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ENHANCING VALUE ENGINEERING ADOPTION IN THE JORDANIAN CONSTRUCTION INDUSTRY: AN ANALYSIS OF BARRIERS AND DRIVERS

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ABSTRACT

The construction industry plays a crucial role in driving economic growth, particularly in developing nations. At the same time, there are many obstacles that are encountered within the construction industry including project budget over-runs, project delays and quality-related concerns. Although Value Engineering (VE) can provide numerous benefits to the construction industry, the use of VE within the construction industry of Jordan has been minimal thus far. This research aims to identify the barriers and drivers that influence VE adoption in Jordan. To achieve this goal, a survey was sent to construction professionals in different areas of construction. The findings indicate that there is a moderate level of awareness regarding VE among construction professionals and that the barriers to VE adoption can be subdivided into four categories: Stakeholder Issues; Training Issues; Client Issues; and Government Issues. The main barriers have been identified as: Lack of awareness of VE; a lack of supportive legislation; and a lack of incentive from government to the construction industry. However, Education regarding VE in higher education institutions, Economic conditions of the country, Demand from clients and financial incentives for participants have been identified as the most significant drivers of VE adoption. The research provides practical guidance for improving VE implementation by providing educational programs; developing VE policy; and providing stakeholder involvement in the process of VE implementation.

KEYWORDS

Barriers, Drivers, Construction, Value Engineering, Jordan.

1. INTRODUCTION

The construction industry has historically been an important contributor to many national economies worldwide. It has been one of the major contributors to the positive momentum or growth within the world economy. The construction industry is one of the principal pillars of the economic environment. The growth and development of many other industries within an economy can often be attributed to the construction industry (Khlaifat et al., 2019). The foundation for the development and advancement of each country's economy is in the area of construction and infrastructure activity (Hajiani et al., 2018). The construction and engineering industries produce a large number of jobs for a large proportion of professionals (Musarat et al., 2021). The bases of the relationship between the construction industry and the budget of most countries are primarily derived from three factors: the government agency as a client of the construction industry; the vast potential for construction industry savings; and the duality of being the single largest job creator, both directly and indirectly (Amoa-Abban & Allotey, 2014).

The construction industry has been identified as one of the world's greatest contributors to the development of economies in all nations. It is important to know that the evolution of the economic status of each nation is dependent on all sectors within the nation (Estache, 2006). The construction industry contributes substantially to the national gross domestic product (GDP) of each nation; it has a multiplicative impact on many other industries, therefore the need for construction industry advancement is imperative. The global construction industry has produced approximately $1.7 trillion of output annually; in the majority of nations, the construction industry provides an estimated 5-7% of their total GDP (Mumssen & Kenny, n.d.). The building industry is important to the quality of life in developing countries because it provides the backbone for many of the basic services that people use every day, including education, healthcare, transportation, food, housing, and other forms of support to their communities. (Memon & Co., 2013).

Like other nations, the building industry is an important engine of social and economic development in Jordan. (World Bank, 2023). In 2023, the building industry contributed 3.6% of Jordan's GDP, and projections indicate this percentage will grow to 3.8% by 2025 as a result of investment in infrastructure projects. (Jordan's Department of Statistics, 2024). The Jordanian building industry has grown at an average annual growth rate (AAGR) of approximately 3.18% between 2010-2019, with the building industry experiencing an overall contraction of -2.1% in 2020 due to the COVID-19 pandemic, and then rebounding to a growth rate of 4.3% in 2022 before falling back to 3.9% in 2023. The peak growth years for the building industry in Jordan were 2012-2014 with average growth rates of 7.8%, 10.4%, and 7.3% respectively (CBJ, 2024). The geopolitical instability of the region as well as declines in foreign investment limit the ability of the Jordanian Building Industry to grow, particularly with regard to large-scale construction projects (IMF, 2023).

While the Building Industry offers many economic benefits, it also faces unique challenges that can lead to negative project outcomes, such as increased costs, delays and poor quality. The industry must consistently deliver its projects on time and within budget while maintaining a high level of quality, and this is a significant ongoing challenge for the Building Industry. Numerous construction projects in Jordan have exhibited a wide gap between the anticipated costs and actual expenditures, with overruns of 101% to 600% (an average of 214% maximum) (Al-Hazim et al., 2017). Moreover, Lageman states that budget overruns and lack of planning have negatively impacted the construction industry's growth. Bakr noted that many variables impacted the increase in project expenditures and length of time spent constructing buildings. These variables include poor planning, significant amounts of change to original design while in processing, lack of complete plans at the start of the project, and not having proper bidding processes completed.

These factors directly add to both delays in constructing the building(s) and the costs associated with constructing buildings in Jordan. As such, the construction industry has begun looking for ways to improve the value of the projects they construct; to increase profits for the companies involved and to better the quality of the built environment through value engineering (VE). According to Lin et al., 2022, Value Management (VM) is well suited to promote the delivery of maximum value for each dollar spent on a construction project through its structured analysis process. VM provides value for its customers while providing sustainable and quality products at a lower cost.

Value Engineering (VE) is a systemized process that provides a tool for measuring and determining the value of a product or service in order to meet the desired performance level while minimizing costs. VE provides an opportunity to manage the entire project life cycle from the initial design to the actual construction. VE can be managed at all levels of development from start to finish. Even though the value of VE is apparent, the application of VE in construction is still low. For developing countries such as Jordan, VE can assist the construction industry due to the importance of the construction industry in the economy and the major issues facing the construction industry in Jordan. The lack of application of VE in Jordan's construction industry suggests that significant barriers to its use exist, which must be identified and eliminated. It is also important to determine which factors may support or facilitate greater use of VE in the construction industry. Despite the existence of previous studies that have identified barriers and drivers to VE, more research is needed to provide a guide for policymakers and practitioners to overcome barriers and promote the drivers to increase usage of VE in construction.

The goal of this research project is to identify barriers and drivers for VE in the construction industry of Jordan and to provide recommendations for the increased use of VE in the construction industry. The lack of research on VE in Jordan will provide valuable assistance to the body of knowledge on VE and also create opportunities for the stakeholders in the industry to increase the implementation and effectiveness of VE in the construction industry. By identifying the main challenges and opportunities of VE, stakeholders will be better able to make informed decisions about VE integration into their projects, which will ultimately improve project deliveries. This research will help to fill the knowledge gap in VE in Jordan and support the transition of the construction sector to more sustainable, cost-efficient practices through the integration of VE.

2. REVIEW OF RELATED LITERATURE

2.1. Definition of value engineering

The project management group generally utilizes a structured methodology for the planning stage of the project known as value engineering (VE) to identify and eliminate all non-value adding costs from the project while still achieving all quality or safety requirements. Said simply, VE defines clear project objectives and creates a greater value product through means of better design and improved performance while still delivering the lowest total project cost (Alhumaid et al., 2024). VE has developed a reputation as an effective method to either enhance the performance of a product or service and reduce overall project costs; therefore, many consider VE a major policy for implementing large scale cost reduction (Maksud & Yusof, 2013).

Moreover, the goal of VE is to provide the minimum total cost over the entire life cycle for the project/system while still providing the project/system with all of its required or desired functions (Prof. Nitin L. Rane, 2016). The goal of VE is to analyze and modify the product's design and function to achieve maximum value; thus VE is the process of identifying the required functions of a product and evaluating the alternative designs available to find the lowest cost options to achieve the performance level desired at the lowest total cost (Prof. Nitin L. Rane, 2016).

Additionally, value engineering is an organized and systematic/linear process whereby the function of a product or service is evaluated throughout its entire life cycle or provide a clear pathway to improve its value by reducing the cost of the product or service while maintaining the necessary quality and functions. VE provides an efficient means by which to meet the standards of product functionality with minimal costs, allowing for a more diverse selection of products or services. This process involves a collaborative effort from a variety of different stakeholders who have a vested interest in the successful completion of the project. VE typically occurs during the design phase of the project but can also take place during manufacturing or post-manufacturing.

Also, the VE methodology includes a service element, whereby the deliverables of the service can be evaluated at any time during the delivery process (Van der Merwe et al., 2015) Value Engineering (VE), in its most simplistic terms, is a process used to assess the functions of a product or service with the goal to enhance or maintain value while simultaneously minimizing potential costs related to that product or service (Robati et al., 2021). The main goal of VE is to prevent the unintentional loss of value in a product or service while attempting to reduce costs. The central concept of VE is that the function of a product and the cost of the product should be examined together to achieve the best outcome possible. Net Value is defined as the difference between the total functions that a particular product offers and the cost of those functions (Eling et al., 2021). Net Value can be increased by increasing the number of functions provided or decreasing the total cost of those functions. In this respect, VE created increased value by evaluating either the functions or the costs associated with them. In addition to being an efficient way of identifying unnecessary expenses, the combination of these definitions also indicates that VE is a systematic approach to improving the value of projects through a systematic process for assessing individual project components and processes with the specific aim of eliminating unnecessary costs while maintaining or improving required levels of performance.

These definitions indicate that VE methodology is a problem-solving methodology that is used to optimize project function while reducing costs. Therefore, Value Engineering can be described in broad terms as "a systematic methodology employed by project management in all phases of the project to remove excess costs while maintaining established quality criteria". The overall goal of the VE methodology is to develop projects that have defined objectives, enhanced value, improved design, and superior performance with minimal overall project costs.

2.2. Barriers of value engineering implementation

Several factors influence the adoption of Value Engineering (VE), including organizational culture, government policies, awareness, education and training (Alhumaid et al., 2024). For example, one of the biggest barriers to adopting VE is the lack of awareness/knowledge about VE by clients and stakeholders (Kissi et al., 2017a; Kineber et al., 2024).

Likewise, the absence of regulatory support for implementing VE within the construction sector and insufficient government encouragement have also been cited as significant barriers to adopting VE (Othman et al., 2021b; Kim, Lee, & Nguyen, 2016a). The majority of barriers to VE adoption in Developing Countries are attributed to the lack of Economic Development experts; the lack of client awareness of VE; the poor working relationship between stakeholders; insufficient facilitation training/skills, and the absence of local guidelines for economic development, which contribute to difficulties related to the practice of VE (Othman et al., 2020). Othman et al. (2020) identified fifteen barriers to VE; however, overall, these fall into four categories: People, Government & Public Policy, Environmental, and Methodological. In addition, prior research has been conducted to identify barriers related to the use of Value Engineering (VE) in the construction industry (Othman et al., 2021b; Hwang et al., 2015).There are various obstacles that limit the use of VE, some of which are that clients have little knowledge about VE; there are no national standards for adopting VE, or any government assistance in this regard; in projects, stakeholders and clients have difficulty aligning their various objectives; there is insufficient time to perform VE studies; procurement and contract methods impede VE implementation; and there are no legal frameworks or guidelines for local VE use.

Furthermore, additional obstacles include that the construction industry does not appear ready to utilize technological advancements in VE; are not ready to implement VE into their organizations; and do not have any commitment to do so.

According to Alhumaid and others, there are currently many more VE limitations impeding the construction sector than are mentioned above, including obstacles preventing VE from being effectively utilized in the construction sector, including inadequate governmental support, a lack of skilled personnel in traditional architecture, little dedication to traditional architectural methods, insufficient training, inadequate management support, and challenges related to engaging all major stakeholders in any given project process.

Further, Ojo and others in 2023 have identified 17 significant barriers to using VE in construction projects in Nigeria based on statistical analyses. Ten of these barriers were considered of particular importance, including: communication gaps between clients and designers; delays in design preparation; the misunderstanding that VE is already being used in the construction industry; and the misunderstanding of VE as it pertains to construction professionals.

Similarly, a study conducted in Vietnam has outlined numerous barriers, including limited understanding of VE methods; limited numbers of VE experts; and insufficiently trained technical employees.

Additionally, Othman and others conducted a study in Egypt to evaluate the use of VE in the building construction industry and identified substantial obstacles to VE use in Egypt's construction sector. Chief among these challenges is the involvement of decision makers and other stakeholders in VE workshops as well as inadequate facilitation and inadequate training. Another research study that identified barriers to VE use in small-scale construction projects was conducted in Malaysia and identified barriers to VE use categorized into five categories: knowledge and guidance; limited resources; environmental; methodological; cultural factors. Also, one of the key issues limiting the implementation of traditional architecture in Sri Lanka's construction sector is the low levels of awareness surrounding the many benefits that traditional architecture offers.

Consequently, according to Thneibat, there are a variety of different reasons limiting the implementation of traditional architecture in the Saudi public sector, including limited access to historical data regarding traditional architecture; vague standards and specifications; and limited knowledge connected with the benefits of traditional architecture. Additionally, leadership voids and a lack of devotion by clients to the use of traditional architecture impede the development of traditional architectural practices. In the same context, Othman and others have identified several major barriers limiting the implementation of traditional architecture in Egypt's construction sector, including sub-optimal facilitation methodology and improper coordination of major stakeholders. The barriers identified above were included in Table 1.

Using the Jordanian construction industry as a case study, this study builds upon this existing knowledge by analyzing the barriers to the effective adoption of VE in the Jordanian construction industry. In doing so, it aims to identify potential strategies for overcoming those barriers and facilitate greater integration of VE within the construction industry. The research has been conducted on various sub-sectors of the Jordanian construction industry and will provide an accurate assessment of the challenges associated with implementing VE within Jordan's construction sector. This research also has developed a number of practical recommendations that can lead to increased use of VE in Jordan. The outcomes of this research will be useful to policymakers, practitioners and researchers interested in enhancing the productivity and success of construction projects within this region. Addressing these barriers can enhance the overall quality and success rate of construction projects in Jordan and enhance innovation and competitiveness in construction.

Table 1. key barriers to the adoption of VE in the construction industry

Barrier	References
Lack of VE awareness among the clients	(Kim, Lee, Viet Thanh, et al., 2016; Kissi et al., 2017b ;Olawumi & EBUNOLUWA, 2022)
Absence of regulations allowing for the implementation of VE in the construction industry	(Xiaoyong & Wendi, 2012; Kissi et al., 2017b)
Government's lack of encouragement	(Aghimien et al., 2018; Lin et al., 2022)
Difficulty in establishing mutual project objectives by stakeholders	(Othman et al., 2021b; Aghimien et al., 2018)
VE workshop incurs additional cost	(Ojo et al., 2023; Makedon et al., 2023)
Difficulty in integrating technological advances into the environmental assessment method	(Li et al., 2022; Danso & Osei Kwadwo, 2020)
Absence of local VE guidelines and legal framework	(Kim, Lee, Viet Thanh, et al., 2016; Xiaoyong & Wendi, 2012;Alhumaid et al., 2024; Xiaoyong & Wendi, 2012)
Lack of time to conduct VE studies	(Othman et al., 2021b; Xiaoyong & Wendi, 2012; AI-Yami, n.d. ;Kalani et al., 2017)
Difficulty in selecting an inappropriate approach or method of VM	(Othman et al., 2021b)
Procurement and contracting strategies are incompatible with VE implementation	(Othman et al., 2021a; Tanko et al., 2018a)
Lack of readiness to adopt VE in the industry	(Othman et al., 2021b; Kissi et al., 2017a)
Absence of contractual provisions governing the implementation of VE between owners	(Othman et al., 2021b; Xiaoyong & Wendi, 2012)
Lack of commitment to implement VM	(Othman et al., 2021b; Li et al., 2022);Xiaoyong & Wendi, 2012)
Client's refusal to fund VE exercise	(AI-Yami, n.d.; Assaf et al., 1996; Othman et al., 2021b)
Difficulty analyzing and evaluating functions and alternatives	(Othman et al., 2021b)
Lack of knowledge about VM	(Kim, Lee, Viet Thanh, et al., 2016; Xiaoyong & Wendi, 2012; Lin et al., 2022)
Inability of the client to express his or her requirements and needs to the design team	(Kineber et al., 2024; Othman et al., 2021b)
Inadequate collaboration and relationship-building among stakeholders	(Kissi et al., 2017b; Li et al., 2022; Jaapar et al., 2009a)
Lack of VE experts	(Li et al., 2022; Kim, Lee, Viet Thanh, et al., 2016;Xiaoyong & Wendi, 2012)
Reluctance to accept state-of-the-art developments	(Othman et al., 2021b; Alhumaid et al., 2024;Jaapar et al., 2009a)
Difficulties in involving decision-makers and other key stakeholders in the VE workshop	(Jaapar et al., 2009b;Othman et al., 2021b; Li et al., 2022)
Inadequate skills and training	(Othman et al., 2021a; Aghimien et al., 2018;Danso & Osei Kwadwo, 2020)

2.3. Drivers of value engineering implementation

Although VE is widely used in developed countries, such as the USA and UK, in many other locations the application of VE in construction continues to struggle due to the reluctance of some regions to accept VE. As a result, much of the world is still developing its use of VE within the construction sector (Abdel-Raheem et al., 2018). Studies have shown that factors such as the economy, customer demand, and previous experience with VE can impact both VE acceptance and its implementation (Mohamad Ramly et al., 2015; Othman et al., 2021b). For example, one of the primary motivators for VE acceptance in the construction sector is the need to reduce overall project costs while increasing profitability within the construction sector (Al-Fadhli, 2020). The development of VE education and awareness of all parties involved in construction procurement (consumers, designers, contractors, etc.) regarding the benefits of VE is also a major motivator of VE acceptance (Oke & Aghimien, 2018). VE is a structured approach to solving a particular problem that will create value for a system through increasing functionality or decreasing costs.

Therefore, it is evident that the value of a project is determined by comparing the cost of the project to the functions provided by that project using the equation ὲ (value) = functional/cost. In addition to these points, it is important to note that VE value proposition studies are completed by multi-disciplinary teams that consist of individuals with specialized skills and expertise in their respective areas. These teams drive VE implementation (X. Zhang et al., 2009).

Several other studies have also focused on identifying various drivers affecting the successful implementation of VE, including the need to adapt existing VE workshops so they are better suited to customer needs; training concerning VE; educating all individuals involved in construction procurement about the significance of VE (Mohamad Ramly et al., 2015); and analyzing VE driver impacts on the performance of Nigeria's construction sector (Tanko et al., 2018a). The Tanko et al. study highlighted that for VE to be successfully implemented in Nigeria, effective communication among all members of the architectural team, ongoing and sufficient support from all stakeholders (clients and contractors), government support, and accessible and up-to-date information regarding the project (costs, scope, and defined roles of architectural team members) are critical requirements.

According to (Mohamad Ramly et al., 2015), one of the ways each person can influence the promotion of value engineering (VE) is through economic development and government policy supporting the needs of the construction industry when engaging with Value Engineering (VE). This requires collaboration among all professionals inducing value engineering data and information dropout. in addition, the people's request for Value Engineering (VE) from the client along with the professional's desire to maximize their clients resources; down the road as the development of sustainable building; and how well all professional organizations work together with each other in the value engineering adoption process; how much each professional (engineers, architects, builders, consultants, etc.) Knows About Value Engineering (VE); Plus Any Previous Experiences That Each Professional (Eng. Arch. Bldg, Const.) Has Had With Value Engineering (VE): Training on Value Engineering; Training All Participants Involved In The Supply Chain For Construction On The Importance Of Value Engineering (VE) And The Availability Of A Value Engineering Institute; Knowledge on Possible Value Engineering Techniques; Knowledge Of Potential Value Engineering Benefits; Are All Drivers For Value Engineering (VE). Additionally, Seven (7) Drivers Of Value Management (VM) Were Identified From A Survey By Aghimien Et Al. (2018). In The Survey By Aghimien Et Al., The Drivers Are: 1. Government Participation In Implementation Of Value Management (VM); 2. Clients' Commitment and Involvement; 3. Awareness of Society on Value Management (VM); 4. Understanding of the Value Management (VM) Methodology; 5. Use of Electronic Value Management (VM) Studies; 6. Establishment of A Support System for Value Engineering (VE) Through Joint Collaboration of All Participants in the Value Management (VM) Process. On The Other Hand, There Are Many Drivers That May Impact The Adoption Of Value Engineering (VE) In The Jordanian Construction Industry, Including: 1. The Economy; 2. Clients Request For Value Engineering (VE); 3. Good Pay by Participants Involved In the Process; 4. The Consultants' Desire to Maximize Clients Resources; 5. Previous Experience of Project Stakeholders; 6. Government Initiatives/Legislation Supporting Adoption Of Value Engineering (VE); 7. The Need for Sustainable Development; 8. Collaboration of All Professional Organizations Involved With the Adoption of Value Engineering (VE). 9. Clients Knowledge of Value Engineering (VE); 10. Previous Experience of Value Engineering (VE) By the Professional. A List of the Drivers of Value Engineering (VE) Found From Previous Literature Is In Table 2.

It appears that previously published research did not investigate what might be responsible for the slow uptake of VE by the Jordanian construction industry, nor did it identify any enabling conditions that might foster its usage. Additionally, this is only the second time, as far as the authors are aware, that the use of virtual reality technology has been studied within the Jordanian context. Although several factors restrict the application of VE in construction companies, they also produce many supporting circumstances under which VE can thrive. By removing identified barriers and promoting enabling circumstances, we have developed a comprehensive approach to improve VE uptake in the construction industry, and thus, help construction companies realise VE's full potential value.

Table 2. Key drivers to the adoption of VE in the construction industry

Drivers	References
VE is taught in higher/postgraduate programs	(Kim, Lee, & Nguyen, 2016a; Ojo & Ogunsemi, 2018a)
Nation's economy	(Ojo & Ogunsemi, 2018a);
Client's request for VE	(Othman et al., 2020; Ojo & Ogunsemi, 2018a)
Participants get good pay	(Ojo & Ogunsemi, 2018a)
Desire of consultants to maximize the value of their clients' resources	(Hayatu, 2015a; Ojo & Ogunsemi, 2018a)
Previous experience of project stakeholders	(Thneibat & Al-Shattarat, 2021a; Hwang et al., 2015;Kineber et al., 2020)
Government policy/legislation in support of VE adoption	(Hayatu, 2015a; Ojo & Ogunsemi, 2018b; Hwang et al., 2015)
The need for sustainable development	(Ojo & Ogunsemi, 2018a; Oloto and Adebato, 2023: Hossain, I. *et al.* 2024)
Collaboration of all professional organizations involved in building in the adoption of VE	(Hayatu, 2015a;Ojo & Ogunsemi, 2018b;Thneibat & Al-Shattarat, 2021a; Alsolami, 2022b:Ahmed.2024)
Client's knowledge of VE	(Kineber et al., 2020;Hayatu, 2015a; Ojo & Ogunsemi, 2018b; Alhumaid et al., 2024)
Prior experience with VE by the professional	(Ojo & Ogunsemi, 2018a; Thneibat & Al-Shattarat, 2021a)
Adapting an existing VE workshop to meet the needs of the customer	(Alhumaid et al., 2024; Ojo & Ogunsemi, 2018a; Alsolami, 2022b; Chua et al., 1999)
VE training	(Ojo & Ogunsemi, 2018a; Oke & Aghimien, 2018)
Sensitization of all participants in construction procurement on the importance of VE	(Oke & Aghimien, 2018; Ojo & Ogunsemi, 2018b)
Availability of VE Institute in the country	(Ojo & Ogunsemi, 2018b)
Adequate knowledge of VE techniques	(Oke & Aghimien, 2018; Ojo & Ogunsemi, 2018b)
Adequate knowledge of the benefits of VE	(Hayatu, 2015a; Ojo & Ogunsemi, 2018b)

3. RESEARCH METHOD

The purpose of this study is to collect valuable information regarding construction industry stakeholders in Jordan as efficiently as possible. This was accomplished through the use of a questionnaire survey that contained thirty-nine criteria (twenty-two barriers, seventeen drivers) based on relevant research, a review of the literature, and input from experts. After gathering all of this information, the criteria were modified and revised for inclusion within the survey. The survey consisted of two main sections: Section I asked for personal and organizational information regarding those completing the survey; Section II evaluated the issues preventing and enabling value engineering from being implemented within construction projects in Jordan. In section II, the respondents were asked to indicate their level of agreement with each criteria using a five-point Likert scale, where five was strongly agree and one was strongly disagree. The survey was distributed in person and via email to owners, contractors, and consulting firms in the construction industry. The respondents included Jordanian engineers, who are registered with the Jordanian Engineers Association (JEA) as of 2020. The sample size was calculated using equation one from Suleiman (2022):

$$N_0 = (t^2 * S^2)/(d^2) \quad (1)$$

Where t: is the critical value at the 0.025 level in each tail (1.96), S: is the estimated population standard deviation (1.25), d: is the allowable error for the estimated mean (0.15), and N_0=266. Eq.2 shall be used to make the correction (Suleiman, 2022):

$$N = N_0/(1 + N_0/pop) \quad (2)$$

In total, 243 questionnaires were distributed, and 112 responses were received, yielding a response rate of 46%.

3.1. Reliability

A pilot study was conducted to assess reliability of the questionnaire. The reliability of the instrument indicates that the findings of the research can be replicated in another experiment and should be viewed as an indication of the robustness of the findings under identical experimental conditions to that of the pilot study. The reliability of the instrument is assessed using Cronbach's coefficient, which is considered reliable when it is equal to or greater than 0.7% (Cronbach & Shavelson, 2004). Cronbach's coefficient of alpha was computed using SPSS (version 27.0) and is provided in Table 3.

Table 3. Reliability of the survey instrument

Subscale	No. of Items	Reliability (Cronbach's Alpha)
Barriers	22	0.94
Drivers	17	0.92
Total Scale	39	0.81

The items in the Barriers Subscale had a Cronbach's Alpha of 0.94 indicating high reliability of internal consistency among the items in this subscale measuring a single construct. The Driver Subscale's Cronbach's Alpha is 0.92 indicating high reliability of internal consistency among the items in this subscale as well, which means it also measures a single construct very well. The total Scale with 39 items had a Cronbach's Alpha of 0.81, which is still reasonably reliable, although lower than that of the two Subscales individually. A slight decrease is to be expected because of differences within the items making up the combined total of the two subscales. The techniques used for analysis were to take the data from the surveys and put them in a format for use in a statistical analytical application (i.e., SPSS). Then the descriptive statistics such as means and frequencies were generated for the overall profile/history of each company based on the responses from the respondent companies after entering the data into SPSS.

4. RESULTS AND DISCUSSION

4.1. Demographic Description

The survey included questions related to each respondent's employer type (i.e., contractor, consultant or client), specialist area and field of practice, and number of years worked in this profession and previous industry experience with the employer organization. The survey results were reported as percentage breakdowns within the chart Fig. 1, which defined the demographic characteristics of the person completing the questionnaire, and as detailed below.

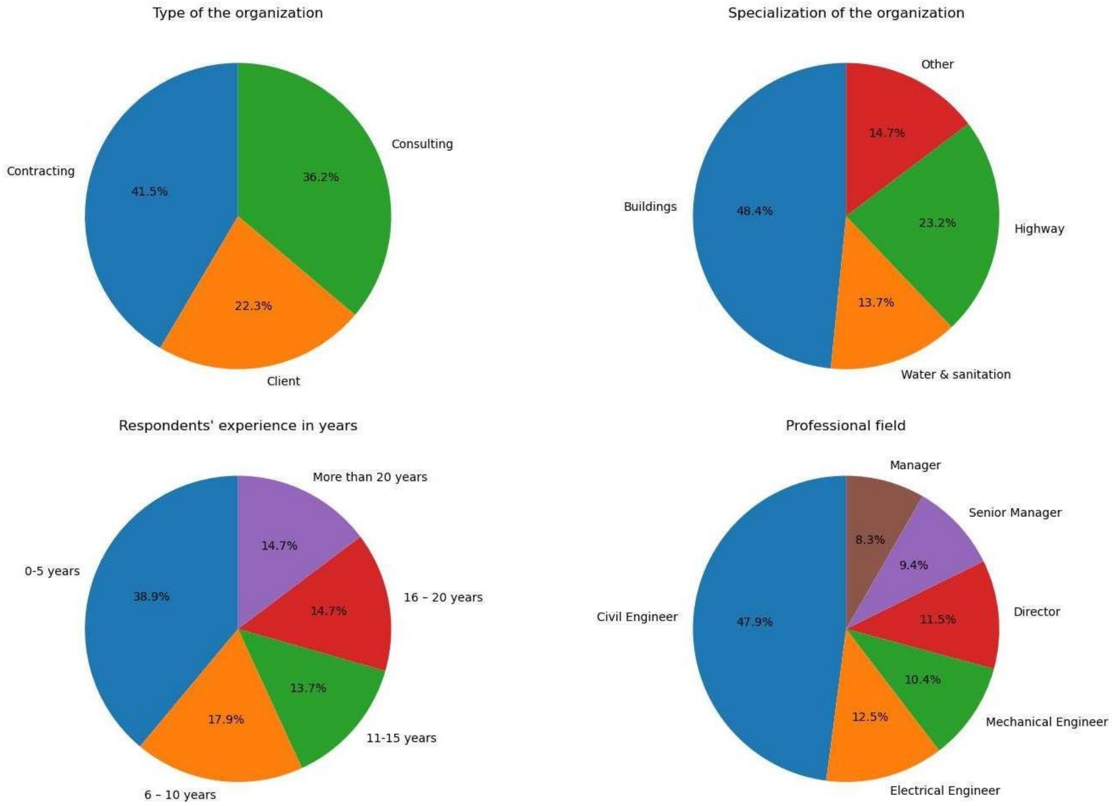

Fig. 1. Respondents and Construction Firms Background

In terms of employer type, the largest group of respondents worked for contracting companies (41.1%), followed by consulting firms (35.8%) and client organizations (22.1%). In terms of specialist area, the majority of respondents were classified in the building sector (48.4%), while 23.2% were classified under highways; 13.7% represented water and sanitation; and 14.7% were classified in other areas. Approximately 38.9% of respondents reported having only 0-5 years of work experience, while 17.9% had 6-10 years of working experience; 13.7% had 11-15 years; 14.7% had 16-20 years; and the remaining 14.7% reported working for more than 20 years. Respondents primarily worked in civil engineering (48.4%); however, also included were electrical (12.6%) and mechanical (10.5%) engineers, along with the following management titles: directors (11.6%); senior managers (9.5%); and managers (8.4%). Accordingly, the experience of respondents with their respective employers also varied accordingly, with respondent groups having the largest amount of experience being: 0-5 years of employment (24.2%), more than 20 years of employment (23.2%), 11-15 years of employment (21.1%); 6-10 years of employment (17.9%); and 16-20 years of employment (13.7%)

4.2. Ranking of VE barriers and drivers

A non-metric ordinal measurement approach was used to rank the results of the research data based upon numerical ascension or descent. The results of the ordinally measured data were analysed with a Relative Importance Index (RII). The RII provides a relatively simple way of measuring how often attitudes are measured in the literature of Construction. Participants rated the significance of barriers and drivers based upon a five-point Likert scale (1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree). The RII is calculated by using the RII equation, which is based on survey responses (Omran & Suleiman 2017; Abu Salem & Suleiman 2020), as shown in the subsequent formula (3):

$$RII = \sum W/(A * N) \tag{3}$$

RII denotes the relative importance index; W represents the respondents' weighting of each element (ranging from 1 to 5); A signifies the maximum weight (in this instance, 5); and N indicates the total number of respondents. The RII score ranged from 0 to 1 (inclusive); a higher RII indicates a more significant cause or effect. Subsequently, the RIIs were rated, with the results presented in Tables 5 and 6.

Table 5. RII and ranking of VE barriers

Barriers	RII	Overall ranking
Lack of VE awareness among the clients	0.613	1
Absence of regulations allowing for the implementation of VE in the construction industry	0.606	2
Government's lack of encouragement	0.604	3
Difficulty in establishing mutual project objectives by stakeholders	0.587	4
VE workshop incurs additional cost	0.583	5
The difficulty of incorporating technological advancements into the VE method	0.583	6
Absence of local VE guidelines and legal framework	0.581	7
Lack of time to conduct VE studies	0.577	8
Difficulty in Selecting an inappropriate approach or method of VM	0.575	9
Procurement and contracting strategies are incompatible with VE implementation.	0.573	10
lack of readiness to adopt VE in the industry	0.573	11
Absence of contractual provisions governing the implementation of VE between owners	0.573	12
Lack of commitment to implement VM	0.571	13
Client's refusal to fund VE exercise	0.568	14
Difficulty analyzing and evaluating functions and alternatives	0.568	15
Lack of knowledge about VM	0.560	16
Inability of the client to express his or her requirements and needs to the design team	0.549	17
Inadequate collaboration and relationship-building among stakeholders	0.541	18
Lack of VE experts	0.539	19
Reluctance to accept state-of-the-art developments	0.539	20
Difficulties in involving decision-makers and other key stakeholders in the VE workshop	0.537	21
Inadequate skills and training	0.514	22

The findings indicate that the ten major obstacles to the application of VE are as follows: RII = 0.613; the most frequently mentioned barrier is a lack of stakeholder/client awareness (Kissi et al., 2017a; Kineber et al., 2020; Kim, Lee, & Nguyen, 2016a; Olawumi & Ebunoluwa, 2022). Stakeholder/client ignorance of VE's benefits is a factor hindering VE adoption among consumers and stakeholders. Multiple studies from numerous geographical locations indicate this is a broad occurrence throughout the construction industry.

Additionally, the general absence of training courses focused on VE is indicative of this barrier. Educational events, workshops, and other instructional initiatives all can be used to increase awareness and reduce this obstacle. The second obstacle is a lack of regulations that support VE (RII = 0.606 (Kim, Lee, & Nguyen, 2016a; Xiaoyong & Wendi, 2012). In many developing countries, there is often little or no regulatory framework supporting VE adoption; it is difficult to apply VE in areas where there are no laws that support it. Additionally, in many geographic areas, the slow speed of developing VE regulations contributes to the barrier. Educating regulatory authorities on the advantages of VE and promoting policy changes that support VE application would help rectify this barrier.

Researchers, (Othman et al., 2021b; Aghimien et al., 2018; Lin et al., 2022) note that the lack of government encouragement is the third impediment to VE adoption (RII = 0.604) because the adoption of VE is contingent upon the support of the government. The lack of incentives and government encouragement can lead to a decline in the implementation of VE. Government agencies may prioritize alternatives to the VE process due to limited resources and conflicting interests. However, by presenting the long-term benefits of VE and demonstrating its value both in terms of project costs and results, governments may increase the likelihood of endorsing VE. The three most significant barriers that constrain the widespread acceptance and use of VE are the influence of environmental and cultural factors that affect acceptance and support for VE.

The following was identified by (Othman Et Al., 2021B; Aghimien Et Al., 2018) as a barrier to VE: the challenges associated with developing common or mutual project objectives by stakeholders. The barriers to VE could be attributed to obstacles in obtaining alignment between the goals and expectations of different stakeholders. This can be caused, in part, by the different levels of importance and priorities associated with the various stakeholders involved in a project. An effective communication plan and a cooperative approach will help to obtain alignment on project objectives. The fifth-most significant barrier to VE is the cost associated with holding VE workshops (Ojo Et Al., 2023; Makedon et Al., 2023), such that VE workshops may be perceived as an expense that will only have a limited benefit, particularly for projects with limited financial resources.

Consequently, this barrier highlights that VE products (e.g., the VE solutions that are provided) should be offered at an affordable price point. By utilizing case studies and other evidence to demonstrate VE's return on investment (ROI), clients could be persuaded to see VE as an investment, rather than an additional cost. The internal factors affecting the performance of the VE process and the dynamics of workshops in VE are reflected by both of these barriers. This type of barrier was ranked sixth in the overall rankings and has an RII score of 0.583; the difficulty in integrating new technologies into the VE process is seen to create a barrier (Li et al., 2022; Danso & Osei Kwadwo, 2020). Due to the fact that VE processes are constantly evolving, it is difficult for VE practitioners to remain current with changes in technological innovations that occur at a high rate.

Therefore, this barrier demonstrates why it is important for VE practitioners to engage in the continuous education of new technologies in order to maintain the relevance and effectiveness of VE methodologies through on-going updates. Keeping VE practitioners informed regarding the most recent technological innovations will minimize this barrier. A commonly referenced barrier is the absence of local VE policies and a corresponding legal structure; this barrier is ranked seventh in terms of the overall ranking, with a RII score of 0.581 (Kim, Lee, Viet Thanh, et al., 2016; Xiaoyong & Wendi, 2012; Alhumaid et al., 2024). This serves to highlight the difficulty in standardizing VE methodologies without having a local guideline and a corresponding legal framework in place. Hence, there is a requirement for the establishment and implication of local VE criteria to facilitate the acceptance of VE methodologies.

Additionally, the establishment of local VE regulations and legal systems will aid in providing a structured approach to the application of VE methodologies.The study (Othman et al., 2021b; Xiaoyong & Wendi, 2012; AI-Yami, n.d.; Kalani et al., 2017) indicates that time is a major constraint when conducting VE studies. Project schedules limit the amount of time allocated for VE studies. The presence of this barrier reinforces the need for improved time management within the overall project planning process. If you allocate sufficient time for VE studies to occur within your project plan, this will help to make VE more productive. As ranked number nine on the barrier scale, with an RII of .575, the barrier that occurs when selecting the right method or approach to use in VE, according to (Othman et al., 2020b). The selection of the right method or approach to VE determines if the VE method or approach is successful or not. This barrier shows the need for specific guidelines and rules so that practitioners can make an educated decision about the right VE method or approach for their project. Providing practitioners with specific training and guidelines about the VE methods of their choosing will assist practitioners in making an informed decision regarding the most appropriate VE methods.

As ranked number ten on the barrier scale, with an RII of .573, there is a barrier between the use of VE and the methods of procurement and contracting. According to (Othman et al., 2021a; Tanko et al., 2018a). The established practices of procurement and contracting may be contradictive to the principles associated with VE. The existence of this barrier points out the urgency to reform the procurement process to be more aligned with VE deployment. There needs to be a change in how the procurement process works to be suitable for VE deployment in order to ensure its successful implementation. This will improve the project outcomes. The barriers identified in this study are consistent with barriers identified in previous research studies. The consistency of these barriers has been recognized in numerous studies and in multiple fields which demonstrate their importance and need for further focus. Addressing these barriers requires a multi-faceted approach which encompasses education, advocating for policy change, involving stakeholders, and making changes to the processes supporting the VE implementation to create an environment suitable for the VE to be applied and that can showcase the positive outcomes from the VE. Table 6 provides the RII and rank data for VE drivers in the construction industry.

Table 6. RII and ranking of VE drivers

Drivers	RII	Overall ranking
VE is taught in higher/postgraduate programs.	0.640	1
Nation's economy	0.615	2
Client's request for VE	0.608	3
Participants get good pay	0.606	4
Desire of consultants to maximize the value of their clients' resources	0.604	5
Previous experience of project Stakeholders	0.602	6
Government policy/legislation in support of VE adoption	0.598	7
The need for Sustainable Development	0.598	8
Collaboration of all professional organizations involved in building in the adoption of VE	0.596	9
Client's knowledge of VE	0.594	10
Prior experience with VE by the professional	0.583	11
Adapting an existing VE workshop to meet the needs of the customer	0.583	12
VE training	0.573	13
Sensitization all participants in construction procurement on the importance of VE	0.573	14
Availability of VE Institute in the country	0.564	15
Adequate knowledge of VE techniques	0.558	16
Adequate knowledge of the benefits of VE	0.541	17

Based on the findings, education is the greatest driver of Value Engineering (VE) adoption. In particular, VE being included in both undergraduate and graduate programs scored an RII of 0.640, making it the greatest driver of VE adoption. Accordingly, previous research has demonstrated that educating students about VE through their engineering curricula enhances their understanding of VE and increases their chance of applying VE in practice (Ojo and Ogunsemi, 2018a), (Kim, Lee, & Nguyen, 2016b). VE should be included in the curricula of higher educational institutions to prepare future professionals to apply VE principles and practices in their industries. Therefore, education is an essential driver to provide future professionals with adequate knowledge of VE.

Furthermore, VE should be integrated into academic programmes to give graduates the knowledge and skills to implement VE properly. The second most significant driver of VE adoption is the economy of a country. The RII value of 0.615 indicates that VE adoption occurs more often in countries with strong economies. Previous research supports this finding by providing evidence that a strong economy is a conducive environment for VE adoption (Hayatu, 2015b; Ojo & Ogunsemi, 2018b). A robust economy gives construction firms the ability to invest in value engineering (VE) practices, resulting in lower overall costs for construction and improved project results.

A strong economy provides the necessary resources for VE investment; as a result of economic stability, construction firms can allocate funds to conduct VE studies over extended periods, which would ultimately lead to greater costs savings and enhanced performance for their projects. The client's request for VE is the next most important driver of VE in construction (RII = 0.608). This statistic reflects the importance of clients' needs and wants when implementing VE practices within the construction industry. Clients who request VE want to reduce costs and achieve better project outcomes than they would obtain through traditional contracting methods; thus, by requesting VE from their project manager, they create a demand for VE, encouraging construction firms to adopt VE practices in order to meet these expectations. Clients creating a direct demand for VE through their request demonstrates the importance of client demand, or market demand, for VE practices, and thus serves as a motivator for construction firms to adopt VE to meet client needs. The next two critical drivers are the economic compensation received by participants and the desire of consultants to maximize the value of their clients' resources. These two points highlight the importance of financial motivation in supporting the adoption of VE. Adequate compensation given to participants of VE studies inspires them to fully participate and contribute to the VE process, as well as assists consultants in maximizing the value of the client's resources through the VE process. It has been widely documented in the academic literature that VE can provide clients with substantial cost savings; therefore, the potential financial benefits received from these savings should serve as motivation for both participants and consultants involved with VE (Thneibat & Al-Shattarat, 2021b), (Ojo & Ogunsemi, 2018b).

Thus, ensuring adequate compensation to VE participants creates a driving force for active participation by all members of a VE team. Second, a prime motive for consultants is to be able to deliver maximum value for their clients, and VE provides a systematic way to accomplish this goal, thereby making VE a very attractive option for consultants striving to create high-values projects. In conclusion, results indicate that VE´s adoption in the construction industry can be influenced by the confluence of many factors, including education, economic conditions, client demand, and financial incentives.

5. CONCLUSIONS

The findings of this study regarding the perceived barriers and drivers for implementing Value Engineering (VE) within the construction sector provide critical information that will assist in future efforts to increase the adoption of VE. One of the largest barriers appears to be the lack of awareness about VE among clients and stakeholders, which is accompanied by a lack of regulations and legal frameworks supportive of VE practices, as well as a lack of encouragement from governments. These barriers demonstrate that much more must be done in terms of educating industry representatives, developing policies to support VE, and increasing government support so that a supportive environment exists for the implementation of VE within the construction industry. Additionally, the inability of stakeholders to agree on common project goals, the view that VE workshops are an extra cost (rather than an investment), and the difficulty in establishing common project objectives among stakeholders contribute to the low levels of VE adoption within the construction industry.

Addressing these issues will require a multifaceted approach. Stakeholder involvement, clear and effective communication, and successful and proven VE implementation will all be critical components of future VE implementation success. Some of the major VE facilitators have been identified through this research and include: inclusion of VE in educational institutions; a strong economy; client demand for VE services; fair and equitable compensation for all stakeholders; and consultants' desire to maximize their clients' available resources. There is a strong correlation between the previously identified VE facilitators and their overall effectiveness in facilitating VE adoption in various geographic locations. Using all identified facilitators and eliminating all barriers identified in the study will result in increased VE adoption, which, in turn, will improve construction project performance and enhance the sustainable development of the environment. Future research on VE should focus on longitudinal studies, regional analyses, incorporation of new technologies, and policies supporting VE, as well as examples of best practices to increase the likelihood of successful VE implementation.

6. RECOMMENDATIONS

Based on the finding from this study, the recommendations below have been crafted with the express purpose of resolving the problem's yet to be rectified, and will help improve future result:

- Implement and deliver educational programs and workshops designed to promote understanding and use of VE by clients and stakeholders.
- Integrate virtual reality into the educational curriculum of higher education institutions in order to provide future professionals with the necessary.
- Advocate for laws and regulations to promote the use of VE.
- Assist governmental agencies in developing policies to promote utilization of VE.
- Work with the government to promote the long-term benefits of VE such as cost savings and improved project outcomes.
- Encourage government to provide incentives and support for VE.
- Encourage open communication and collaboration among all stakeholders so that project objectives are accomplished.
- Create guidelines and training to help stakeholders select appropriate VE methods.
- Provide examples of the ROI of VE through case studies and success stories.
- Demonstrate the long-term financial and value added benefits VE can provide to projects.

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