proposed model responds to the need to measure the value creation expected by different customers within the design process through indexes of desired, potential, and generated value and the percentages of the fulfillment of desired and potential value (Giménez, et al., 2020). Jadidoleslami & Azizi, (2022) have evaluated the importance of constructability in value engineering and provide some suggestions for facilitating and improving it with value engineering. Also, have covered the subject of the position of constructability and value engineering in the project lifecycle (Jadidoleslami & Azizi, 2022). Khashaba & El-Shourbagy, (2023) have used value engineering and Functional Analysis System Technique, "FAST" to identify/classify the functional relationships of a study project. Results clarifies that the value engineering, FAST technique can be applied in the road design process in Egypt. (Khashaba & El-Shourbagy, 2023).

In the context of Saudi Arabia, Al-Hammad & Hassanain, (1996) have presented an evaluation and selection technique based on value engineering principles for exterior wall systems (Al-Hammad & Hassanain, 1996). Alattyih, et al., (2019) have proposed a framework to develop a set of the most important value creation drivers (VCDs) for green buildings design and the associated costs (Alattyih, et al., 2019). In their questionnaire survey, Aboelmagd and Mobarak (2021) analyzed the role of design in the value engineering process for construction projects in Saudi Arabia. They aimed to determine the most effective types of construction works in terms of cost-saving. (Aboelmagd & Mobarak, 2021). Al-Ghamdi & Al-Gahtani, (2022) have presented a case study of a building in Riyadh, Saudi Arabia, which the HVAC selection model were implemented. The programmed model can significantly facilitate the selection process for designers (Al-Ghamdi & Al-Gahtani, 2022). QUFFA, (2023) has dedicated to demonstrating the methodology of value engineering while highlighting its impact on construction projects through a case study: Magrabi Offices in Saudi Arabia (QUFFA, 2023). Alsanabani, et al., (2023) have applied a value engineering approach to select the best foundation type from seven alternatives that covered shallow and deep foundations (Alsanabani, et al., 2023).

3.2.8.4. Facilities Management Applications and Integrations:

Venner, et al., (2007) have examined the principles, similarities, and opportunities for reinforcement of Context-sensitive solutions, value engineering or value analysis, and asset management systems (Venner, et al., 2007). Trigunarsyah & Hamzeh, (2017) have provides evidence of the significant saving that resulted by implementing VE for temporary facilities of a construction project. A case study of temporary facilities for a large power plant project is presented, and includes the VE steps and actual results. The main findings of this study suggest that implementing VE study for temporary facilities of construction projects could lead to a significant cost reduction, particularly in mega projects and remote projects (Trigunarsyah & Hamzeh, 2017). Zhao, et al., (2019) have provided organizations with a strategic system and process to select proper facilities or buildings for business expansion using value engineering approach (Zhao, et al., 2019). In Saudi Arabia, facilities management and value engineering/management publication within the construction industry is limited.

3.2.8.5. Risk Management Application and Integration:

Haghnegahdar & Asgharizadeh, (2008) have discussed via a case study that risk management and value engineering can be used together as an effective mechanism to provide value successfully throughout the development of new products (Haghnegahdar & Asgharizadeh, 2008). Kenari, (2015) have highlighted the importance of integrating risk management and value engineering and presented an integrated approach by which project management process can

be evaluated and controlled at any specific stage. (Kenari, 2015). Jahromi, et al., (2018) have studied interactional function of value engineering and risk management in civil projects. In this study implementation of value engineering and risk management was done in a unified practical way. (Jahromi, et al., 2018). Elsaeed & Gomaa, (2022) have integrated value engineering and risk management, to simulate the best relations between the efficiency of functional performance, quality level and the building cost (Elsaeed & Gomaa, 2022).
In the context of Saudi Arabia, Alattyih, (2015) has explored tangible and intangible value creation processes and drivers in the quest for value creation in green building development. The developed value creation framework and associated assessment risk and value tools are usable at the early stages of preparing a business case and design for developing green buildings (Alattyih, 2015). Alattyih, et al., (2020) have developed a structured framework to examine various risks that may lead to green buildings' value destruction in Saudi Arabia. The framework initiates with identification of 66 potential risk factors from reported literature. (Alattyih, et al., 2020).

4. Contemporary Trends and Future Directions

This section presents informed recommendations for future research in value engineering in the Saudi Construction Industry, based on a comprehensive literature review. The recommendations delineate areas that necessitate further investigation, including but not limited to the integration of value engineering/management with different decsciplains. These recommendations are provided to facilitate the advancement of knowledge and best practices in value engineering/management in the context of the Saudi Construction Industry.

4.1. Recommendation for further Studies:

The following are some significant unanswered questions and potential areas for further research regarding value engineering practices in Saudi Arabia:

1. Offering more insights regarding the present state of value engineering practice, specifically in the context of public projects in Saudi Arabia? This can be interesting and valuable to the industry knowledge of the current state of value engineering/management practice. As to whether value engineering/management continues to advance within the construction industry of Saudi Arabia, or if it has been impeded by the recent protocols introduced by the Expenditure Efficiency & Project Authority (EXPRO).
2. Investigate the relationship between value engineering and achieving client satisfaction. This can be interesting and valuable to the industry knowledge, providing organizations with valuable insights to optimize project outcomes, align with client expectations, and deliver enhanced value. It supports the development of successful projects, fosters client trust and satisfaction, and contributes to long-term business success.
3. Investigating whether value engineering hinders architects' innovation is important for understanding the impact of value engineering on the architectural design process and the overall outcomes of construction projects. By investigating this, organizations can promote effective collaboration, optimize design outcomes, and balance creative vision and cost considerations. This knowledge contributes to more successful and harmonious projects that achieve value and innovation.
4. Understanding the current level of knowledge and practice of value engineering in architecture and engineering firms in Saudi Arabia is crucial for making a significant contribution to knowledge. This is expected to provide a foundation for improvement, knowledge sharing, and targeted interventions. It drives the enhancement of value engineering capabilities, fosters innovation, and contributes to the overall growth and development of the industry.
5. Implementation of value engineering and value management in construction projects, particularly concerning BIM: Investigate current practices, challenges, and impacts on project outcomes:
    a. Enhancing value engineering studies with BIM: Explore how BIM can improve data analysis, collaboration, and decision-making in value engineering processes.
    b. Accelerating value engineering procedures through BIM: Investigate how BIM can expedite value engineering processes throughout the project lifecycle.
    c. Adoption of Industry 4.0 technologies (BIM and blockchain) for value engineering: Assess the benefits and challenges of using BIM and blockchain to enhance data integrity and transparency in value engineering.
    d. Integration of BIM and blockchain for value engineering: Explore the combined use of BIM and blockchain to improve data interoperability and decision-making in value engineering processes.
    e. Case studies and best practices: Analyze successful projects implementing BIM and blockchain in value engineering, identifying lessons learned and best practices.
    These studies will contribute to advancing knowledge, informing industry practices, and driving innovation in value engineering within the construction industry.

6. Investigate the Impact of Change Orders on the Implementation of Value Engineering: Explore the relationship between change orders (variation orders) and the successful implementation of value engineering and value management in public construction projects. Analyze how change orders affect the application of value engineering principles, project costs, timelines, and overall project outcomes.
    a. Assess the Causes and Frequency of Change Orders in Public Construction Projects: Examine the underlying causes and frequency of change orders in public construction projects. Identify common factors contributing to change orders, such as design changes, scope modifications, unforeseen conditions, or client requests. Evaluate how these change orders impact the implementation of value engineering practices.
    b. Examine Strategies for Managing Change Orders and Value Engineering: Investigate strategies and best practices for effectively managing change orders while incorporating value engineering principles. Explore approaches to minimize the number and impact of change orders, enhance communication and collaboration among project stakeholders, and optimize value engineering opportunities despite changes in project requirements.
    c. Analyze the Cost Implications of Change Orders on Value Engineering: Evaluate the cost implications of change orders on implementing value engineering in public construction projects. Assess how change orders affect the identification and realization of cost-saving opportunities through value engineering. Explore the potential trade-offs between accommodating change orders and achieving cost optimization objectives.
    d. Identify Barriers and Challenges to Integrating Value Engineering in the Change Order Process: Identify barriers and challenges that hinder the effective integration of value engineering practices during the change order process in public construction projects. Investigate factors such as contractual issues, time constraints, stakeholder resistance, or limited awareness of value engineering concepts. Propose strategies to overcome these barriers and enhance the integration of value engineering in change order management.
    e. Develop Guidelines and Frameworks for Integrating Value Engineering in Change Order Management: Based on the findings, develop practical guidelines and frameworks for integrating value engineering practices in managing change orders in public construction projects. Provide recommendations for project owners, contractors, and consultants to effectively incorporate value engineering principles while addressing change orders to optimize project outcomes.

    By conducting further studies on the relationship between change orders and the implementation of value engineering in public construction projects, researchers can contribute to improving project management practices, minimizing cost overruns, and enhancing the effectiveness of value engineering in the face of changing project requirements.
7. Evaluation of Contractors' Practice of Value Engineering to Reduce Costs and Improve Quality: Conduct a comprehensive evaluation of contractors' implementation of value engineering practices in construction projects.
    a. Assess how contractors utilize value engineering techniques to reduce costs while enhancing project quality. Investigate the factors influencing contractors' adoption of value engineering, their challenges, and the outcomes achieved. Provide insights into effective strategies for contractors to implement value engineering and optimize project performance.
    b. Case Study of Contractors' Collaboration with the Client to Implement Value Engineering in Projects: Conduct in-depth case studies that examine the collaborative efforts between contractors and clients in implementing value engineering. Analyze successful projects where contractors and clients worked together to identify cost-saving opportunities and improve project outcomes through value engineering. Explore the collaborative processes, tools, and communication methods contractors and clients employ. Identify the key factors that contribute to successful collaboration in implementing value engineering and provide recommendations for fostering effective partnerships.

    By conducting further studies on these topics, researchers can enhance contractors' practices in value engineering, improve project outcomes, and foster effective collaboration between contractors and clients. The findings can inform industry practices, guide decision-making, and contribute to the overall advancement of value engineering in construction projects.
8. Investigate the Impact of Value Engineering and Value Management on Sustainability in Construction Projects: Explore the role of value engineering and value management in enhancing sustainability practices in construction projects within the Kingdom. Assess how value engineering can reduce environmental impacts, improve energy efficiency, promote green building materials and technologies, and achieve sustainability certifications. Investigate the challenges and opportunities associated with integrating sustainability considerations into value engineering processes.
    a. Examine the Relationship Between Value Engineering and Innovation in Construction Projects: Investigate how value engineering and value management practices can foster innovation within the construction

industry in the Kingdom. Analyze how value engineering can promote creative problem-solving, encourage the adoption of new technologies and materials, and drive innovation in project design, construction, and operations. Explore how value engineering processes can support innovative thinking and contribute to the development of sustainable and resilient infrastructure.

b. Assess the Implementation of Value Engineering in Sustainable Construction Projects: Conduct case studies and assessments of construction projects in the Kingdom that have successfully integrated value engineering and sustainable practices. Evaluate the methodologies, strategies, and outcomes achieved in these projects. Analyze the effectiveness of value engineering in identifying sustainable solutions, optimizing resource use, reducing waste, and enhancing overall project sustainability performance.
c. Identify Best Practices for Integrating Value Engineering and Sustainability: Identify and document best practices for integrating value engineering and sustainability in construction projects. Explore the approaches, tools, and collaborative processes that enable effective integration. Provide recommendations for project stakeholders on maximising the benefits of value engineering in achieving sustainability goals, ensuring long-term environmental and social benefits.
d. Investigate the Economic Implications of Value Engineering and Sustainability Integration: Assess the economic implications of integrating value engineering and sustainability practices in construction projects. Analyze the cost-effectiveness of sustainable design and construction solutions identified through value engineering. Explore the potential for achieving life cycle cost savings, improving return on investment, and enhancing the overall financial viability of sustainable construction projects.

By conducting further studies on the role of value engineering and value management in enhancing sustainability and innovation in construction projects within the Kingdom, researchers can contribute to developing sustainable and innovative practices, inform decision-making, and support the Kingdom's goals for sustainable development and infrastructure advancement.

9. Investigate Cultural Factors Influencing the Adoption of Value Engineering and Value Management: Explore the cultural factors influencing the adoption and implementation of value engineering and value management practices in the Saudi Arabian construction industry. Analyze how cultural norms, beliefs, attitudes, and values impact the acceptance and utilization of value engineering concepts. Investigate how cultural factors may facilitate or hinder the adoption of value engineering practices and identify strategies to address cultural barriers.
    a. Assess Organizational Factors Affecting the Effectiveness of Value Engineering and Value Management: Examine the organizational factors that impact the effectiveness of value engineering and value management practices in the Saudi Arabian construction industry. Analyze how organizational structures, processes, leadership styles, and decision-making frameworks influence the implementation and outcomes of value engineering initiatives. Identify organizational best practices and strategies to optimize the integration of value engineering in construction organizations.
    b. Explore the Role of Communication and Collaboration in Value Engineering: Investigate the role of effective communication and collaboration in facilitating the adoption and effectiveness of value engineering and value management practices in the Saudi Arabian construction industry. Analyze how communication channels, teamwork, and stakeholder engagement influence the successful implementation of value engineering initiatives. Identify communication and collaboration strategies to enhance the integration of value engineering in construction projects.
    c. Examine the Influence of Regulatory Frameworks on Value Engineering: Assess the influence of regulatory frameworks, policies, and standards on the adoption and effectiveness of value engineering and value management practices in the Saudi Arabian construction industry. Analyze how regulatory requirements and incentives impact the integration of value engineering in construction projects. Explore opportunities to align regulatory frameworks with value engineering principles to promote its wider adoption and implementation.
    d. Investigate the Role of Training and Education in Promoting Value Engineering: Explore the role of training and education in promoting the adoption and effectiveness of value engineering and value management practices in the Saudi Arabian construction industry. Analyze the availability and effectiveness of training programs, certification courses, and educational initiatives related to value engineering. Identify gaps in knowledge and skills and propose recommendations for promoting value engineering education and professional development opportunities.

    By conducting further studies on the potential impact of cultural and organizational factors on the adoption and effectiveness of value engineering and value management practices in the Saudi Arabian construction industry, researchers can enhance understanding, inform policy-making, and provide practical recommendations for promoting the successful implementation of value engineering initiatives.

10. Investigate the Integration of Value Engineering into Operation and Maintenance Processes: Explore how value engineering can be effectively integrated into construction projects' operation and maintenance phases. Analyze the challenges and opportunities in applying value engineering principles to optimize built assets' ongoing operation, maintenance, and lifecycle management. Assess the impact of value engineering on improving asset performance, reducing life cycle costs, and enhancing user satisfaction throughout the operational phase.
    a. Assess the Benefits of Value Engineering Integration in Operation and Maintenance: Evaluate the benefits of integrating value engineering into construction projects' operation and maintenance processes. Analyze the impact on asset performance, maintenance costs, energy efficiency, sustainability, and overall value for money. Quantify value engineering integration's financial and non-financial benefits and develop metrics to measure and evaluate the outcomes throughout the operational phase.
    b. Investigate Organizational and Process Changes for Value Engineering Integration: Study the organizational and process changes required to effectively integrate value engineering into operation and maintenance processes. Analyze the roles and responsibilities of stakeholders involved in the operation and maintenance phases and identify strategies for effective collaboration and communication. Explore organizational structures, contractual frameworks, and project management approaches that facilitate the integration of value engineering in ongoing asset management.

    By conducting further studies on how value engineering can be effectively integrated into the operation and maintenance of construction projects, researchers can contribute to improving asset performance, optimizing life cycle costs, and enhancing user satisfaction. The findings can inform industry practices, guide the development of guidelines and frameworks, and drive the adoption of innovative technologies for value engineering integration in the operation and maintenance phases.
11. Investigate the Role of Project Management Offices (PMOs) in Value Engineering Integration: Explore PMOs' specific role and functions in integrating value engineering principles into their operations to enhance project value and sustainability in the construction industry. Analyze how PMOs can effectively support the implementation of value engineering practices throughout the project lifecycle. Assess the strategies, tools, and methodologies PMOs employ to promote value engineering and align it with project objectives and sustainability goals.
    a. Assess the Impact of PMOs on Value Engineering Adoption and Outcomes: Evaluate the impact of PMOs on the adoption and effectiveness of value engineering practices in construction projects. Analyze how the presence of a PMO influences project teams' awareness, understanding, and utilization of value engineering methodologies. Assess the outcomes achieved in projects where PMOs actively promote and facilitate value engineering, such as improved project performance, cost savings, enhanced quality, and increased sustainability.
    b. Examine PMO Structures and Processes for Value Engineering Integration: Study the organizational structures, processes, and governance frameworks of PMOs that facilitate the integration of value engineering principles. Analyze how PMOs can effectively collaborate with project stakeholders to identify value engineering opportunities, assess feasibility, and drive implementation. Investigate the communication channels, decision-making processes, and project controls PMOs use to support value engineering integration.
    c. Identify Best Practices and Challenges in PMO-led Value Engineering Initiatives: Identify best practices and challenges in PMO-led value engineering initiatives within the construction industry. Analyze successful case studies and lessons learned from projects where PMOs have effectively integrated value engineering practices. Explore the critical success factors, barriers, and enablers for PMOs in promoting and implementing value engineering. Provide recommendations for PMOs on optimising their role in value engineering integration.
    d. Investigate the Skills and Competencies Required for PMOs in Value Engineering: Examine the skills, knowledge, and competencies necessary for PMO professionals to effectively integrate value engineering principles into their operations. Analyze PMO staff's training and development needs to enhance their understanding of value engineering concepts and methodologies. Identify gaps in skills and competencies and propose strategies for PMOs to build the necessary capabilities for successful value engineering integration.

    By conducting further studies on the role of PMOs in promoting value engineering practices within construction projects, researchers can contribute to enhancing project value, sustainability, and overall project success. The findings can inform PMO practices, guide the development of frameworks and guidelines, and support the integration of value engineering principles into project management processes.

5. Conclusion

The historical perspective of value engineering/management provides a foundation for understanding the evolution and significance of value engineering/management in the construction industry. By tracing its origins, milestones, and global adoption, this review paper underscores the value of value engineering/management as a systematic approach to optimize project value. Understanding the historical context of VE enables practitioners, researchers, and policymakers to appreciate its contributions and explore future advancements in the field.

In conclusion, this literature review provides a comprehensive analysis of the value engineering/management practices focusing on the Saudi Construction Industry. By identifying the gaps in the existing research, the study has provided recommendations for further research directions that will help enhance project efficiency, achieve cost savings, and contribute to the Kingdom's Vision 2030 objectives. The findings of this research paper can be used as a valuable resource for researchers, practitioners, and decision-makers in the construction industry. By implementing the suggested research directions, the Saudi Construction Industry can benefit from the principles of value engineering/management, enabling it to improve its project outcomes, increase efficiency, and contribute to the country's development.

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