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VALUE ENGINEERING IMPLEMENTATION IN CONSTRUCTION PROJECTS IN MOROCCO: AWARENESS, BENEFITS AND CHALLENGES

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ABSTRACT

Value engineering is a systematic and structured approach that aims to optimize the value of a project by analyzing its components and functions. This article intends to explore the current level of awareness of value engineering, the benefits that can be derived, and the major challenges of successful implementation in construction projects in Morocco. The study was conducted based on a quantitative approach using a structured survey among construction professionals in Morocco. Interviews were carried out with academics, representatives of project owners, technical design offices, and work execution companies, and responses to the questionnaire were collected from various stakeholders in the field of construction in Morocco. The results show that value engineering is still in its infancy in the Moroccan construction sector since 65 percent of respondents are not familiar with the concept of value engineering and only 8% of respondents have implemented value engineering with its recognized standards. The findings have also confirmed the benefits of implementing value engineering in construction projects in Morocco, especially significant potential savings, both initial and Life-Cycle Costs, the reduction of completion times, and early uncovering of potential design deficiencies or alternative approaches. The major challenges emphasized in this study are the understanding and support of top management, the resistance of designers, and the adaptation of the contracts of the stakeholders. This is the first scientific article addressing the value engineering process and its adoption in the construction sector in Morocco. Thus, it could be considered as a first step towards comprehension and vulgarization of value engineering concepts and techniques among construction professionals in Morocco. This study presents for the first time the level of awareness of value engineering in the construction sector in Morocco, demystifies the process as a whole, emphasizes the potential benefits derived from it, and clarifies the major challenges to a successful implementation.

Keywords: value engineering, construction, morocco, awareness, benefits, challenges, survey.

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1. INTRODUCTION

The construction sector plays a crucial role in the economies of countries, producing buildings, infrastructure, and industrial facilities until the end of their service life. In 2022, expenditure on the construction industry exceeded $11 trillion a year, which was equivalent to about 13 percent of global gross domestic product (GDP).

The construction sector in Morocco contributes significantly to the development of the national economy and the reduction of the unemployment rate. It represents more than 6 percent of the national GDP.

Very significant budgetary envelopes have been allocated to substantial construction programs in Morocco, in particular: $11.7 billion for the Al Haouz earthquake reconstruction program over the next five years and $5.6 billion as investment in renewable energy over the next four years. In addition, an envelope of around 2 billion dollars was estimated for the construction and renovation of stadiums in Morocco, 1 billion dollars for training centers with hotels and playing sites, and 2 billion dollars for transport and infrastructure, as part of the organization of the 2025 African Cup and the 2030 World Cup. Furthermore, given the effects of drought and climate change in recent years, an allocation of $14 billion for the National Drinking Water Supply and Irrigation Program (PNAEPI 2020-2027) will be released.

Value engineering has been used in the United States of America for over 70 years. During this time, it has proven to be a valuable tool for improving value and reducing life cycle costs for a multitude of construction projects [1].

Based on worldwide experience, the implementation of value engineering can ensure an average saving of about 20-30% of total project costs in developing countries [2].

This study will enable the various stakeholders involved in construction and civil engineering, in particular project owners, technical design offices, and companies, to assess the level of maturity of the implementation of value engineering in the construction sector in Morocco. Furthermore, this research will constitute a basis for the development of future studies relating to value engineering in the construction sector in Morocco.

2. LITERATURE REVIEW

2.1 Definition and Standards of Value Engineering

Value engineering (VE) is a systematic process carried out by a multidisciplinary team and led by a qualified facilitator, to improve the value of a project, a product, a process, or an organization through analysis of functions. Value can be defined as the ratio of function to the resources required to achieve it [3]. It's important to emphasize that in project management, a project's value refers to the value a project creates for the stakeholders and therefore the efficiency, technical effectiveness, and client satisfaction are part of the value created. The function/cost ratio implies that the value of a project can be increased by improving its functionality or reducing its cost (the life cycle cost), both being possible simultaneously and thus generating an even greater increase in value. More specifically in the field of construction, this involves the detailed analysis of the different components of a project. This includes examining materials, construction methods, processes, and designs to identify more cost-effective alternatives. We conclude that value engineering goes well beyond simple cost reduction. It is a method focused on increasing value, through the search for alternatives that improve quality or reduce lead time at the same price or maintain quality while reducing life cycle costs.

The process is generally performed in a workshop environment by a multidisciplinary team representing all key stakeholders and facilitated by an experienced, trained, and/or certified in leading VE teams through defined phases [4]. There are several commonalities in all definitions of value engineering found in literature, including:

- **Life-cycle cost:** The focus is not only on the design and construction costs but also on the costs of the operation and maintenance phase and salvage value or disposal cost.
- **Value optimization:** The focus is on finding alternative solutions for optimizing value for the owner.
- **Structured process:** The team must follow a structured process

The Value Engineering process typically is applied following the job plan consisting of the eight general steps, illustrated below [3].

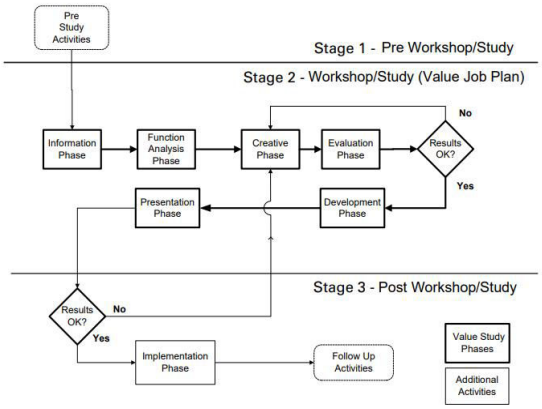


Figure-1. Typical job plan [3].

2.2 History of Value Engineering

Value engineering was first utilized in the manufacturing industry during the Second World War when many manufacturers faced material shortages and were constrained to use substitute materials and designs. Indeed, after finding that many of the substitutes were providing equal or better performance less expensively, General Electric Company launched a process in 1947 to improve product efficiency by developing less costly alternatives. This effort was led by Lawrence D. Miles, an engineer at General Electric [5]. The concept has spread throughout the industry as major economies have been confirmed. This methodology was initially known as value analysis or value control. SAVE which is The Society of American Value Engineers, was established in 1959 as a professional entity dedicated to promoting value engineering by ensuring a better understanding of the concepts and methods involved.

Value engineering was initially used by the Department of Defense of the United States of America upon authorization from the command. However, in June 1962, Department of Defense procurement rules were amended to make VE a mandatory process for the Department as well as its subcontractors. In 1988, the Office of Management and Budget (OMB), the organization that oversees the implementation of the vision of the President of the United States through the executive branch, issued Circular A-131 to expand the program into other organizations where appropriate. Currently, the Circular requires all Federal departments and agencies to use VE while notifying OMB of major projects that have achieved net life cycle cost savings through the use of VE.

The VE concept has since been so successful that it is now widely practiced in several countries around the world [5].

2.3 Factors Considered During Value Engineering

In practice, increasing the value of a construction project is searched by verifying some factors and trying to answer several related questions [6]. The factors to be considered are:

Cost: The aim is to find a less costly alternative that performs the same function. For example, a type of coating that meets the specifications of strength, design, and durability but costs 10% less than the marble initially suggested can be an effective alternative.

Function: Is there another item that accomplishes the same result or better without increasing the life cycle cost? A window with a thermal break that costs 10% more but assures thermal insulation, reducing energy costs during building operation by 20% and providing more comfort for users.

Longevity and lifespan: The question is how long does the retained technical solution last. For example, fixtures that cost 5% more than the ones recommended by the design team but offer greater resistance to corrosion in the coastal area allow the reduction of the life cycle cost by reducing the cost of major repair and replacement.

Lead time: How long will procurement take? Flooring that costs more than the basic solution but can be procured immediately reducing the schedule by three months.

2.4 A Glimpse of the Implementation Status of Value Engineering Worldwide

Value engineering has been widely practiced in different construction projects in developed countries, like the US and UK [7]. There are plenty of institutes in developed and emerging countries that promote value engineering. Among them, we can cite: The Institute of Value Management in the UK, which develops and promotes the professional practice of managing sustainable value by BS EN12973:2020 Value management standard, the Australian Institute of Value Management which supports the Value Management standard, AS4183-2007, the Indian Value Engineering Society and Value Analysis Canada which promote the dissemination of Value Engineering knowledge. In Singapore, VE implementation is related to the project size independently of the project nature and type [8].

VE is not as established in the construction sector of developing countries. Some emergent countries have established requirements for the mandatory inclusion of VE in their construction projects. In Malaysia, it's mandatory to implement a Value Engineering study for all types of public projects costing more than approximately $11.5 million. Indonesia requires a Value Engineering Workshop for projects with a total construction area above 12,000 m2 or eight floors (Regulation No. 45/2007 of the Ministry of Public Works) [1]. It is only in the last two decades that some African countries have started to realize and adopt this innovative approach. This situation can be explained by the lack of awareness of the existence and the wide application of VE [9]. However, VE has not yet been fully implemented in the construction industries in South Africa Nigeria, Ghana, or Sri Lanka [1]. Value Management implementation in Egypt in the construction sector is still at a very low level [10].

As for articles published on the subject of value engineering, Figure-2 shows the distribution of VE research between 2007 and 2021 by country/region in which the study was situated. Over this period, India led with 12 articles followed by Malaysia with seven, while Egypt, Hong Kong, and Indonesia had five. This distribution confirms an awareness of the importance of VE in emerging countries across Asia and the Middle East as well as countries where VE is already established and required for some projects [1].

The delay recorded in African countries could be explained by the late introduction of VE in the continent resulting in weak research in this field [11].

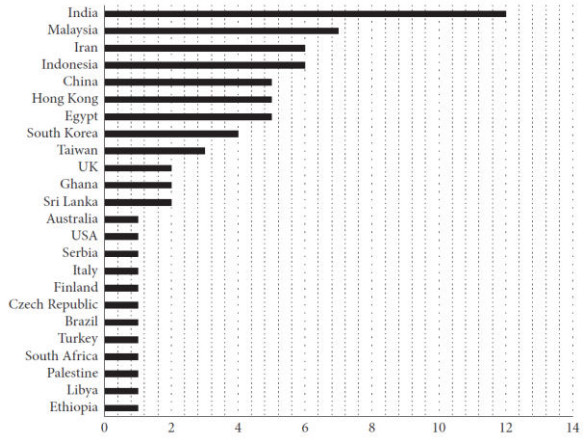


Figure-2. Number of publications by country [1].

2.5 Value Engineering Benefits

Value Engineering (VE) is not a peer review of the design nor a classical cost-cutting exercise. VE is a creative and organized effort, which aims to achieve the necessary functions at the lowest resources including especially capital expenditure, time, staffing, and maintenance over the life cycle of the project [12]. VE can be applied to any phase of a project, even during work. However, generally, the earlier it is applied, the higher the return on this engineering investment, which is illustrated in Figure-3. The benefits of value engineering in the three stages of a project are explained below.

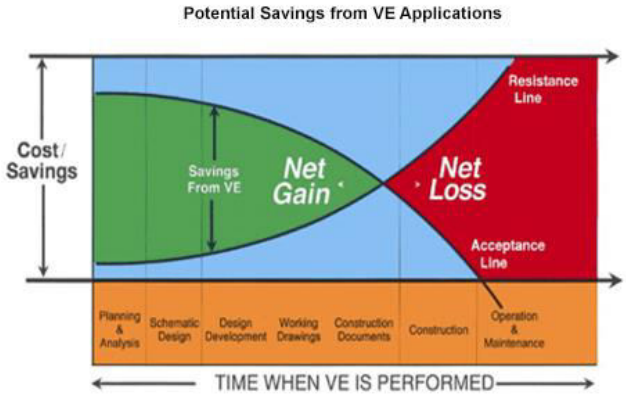


Figure-3. Potential savings from VE applications [12].

Programming phase

The technical and functional program of the asset includes in particular the functional diagrams, the functional requirements, and the technical recommendations and requirements. In the Programming phase, there are plenty of benefits to be derived from a Value Engineering Workshop. An independent team can review the program and offer effective alternative solutions given the owner/user's definition of value, thus making it possible to challenge the budget defined during this phase.

Design phase

This is the stage that most VE participants are used to becoming involved in when the design has at least reached the stage of schematic design or detailed design. The number of hours of the VE workshop can be defined and customized considering the size of the project. The workshop of value engineering session with the presence of stakeholders, especially the client and the design team, will allow the implementation of the best value for the project. It's worth noting that the definition of what is good value will vary from client to client and project to project. The benefits are enormous:

- The project will be developed with a minimum of changes and redoing of design studies. Additionally, a better understanding by all parties of the final function will be ensured.
- An independent team will be able to provide a new outside perspective on alternative solutions from other similar projects.

Construction phase

Value engineering can also be applied during the construction phase because new constraints can appear and new ideas issued from stakeholders' experiences can generate substantial savings or solve issues related to project values. When a value engineering change proposal is agreed upon, the savings can be shared between the contractor and the client. The change may reduce the cost of construction or the life cycle cost of the building, but must not reduce building performance, design quality, and safety. For example, a value engineering study could be conducted in the construction phase due to a constraint of the reduction of the delay imposed by the client. Therefore, a VE study can lead to the substitution of a building material. It is important to remember that a value engineering exercise, properly applied, focuses on life-cycle costs, not initial construction costs alone. This is how a value engineering study can recommend solutions that would increase construction costs, but reduce the life cycle cost of the project. The value engineering effort can constitute a valuable tool to optimize important inputs such as life cycle cost analysis, energy conservation, and environmental and technical risk studies [13]. Potential benefits of Value Engineering can be summarized in:

- Greater understanding by all the stakeholders of scope and functions
- Significant potential savings, both initial and Life-Cycle Cost
- Reduction of completion times
- Early uncovering of potential design deficiencies or alternative approaches
- Improvement in sustainability, quality, safety, and energy consumption
- Generating substantial savings even in the construction phase.

2.6 Challenges of Value Engineering Implementation

Challenges in implementing VE include a lack of knowledge and awareness, a lack of qualified personnel to guide the VE process as well as lack of willingness to implement VE by standards [9]. The effectiveness of a value engineering program can be hindered by designers and program managers. Indeed, designers may manifest resistance as they will be exposed to a type of design review. Also, a value engineering program can suffer from the lack of top and middle management understanding and support [13]. The presence of strong leadership and an experienced value engineering team is important to ensure the adequate progress of the VE process taking into account possible resistance from the design team. For designers, it may be a question of the following:

- The client verifies their professional abilities and expertise;
- Expertise in engineering fields and original technical solutions can be exposed to competitors;
- It would be a waste of time to respond to trivial or poorly thought-out suggestions;
- The review and possible resumption of studies will cause a delay in the project.

Stakeholders involved in the value engineering exercise should understand that this additional effort is a way to bring innovative approaches and a method to improve the design results. Implementation challenges can be summarized into:

- Designers will be exposed to a type of design review that may be subject to resistance
- A value engineering program can suffer from a lack of top and middle management understanding and support
- Allocation of necessary resources and support of staff mobilization costs
- Getting value engineering studies performed properly
- Value engineering workshops require skilled facilitators who can guide the process and help the team identify cost-saving opportunities
- Getting study recommendations accepted and duly implemented.

3. RESEARCH METHODOLOGY

This research is conducted based on a questionnaire survey approach to outline an overview of the current level of awareness of value engineering

concepts and practices in the Moroccan construction sector, the main benefits of its implementation, and the major challenges impeding the successful application of value engineering in Morocco. The literature review was very helpful in developing the survey questionnaire used in this study [14]. Similar approaches were carried out in previous studies to evaluate the level of awareness and application of value engineering practices, in particular those conducted in South Africa and Egypt [15]. The research process followed in this study is illustrated in Figure-4.

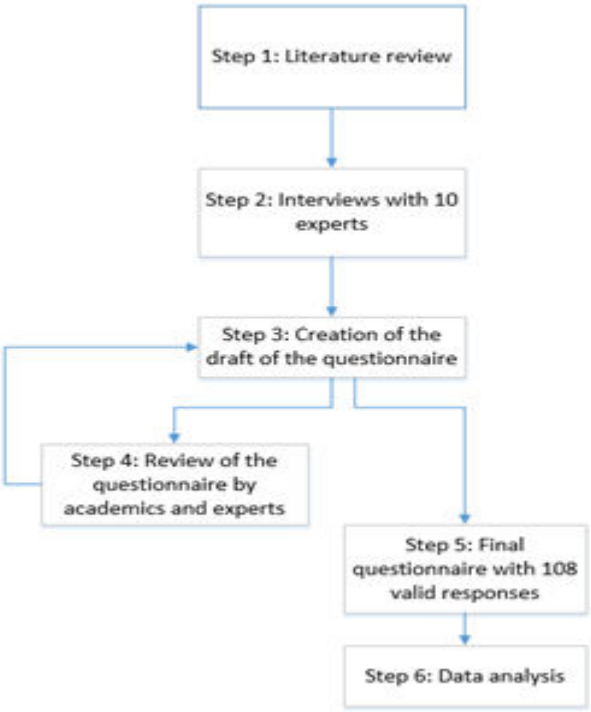


Figure-4. Research flowchart.

In parallel with the literature review, semi-structured interviews with ten experts were carried out to discuss the value engineering process and the state of its implementation in the expert's organization if applicable. Interviewees include three senior project managers, three academics, and four directors from the building and civil engineering sector with over 25 years of professional experience. Based on the above elements, a draft of the questionnaire was created. Following this step, a review of the said questionnaire was carried out several times taking into account the recommended improvements and the advice provided by the academics and construction experts consulted. The aim is to ensure the pertinence of the questionnaire and to confirm the suitability of the retained factors in the Moroccan context. It has been suggested to distribute the questionnaire in the French language to attain a large number of respondents. In addition, it was recommended to add a presentation note of value engineering summarizing the definition of value engineering, the aim and objective of its adoption in the construction field, the typical steps followed in the job plan, and the potential benefits of its implementation. These suggestions have been implemented. The questionnaire updated includes five main parts:

The first part collects general information about the respondent, especially the number of years of experience, the sector (public or private), the type of organization of the respondent: Contracting authority/delegated project owner, assistant to the project owner/OPC (Scheduling, Steering, Coordination), architect, technical studies office, technical control office, laboratory, topographic surveyor engineer or work execution company, the major domain of intervention (buildings, infrastructure, and public works or industrial) and its position of intervention (director, program manager, project manager, construction manager, architect, specialized engineer, project control cost or planning, quantity surveying services).

The second part attempts to get an idea about the degree of awareness of value engineering concepts and practices in the Moroccan construction sector. The respondents were invited to choose one of the three options: “not familiar with”, “familiar with but not currently implemented” or “familiar with and implemented” for the following items most of which are mentioned in & “2.1 Definition and standards of Value engineering”:

- Value Engineering concept
- Life-cycle cost:
- Value Engineering Job Plan
- Value Engineering Workshops
- Function Analysis System Technique (FAST diagram)
- Creativity Phase/Alternatives
- Value Engineering Change Proposal (VECP)

Function analysis - A detailed examination of a project, process, product, service, or organization to identify, classify, and organize its functions; allocate performance and resources; and prioritize functions for value improvement.

The FAST diagram is a graphical representation showing the logical relationships between the functions of a project, product, or process based on the questions “How” and “Why”. The FAST diagram can be considered a powerful, structured tool used to identify and analyze functions with intuitive logic to stimulate creative and innovative thinking.

In the third part, the focus was on the evaluation of the benefits of value engineering implementation in the Moroccan construction sector by adopting a three-point Likert scale (1 = Low, 2 = Average, 3 = High).

Mean scores of responses were used to evaluate the five benefits retained for this survey, namely:

- Greater understanding by all the stakeholders of scope and functions
- Significant potential savings, both initial and Life-Cycle Cost
- Reduction of completion times

- Early uncovering of potential design deficiencies or alternative approaches
- Generating substantial savings even in the construction phase

The fourth part tries to respond to the question about the main barriers impeding successful value engineering implementation in Moroccan construction projects. The six challenges selected for this study taking into account the parts developed previously are:

- Designers will be exposed to a design review which can arouse resistance
- Lack of understanding and support from top management
- Getting top management to allocate the necessary resources
- Carrying out value engineering studies in a structured manner according to the current standards
- Value engineering workshops require skilled facilitators who can guide the process and help the team identify cost-saving opportunities
- The adaptation of the contracts of the stakeholders concerned, in particular architectural and technical project management, taking into account the adoption of value engineering processes and the implementation of the resulting recommendations.

In the last part, survey participants are asked if they would be interested in adopting value engineering in their projects with a choice between three options: yes for medium and large projects, yes for any type of project, or no.

To target construction professionals from different horizons in Morocco, a simple random sampling approach was adopted. In a simple random sampling technique, the researcher selects a random subset of people from a larger population. The method is commonly used in statistics to obtain a representative sample of the targeted population.

We have targeted representative samples of potential respondents, especially:

- Contracting authorities (public and private project owners or delegated project owners) specialized either in building or infrastructure or industrial or covering several sectors of the construction industry. We can enumerate the Ministry of Equipment and Water through the directorate of technical affairs and relations with the profession, ANEP (National Public Facilities Agency) which is an agency under the supervision of the Ministry of Equipment and Water, Al Omrane SA operator of the Ministry of National Territorial Planning, Urban Planning, Housing and Urban Policy, CGI (general real estate company), OCP SA, JESA (OCP and Worley joint venture), ADM (National Highway Company of Morocco), ONDA (National Airports Authority), ONCF (Railways National Office), AREP (Regional Project Implementation Agencies), ONEE (National Office of Electricity and Drinking Water), TMSA (Tanger Med Special Agency), SMIT (Moroccan Society of Tourist Engineering)
- Technical studies offices through FMCI (Moroccan Federation of Consulting and Engineering), which includes renowned design offices such as NOVEC, CID, JESA, Omnium Technologique, TechniProjet, TME, etc.
- Work execution companies through FNBTP (Moroccan Federation of Buildings and Civil Engineering), which includes renowned companies such as SGTM, TGCC, BYMARO, SOMAGEC, Sogea Maroc, Jet Contractors, etc.

The dissemination of the questionnaire was ensured by sending emails and WhatsApp messages containing the link to Google Forms and the presentation note of value engineering. The survey data were collected using Google Forms. The questionnaire survey began in March 2024 and was closed towards the end of April 2024. In total, 108 completed questionnaires were collected. As responses were collected and analyzed, a general trend began to emerge. It can be emphasized that the saturation aspect (sufficient data to draw the necessary conclusions) has been achieved.

This study reached a panoply of sectors, organizations, focus areas, and practitioners with different levels of experience and roles in the organization as shown in Figures 5 and 6.

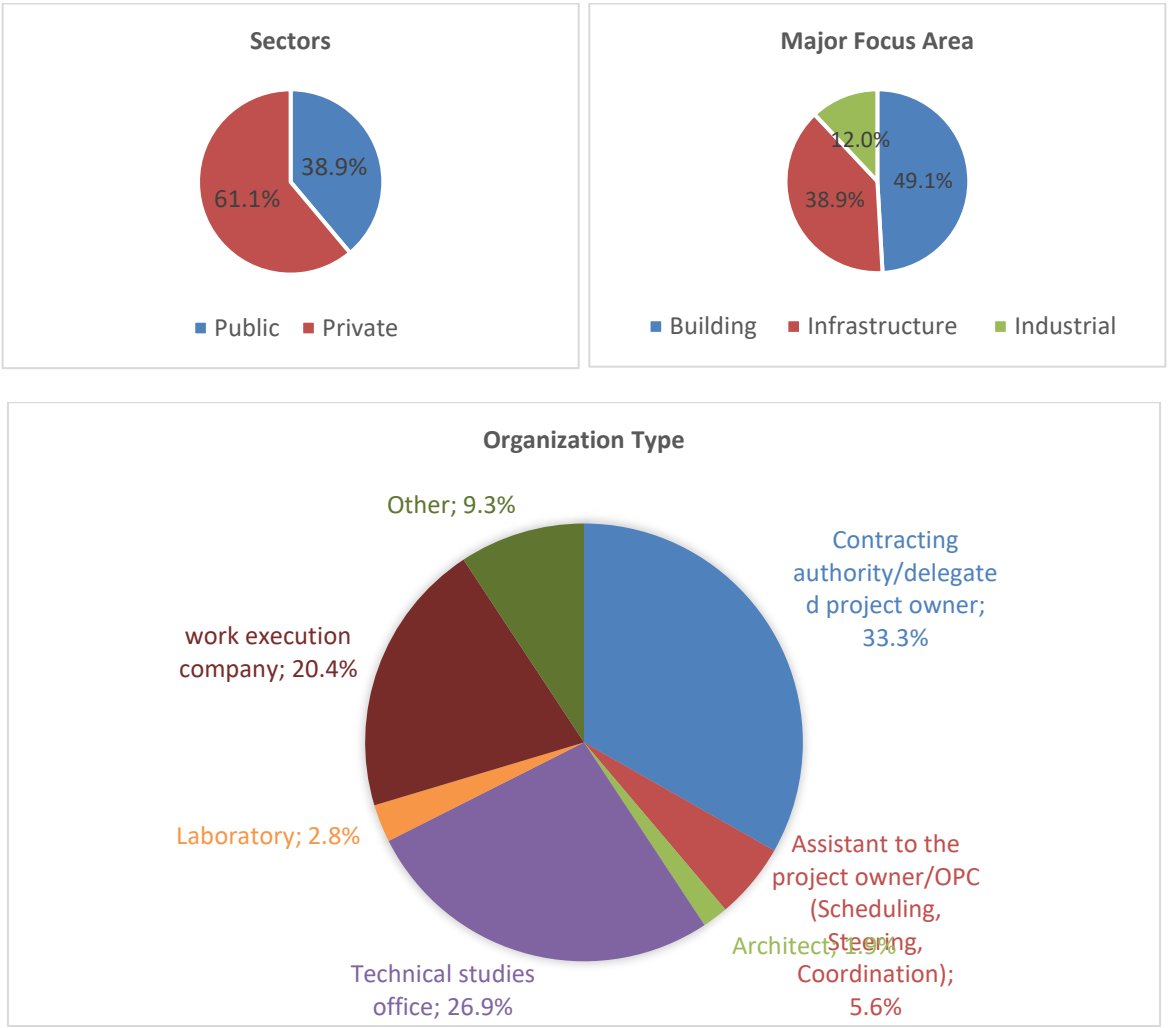
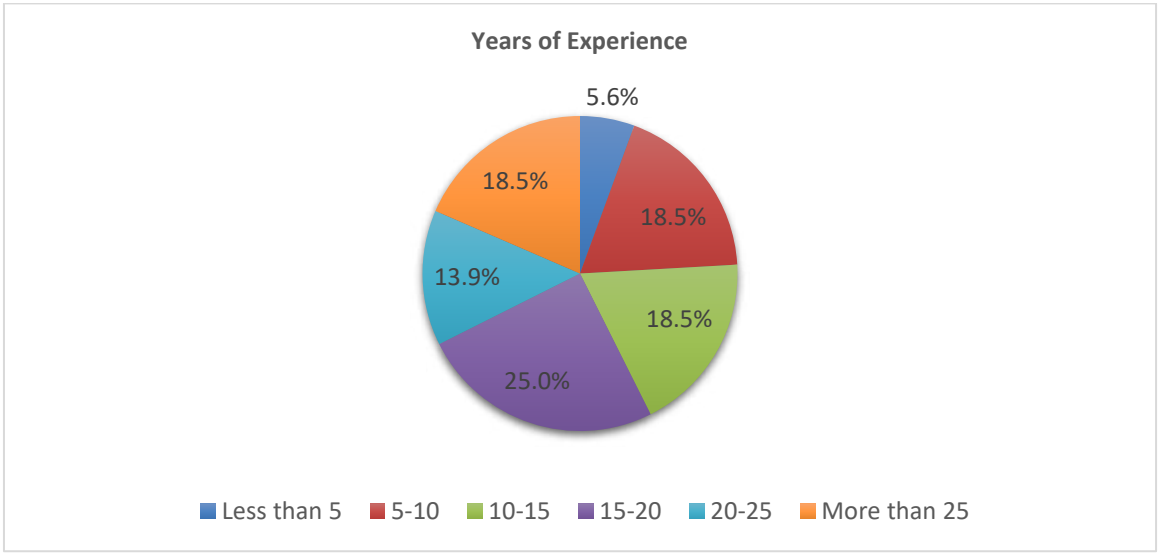


Figure-5. Distribution of the sample of respondents (organizations cluster).



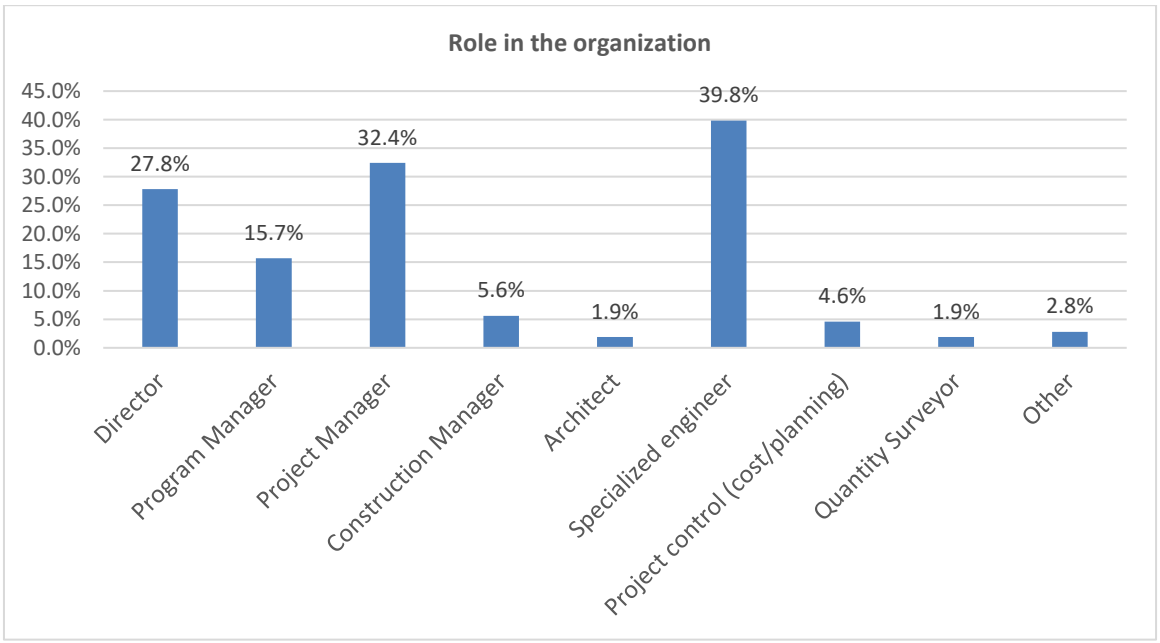


Figure-6. Distribution of the sample of respondents (individual cluster).

Figure-5 shows that 61 percent of responses represent the private sector and 39 percent represent the public sector; 49 percent of respondents are involved in the building field, 39 percent in infrastructure and civil engineering area while 12 percent are involved in the industrial sector; 33 percent belong to contracting authorities (project owners or delegated project owners), 27 percent belong to technical studies offices while 21 percent belong to work execution companies. It is noted from figure 6 that 28 percent occupy the position of director, 32 percent occupy the position of project manager and 40 percent are specialized engineers. In addition, the majority of participants have senior profiles (94 percent have more than five years of experience and 76 percent have more than ten years' experience). The mean item score allowed the evaluation of the benefits retained in the final questionnaire.

4. RESULTS AND DISCUSSIONS

4.1 The Level of Awareness of Value Engineering Concepts and Practices

The analysis of the responses related to value engineering awareness in the construction sector in Morocco reveals the following: 65 percent of the respondents are not familiar with the value engineering concept, 24 percent are familiar with the VE concept but have not yet implemented it in their projects and 11 percent are familiar with VE concept and have used it at least in a project. Seen from another angle, the results of this survey show that 35% of respondents are familiar with the general concept of value engineering (24% are familiar but not currently implemented and 11% are familiar and implemented). This can be explained in particular by the senior profile of the respondents (76% have more than ten

years of experience) and taking into account the large companies consulted which have already recognized the importance of value engineering in the field of construction and which have already implemented it, even if only partially or in an unstructured way.

However, Figure-7 shows also that some of the fundamental notions and aspects related to VE are still unknown by a large population of professionals in the construction sector. 70 percent are not familiar with the VE job plan, 76 percent are not familiar with VE workshops and 74 percent are not familiar with the VE creativity phase. It's also important to emphasize that this study revealed that only 8% have implemented value engineering with its recognized standards, in particular the job plan, workshops, and the creativity phase.

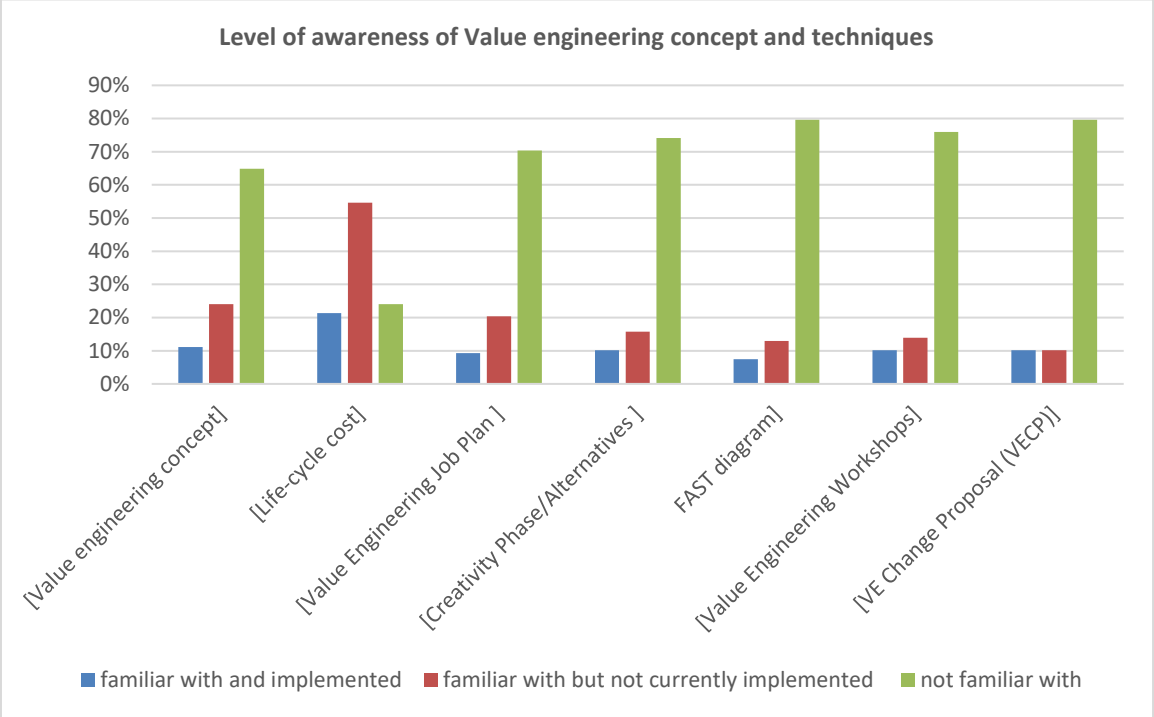


Figure-7. The current level of awareness of Value engineering among Moroccan construction professionals.

These findings show that although Value Engineering is still in its infancy in the Moroccan Construction industry, 35 % of respondents are familiar with the general concept of value engineering and 8 % have implemented value engineering with its recognized standards. These findings reveal a noteworthy awareness level of value engineering among Moroccan professionals in the construction sector.

4.2 Benefits of VE Implementation in the Construction Sector in Morocco

Figure-8 shows that Significant potential savings, both initial and Life-Cycle Cost ranked as the first benefit of adopting the value engineering approach (mean = 2.56). The second benefit is the Early uncovering of potential design deficiencies or alternative approaches (mean = 2.42) followed by Generating substantial savings even in the construction phase (mean = 2.34) and Greater understanding by all the stakeholders of scope and functions (mean = 2.31). The reduction in completion times was ranked as the fifth benefit (mean 2.24). Generally, all of the benefits mentioned were confirmed by survey participants (with an overall mean value of 2.37). These results indicated that Moroccan construction professionals recognize the benefits and the importance of value engineering implementation.

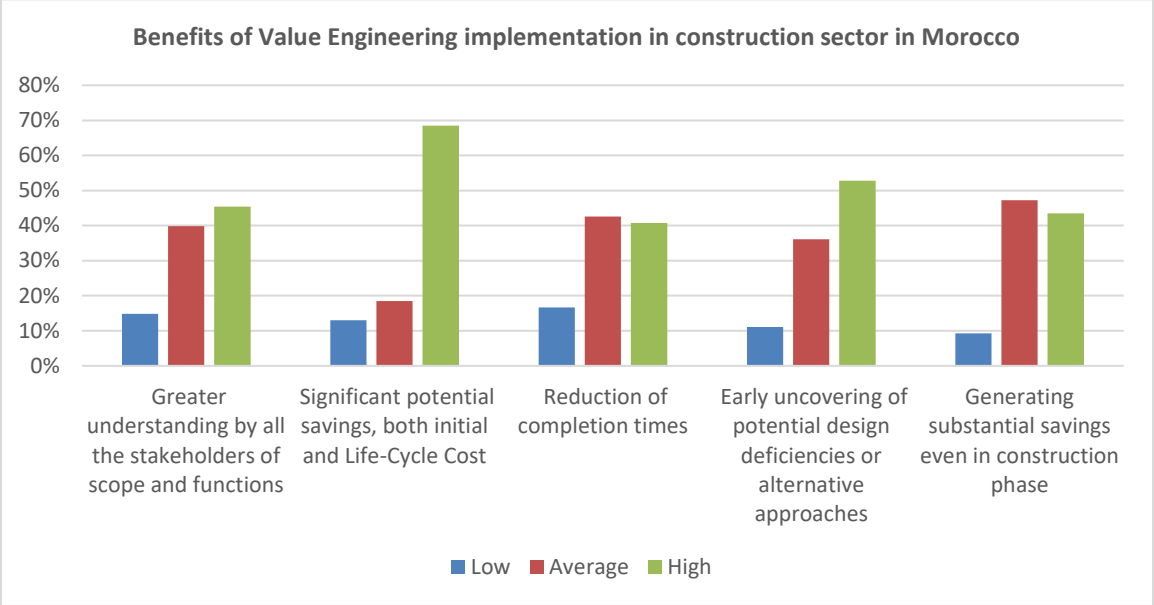


Figure-8. The current evaluation of benefits of VE implementation in the construction sector in Morocco.

The ranking of Value engineering benefits is illustrated in Table-1.

Table-1. Ranking of Value engineering benefits according to the survey.

Item	1 (Low)	2 (Average)	3 (High)	Mean	Standard Deviation	Ranking
Significant potential savings, both initial and Life-Cycle Cost	13%	19%	69%	2,56	0,71	1
Early uncovering of potential design deficiencies or alternative approaches.	11%	36%	53%	2,42	0,69	2
Generating substantial savings even in the construction phase	9%	47%	44%	2,34	0,64	3
Greater understanding by all the stakeholders of the scope and functions	15%	40%	45%	2,31	0,72	4
Reduction of completion times	17%	43%	41%	2,24	0,72	5

The fact that "Reduction of completion times" was the lowest ranked can be explained by a misunderstanding of the whole meaning of the term value. Indeed, as mentioned earlier, a project's value is defined by the value a project creates for its stakeholders. So, significant time savings increase value to the owner which can be reached by reducing the lead times of construction project components and thus respecting or reducing the completion times.

4.3 Major Challenges of Implementing Value Engineering Practices in the Moroccan Construction Sector

The analysis of the responses received regarding the major challenges of implementing value engineering in the construction sector in Morocco is summarized in Figure 9 which shows that five barriers are recorded with more than 50 percent, namely:

- Designers will be exposed to a design review which may be subject to resistance (75.9 percent)
- The adaptation of the contracts of the stakeholders concerned, in particular, architectural and technical project management (69.4 percent)
- A value engineering program can suffer from a lack of top and middle management understanding and support (59.7 percent)
- Getting top management to allocate the necessary resources (54.6 percent)
- Value engineering workshops require skilled facilitators who can guide the process and help the team identify cost-saving opportunities (54.6 percent)

Finally, "Carrying out value engineering studies in a structured manner according to the current standards" was ranked with the lowest response frequency, 35.2 percent. This can be explained by a certain lack of knowledge of the value engineering process, which was highlighted in the section degree of awareness of value engineering practices.

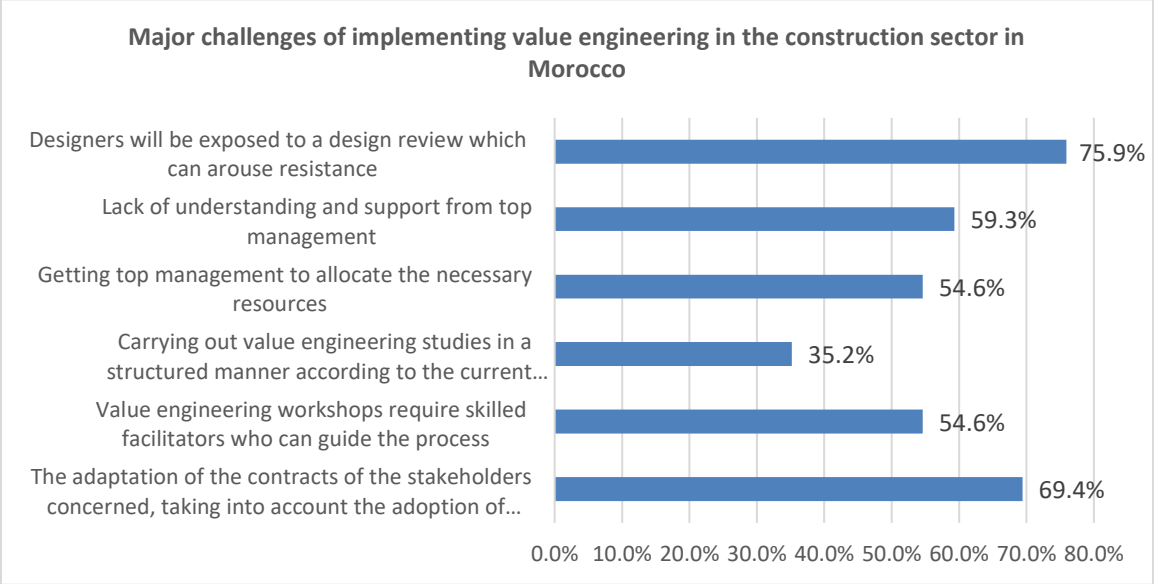


Figure-9. Major challenges of implementing value engineering in the construction sector in Morocco.

It follows that the challenges retained in this study have been globally confirmed as the main barriers to the implementation process of value engineering with some differences in appreciation among respondents.

4.4 Interest Expressed for the Adoption of Value Engineering in Construction Projects in Morocco

The results received regarding the point of view of the adoption of value engineering in projects are shown in Figure-10. Thus, 69 percent of the respondents are favorable to the implementation of value engineering in medium and big projects and 29 percent recommend the implementation of value engineering for all types of construction projects while 2 percent only are not interested in implementing value engineering in their projects.

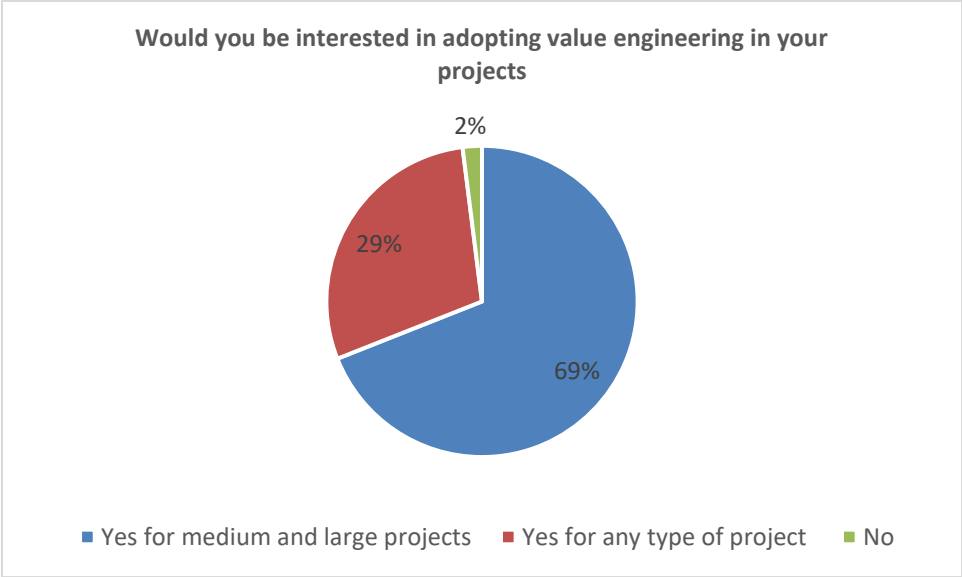


Figure-10. The opinion expressed regarding the adoption of Value engineering in construction projects in Morocco.

5. CONCLUSIONS

This study was conducted to assess the level of awareness, the benefits that can be derived from value engineering, and the major challenges impeding a successful implementation of construction projects in Morocco through a structured questionnaire survey among construction professionals.

This is the first study carried out on the implementation of value engineering in the construction sector in Morocco. Thus, it could be considered as a first step towards a strong understanding and application of

value engineering concepts and techniques among construction professionals in Morocco.

It has been shown that the practice of Value Engineering by current standards is still in its infancy in the Moroccan Construction industry. It has also been found that several techniques require further awareness and training for a successful implementation, especially Value engineering job plans, Value engineering workshops, and FAST diagrams.

It was also demonstrated that the Moroccan construction professionals recognize the importance of value engineering in achieving great benefits for projects especially significant potential savings, both initial and Life-Cycle Costs, early uncovering of potential design deficiencies or alternative approaches, greater understanding by all the stakeholders of project scope and functions and reduction of completion times.

We can conclude from the challenges confirmed in this study that some success factors should be considered to successfully implement value engineering in construction projects in Morocco, namely:

- **Management support:** Top management support is essential to ensure that value engineering is integrated into the project planning and procurement processes.
- **Collaboration:** Successful value engineering requires collaboration between all stakeholders, including the owner, designers, contractors, and suppliers.
- **Training:** Training programs should be provided to increase awareness and understanding of value engineering principles among construction professionals in Morocco.
- **Experienced facilitators:** Value engineering workshops require skilled facilitators who can guide the process and help the team identify cost-saving and value-improvement opportunities.

In conclusion, while value engineering has the potential to bring significant benefits to construction projects in Morocco, its implementation is still in its early stages. Construction professionals in Morocco need to be trained on the principles of value engineering, and management support is necessary to ensure its integration into project planning and procurement processes. Effective collaboration and skilled facilitators can help to overcome resistance to change, time constraints, and data availability issues that may arise during the implementation process. Furthermore, recent challenges in sourcing materials promptly have made value engineering more necessary than ever. The rise of artificial intelligence could be a valuable tool to create opportunities to quickly and thoroughly research all possible alternatives to an item, taking into account price, technical specifications, delivery times, and sustainability.

Case studies of application for value engineering in different construction projects should be carried out and highlighted to consolidate a roadmap for value engineering implementation in the Moroccan construction industry. Further research should be performed to develop how value engineering and project management can be used together to optimize the value of a project, especially by managing the risks associated with implementing value engineering recommendations to ensure that the project is achieved safely and without any negative impact on quality or performance.

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