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Value Engineering Practices in Indonesia: A Systematic Literature Review

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Abstract

This study systematically reviews the development and implementation of value engineering (VE) practices in Indonesia to identify research trends, methodological approaches, and key thematic areas. Using the PRISMA framework, 18 relevant studies were retrieved from the Scopus and Google Scholar databases. The findings reveal that VE research in Indonesia remains fragmented, with limited integration between academic studies and industry applications. Most publications focus on construction and infrastructure sectors, emphasizing cost optimization rather than holistic value creation. Methodologically, case studies dominate, while quantitative and decision-support approaches are underrepresented. The review highlights challenges such as the lack of standardized procedures, institutional support, and awareness of VE benefits among practitioners. Strengthening interdisciplinary collaboration, policy support, and methodological diversity is essential to advance VE implementation and research impact in Indonesia.

Keywords: *construction management; literature review; PRISMA; value engineering.*

Introduction

Value engineering (VE) is a systematic methodology aimed at improving the value of a project or product by optimizing the relationship between its function, quality, and cost (SAVE International, 2015). Initially developed by General Electric in the 1940s as a response to raw material shortages, VE evolved into a globally recognized value management practice (Dell'Isola, 1982; Kelly & Male, 1993). Over time, it has been institutionalized in many developed countries, particularly in the construction sector, where governments mandate its implementation for major infrastructure projects. For example, the U.S. Federal Highway Administration requires VE studies for large-scale highway developments, underscoring its importance in public infrastructure management.

Extensive global research demonstrates the versatility and benefits of VE. It has been shown to prevent design defects in buildings (Lee, 2018), improve cost efficiency in highway projects (Lee et al., 2010), and foster innovation through integration with building information modeling (BIM) (Park et al., 2017). Beyond construction, VE principles have been successfully applied in automotive manufacturing (Ibusuki & Kaminski, 2007), information technology project management (Tohidi, 2011), energy systems (Shu et al., 2010), and sustainable manufacturing (Sreenivasan et al., 2010). This broad applicability demonstrates VE's flexibility in promoting cost efficiency, technical performance, and sustainability across diverse industries.

In Indonesia, VE was introduced in the mid-1980s and institutionalized through the establishment of the Indonesian Value Engineering Association (HAVEI), affiliated with SAVE International (Sesmiwati et al., 2016; Yanita & Mochtar, 2021). Despite this institutional foundation, VE application remains limited and often incidental. Prior studies identify persistent challenges such as the absence of mandatory regulations, low stakeholder awareness, and the limited number of certified experts (Sesmiwati et al., 2016; Yanita & Mochtar, 2021). Yet, international evidence confirms that systematic VE implementation can reduce project costs by 10–30% (Dell'Isola, 1982), indicating significant untapped potential within Indonesia's project management practices.

Several Indonesian studies report promising outcomes. For instance, applying VE in the Juanda jet fuel pipeline project reduced costs by nearly 40% (Kustamar et al., 2019), integrating VE with M-PERT improved schedule accuracy in toll road projects (Husin et al., 2021), and VE-driven façade

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design in a green hotel with photovoltaic panels reduced electricity consumption by almost 50% (Husin et al., 2021). Beyond construction, VE has also been used in food product development, such as powdered soy milk (Husin et al., 2021) and processed chocolate (Budiyanto & Sari, 2024).

However, research on VE in Indonesia remains fragmented and largely case-based. Most publications focus on single projects—such as toll roads (Berawi et al., 2020), jet fuel pipelines (Saroji et al., 2020), or green buildings (Husin et al., 2021)—with limited analytical depth or generalization. These studies demonstrate VE's technical and financial benefits but rarely build toward a cohesive theoretical or conceptual framework. Consequently, the cumulative contribution of VE research in Indonesia remains underdeveloped, with findings scattered across isolated case studies.

Furthermore, few efforts have been made to integrate these findings into a broader trend analysis or conceptual synthesis. For example, studies in transit-oriented development (Berawi et al., 2020; Saroji et al., 2020) highlight VE's social benefits, such as increased public transport ridership, while research in food manufacturing (Budiyanto & Sari, 2024; Sayekti et al., 2021) emphasizes enhanced consumer satisfaction. Yet, the absence of a systematic review linking these diverse applications prevents a comprehensive understanding of VE's overall contribution in Indonesia at the macro level.

Another limitation is the uneven sectoral distribution of research. Most studies remain concentrated in construction and infrastructure, while emerging sectors—such as renewable energy, healthcare, and digital technology—are largely unexplored. This contrasts with international trends where VE has demonstrated clear value in optimizing energy systems (Shu et al., 2010) and IT project management (Tohidi, 2011). Without a comprehensive synthesis, Indonesian stakeholders are unable to fully recognize the cross-sectoral potential of VE as a tool for sustainable and cost-efficient innovation.

This condition underscores the urgency of conducting a systematic literature review (SLR) to consolidate fragmented research on VE in Indonesia. Therefore, this study adopts the SLR approach guided by the PRISMA framework to systematically identify, evaluate, and synthesize existing scholarly works. Through this approach, dispersed findings can be mapped, compared, and integrated to provide a comprehensive understanding of the development, challenges, and opportunities of VE implementation in Indonesia. The synthesized results are expected to inform policy formulation, implementation strategies, and future research agendas aimed at strengthening VE practices nationwide. Accordingly, this study seeks to address the following research questions:

1. To what extent has research on VE been conducted in Indonesia?
2. In which sectors has VE been applied, and what methodologies are predominantly used?
3. What are the key benefits, challenges, and opportunities for the development of VE in Indonesia as reported in the existing literature?

Methods

This study follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure a transparent, systematic, and replicable selection process (Page et al., 2021). The PRISMA approach is widely recognized for enhancing methodological rigor in systematic reviews by providing a structured procedure for identifying, screening, and including relevant studies. By adopting this framework, as illustrated in Figure 1, the present review ensures methodological consistency and reliability in evaluating research on VE practices in Indonesia.

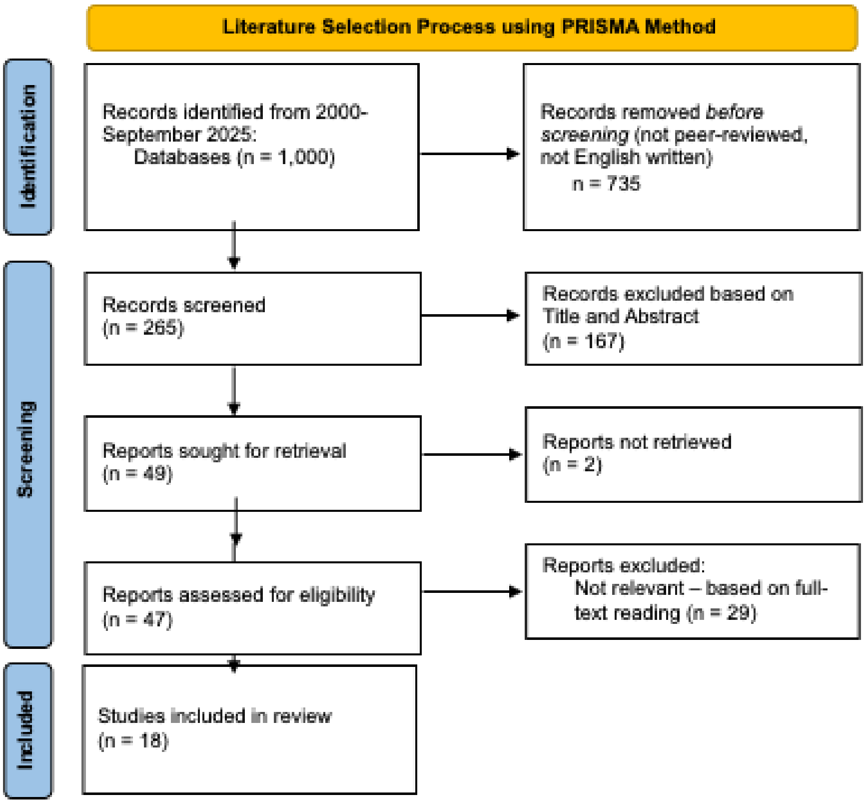

Figure 1. Literature Review Process based on PRISMA Framework

The initial literature search was conducted using the Scopus database, selected for its comprehensive and multidisciplinary coverage of peer-reviewed academic sources. Scopus provides extensive indexing in engineering, management, and social sciences, making it suitable for capturing the diverse applications of VE. Compared with Google Scholar, Scopus applies stricter inclusion criteria that minimize the retrieval of non-scholarly or low-quality materials (Mongeon & Paul-Hus, 2016). Furthermore, relative to the Web of Science (WoS), Scopus offers broader coverage, encompassing major publishers such as Elsevier, Springer, Wiley, Taylor & Francis, and IEEE (Singh et al., 2021). The search query used was: TITLE-ABS-KEY ("value engineering" AND "Indonesia"). This query was designed to capture studies that explicitly investigate VE within the Indonesian context. The search was limited to publications between 2000 and 2025, reflecting the increasing relevance of VE during Indonesia's period of rapid infrastructure expansion and industrial development.

To maintain academic rigor, only peer-reviewed journal articles were included. This ensures that all studies met established standards for methodological validity and reliability. Additional inclusion criteria required that articles:

1. explicitly address VE or value management in Indonesia;
2. are published in English; and
3. present either conceptual, empirical, or case-based analyses relevant to VE implementation.

Conference proceedings, non-peer-reviewed papers, dissertations, and non-English sources were excluded to preserve consistency and scholarly quality.

The database search initially identified 1,000 documents. After removing duplicates and applying the inclusion criteria, 265 records remained for screening. Titles and abstracts were examined to determine thematic relevance, resulting in the exclusion of 167 articles that did not align with the study's focus. The remaining 47 articles underwent full-text assessment to confirm alignment with the research objectives. Following this review, 18 studies met all criteria and were included in the final analysis.

This stepwise process ensured that the review encompassed only those studies that directly contribute to understanding the development, application, and challenges of VE in Indonesia. The PRISMA flow diagram in Figure 1 summarizes the literature identification and selection process.

After the final selection of 18 eligible studies, a data extraction process was conducted to systematically collect relevant information from each article. The analysis aimed to map the scope, trends, methodologies, and thematic focus of VE research in Indonesia.

Results

Trend analysis

This study analyzes the temporal and source distribution of VE research in Indonesia based on the 18 studies selected through the PRISMA framework. The analysis includes the number of publications per year, the distribution of articles by journal source, and the most frequently cited works within the dataset.

Figure 2 illustrates the annual trend of publications related to VE in Indonesia from 2015 to September 2025. The data show that academic attention toward VE remained limited until 2019, with only one or two publications per year. A notable increase occurred between 2020 and 2021, reaching a peak of four publications in 2021. Although there was a temporary decline in 2022, publication activity rebounded in 2023 and 2024, maintaining the same peak level. The sharp drop observed in 2025 reflects the incomplete nature of the publication cycle at the time of data collection. Overall, the trend suggests a growing and cyclical interest in VE research, coinciding with Indonesia's intensified infrastructure programs and the rising awareness of cost-efficiency and sustainability principles in project management.

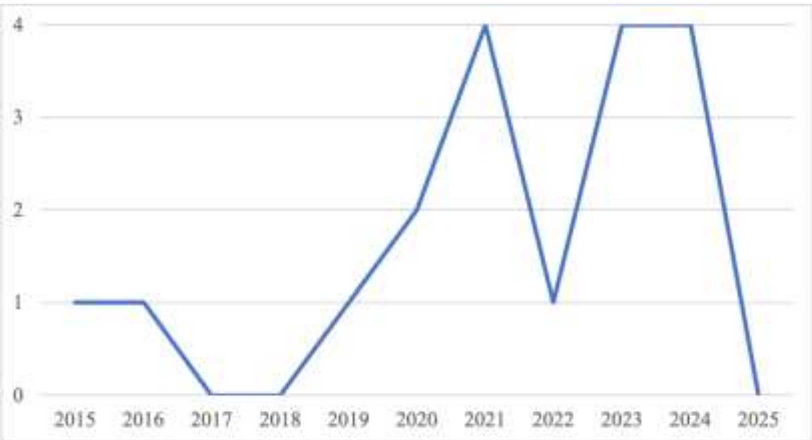

Figure 2 Number of Publications by Year

Number of publications by journals

Building on the trend analysis, the distribution of publications across journals (Figure 3) shows that research on VE in Indonesia is concentrated in a limited number of academic outlets. The *International Journal of Construction Management* (SJR 2024 = 1.015), *Open Civil Engineering Journal* (SJR = 0.273), and *Civil Engineering and Architecture* (SJR = 0.223) each published two articles, representing the highest frequency within the dataset. Other journals contributing to VE scholarship include *Food Research* (SJR = 1.698), *Physics and Chemistry of the Earth* (SJR = 0.857), and *Information* (SJR = 0.648), each publishing one article.

This distribution suggests that the academic discussion on VE in Indonesia remains dominated by construction and civil engineering domains, with limited representation in interdisciplinary or management-oriented journals. While the inclusion of journals such as *Food Research* and *Information* reflects an emerging diversification of VE applications, the overall pattern indicates that VE research in Indonesia is still disciplinary rather than cross-sectoral, highlighting the opportunity to expand VE inquiry into broader industrial and policy contexts.

Figure 3. Number of publications by journal

Citation Analysis

Citation analysis further reinforces this concentration of scholarly influence. Figure 4 presents the five most cited articles on VE in Indonesia. The results reveal that Berawi et al. (2020) play a pivotal role in shaping VE research within the country. Their article published in *Sustainability* received the highest citation count (46), reflecting its substantial contribution to the application of VE for optimizing land use within transit-oriented development (TOD) projects. This is followed by their subsequent publication in the *International Journal of Construction Management* (27 citations), which explores the integration of smart technologies to enhance building energy efficiency. Husin et al. (2015) also demonstrate considerable influence, with 25 citations for their study on demand forecasting for mega bridge infrastructure to improve financial feasibility. Meanwhile, Sutikno et al. (2022) and Yanita & Mochtar (2021) each received 14 citations, contributing to the advancement of knowledge in cost optimization for green MICE projects and the regulatory framework of VE implementation, respectively.

Collectively, these citation patterns indicate that Indonesian VE research has been primarily shaped by a small number of influential authors whose work bridges technical innovation and policy relevance. Their contributions not only elevate Indonesia's profile in the global VE discourse but also highlight the importance of sustained interdisciplinary collaboration for future research growth.

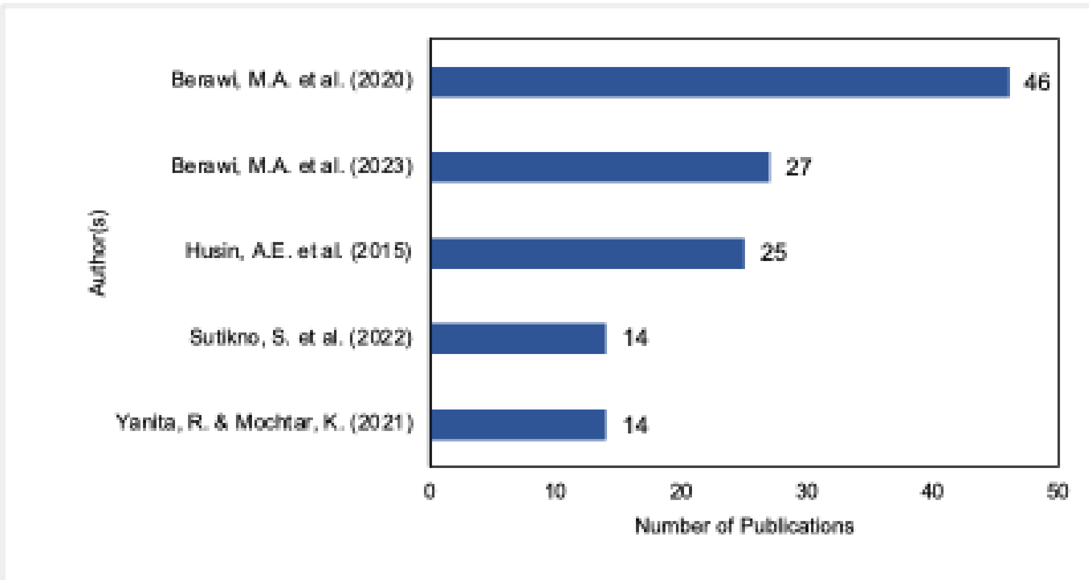

Figure 4. Most Cited Articles

Analysis of VE Methodologies

Value Engineering (VE) in Indonesia has been applied as a systematic and function-oriented method to improve the value of products, services, and processes by optimizing performance while minimizing cost without compromising quality. However, the implementation strategies and methodological designs vary substantially across sectors, reflecting the differing project objectives and contextual characteristics (Table 1). Based on methodological orientation, the reviewed studies can be categorized into three primary research approaches—qualitative, quantitative, and mixed-method designs (Cooper & Schindler, 2014; Sekaran & Bougie, 2016).

Qualitative methods are primarily used to explore and identify potential value improvements through literature reviews (Gunawan et al., 2024; Saroji et al., 2020), in-depth interviews, and field observations (Kustamar et al., 2019). Other commonly used techniques include brainstorming, benchmarking, and case studies (Azis et al., 2016; Husin et al., 2022; Saroji et al., 2020). Some studies employ focus group discussions (FGDs) to validate proposed improvements or finalize project recommendations (Siradjuddin, 2023; Yanita & Mochtar, 2021). This approach is particularly dominant in the information and function analysis phases of VE, enabling researchers to understand project conditions, identify functional requirements, and generate preliminary improvement alternatives.

Quantitative approaches provide empirical validation of VE's impact on cost efficiency and performance. The Partial Least Squares–Structural Equation Modeling (PLS-SEM) technique is the most frequently applied, demonstrating significant positive relationships between green building factors, VE stages, and life-cycle cost performance (Sutikno et al., 2022, 2023, 2024). Other studies employ System Dynamics simulations to assess the economic feasibility of large-scale infrastructure projects (Husin et al., 2015). These quantitative frameworks strengthen the statistical credibility of VE research and provide measurable evidence of its contribution to sustainability and project optimization.

Several studies combine qualitative exploration with quantitative analysis to achieve methodological complementarity. Typical designs integrate literature reviews and interviews with Analytical Hierarchy Process (AHP), cost–benefit analysis, or Value Index evaluation (Yung et al., 2024). In product development research, fuzzy logic analysis and sensory evaluation are used alongside qualitative observation to select the most value-added alternatives (Sayekti et al., 2021). More advanced applications integrate IoT-based simulations for smart workspace design (Berawi et al., 2023), linear programming for land-use optimization (Berawi et al., 2020), and Relative Importance Index (RII) analysis to improve construction scheduling (Husin, Rahmawati, et al., 2021).

Across methodologies, the application of VE generally follows its classical functional phases—information, function analysis, creative, evaluation, and development.

1. The information phase relies heavily on literature review, field observation, and interviews to identify baseline conditions and key indicators (Berawi et al., 2023; Gunawan et al., 2024; Kustamar et al., 2019; Sayekti et al., 2021).
2. The function analysis phase almost universally employs the Function Analysis System Technique (FAST) to translate technical problems into systematic functional hierarchies (Berawi et al., 2023; Husin et al., 2022; Sayekti et al., 2021; Yung et al., 2024).
3. The creative phase integrates brainstorming, simulation, and FGDs to generate and refine value-added alternatives (Berawi et al., 2023; Kustamar et al., 2019; Saroji et al., 2020; Siradjuddin, 2023).
4. The evaluation phase is dominated by quantitative tools such as Value Index, cost–benefit, and life-cycle cost analysis, ensuring that proposed alternatives are selected based on measurable trade-offs between performance and cost (Budiyanto & Sari, 2024; Yung et al., 2024; Husin, Rahmawati, et al., 2021).
5. The development and implementation phases increasingly emphasize practical realization, translating VE outcomes into conceptual models, technical frameworks, prototypes, and policy recommendations (Berawi et al., 2020, 2023; Budiyanto & Sari, 2024; Kustamar et al., 2019; Sayekti et al., 2021; Siradjuddin, 2023).

Although most studies remain at the conceptual or analytical level, several have progressed toward practical implementation—such as community-based housing programs (Siradjuddin, 2023) and smart integrated workspace systems realized in Jakarta (Berawi et al., 2023). These examples demonstrate the growing maturity of VE research in Indonesia, though further empirical validation and cross-sectoral integration remain necessary to enhance its policy and industrial impact.

Table 1. Analysis of VE Methodologies and Their Application in Various Sectors in Indonesia

Research Method		Sectors Applied	Innovation Proposed	References
Qualitative	Literature review, case study	Construction Industry	Smart Homes	(Gunawan et al., 2024)
	In-depth interview, focus group discussion, survey	Construction Industry	Legal Aspects (Government regulations and Laws)	(Yanita & Mochtar, 2021)
	Case study	Construction Industry	Green hotel building	(Husin et al., 2022)
	Observations, interviews, survey	Construction Industry	Avtur Pipeline Engineering, Procurement, and Construction (EPC) project.	(Kustamar et al., 2019)
	Case study	Construction Industry	Tertiary irrigation channel	(Azis et al., 2016)
	Descriptive, FGD	Urban development	Mutual Cooperation Culture (Gotong Royong) Implementation for House Development	(Siradjuddin, 2023)
	Literature review, FGD, benchmarking, brainstorming	Urban planning and transportation	Transit-Oriented Development (TOD) Project	(Saroji et al., 2020)
Quantitative	PLS-SEM, CVI	Construction Industry	Green Building Construction Project	(Sutikno et al., 2024)
	System dynamics for forecasting	Construction Industry	Mega bridge infrastructure project	(Husin et al., 2015)
	Questionnaire	Manufacturing Industry	Sweet chocolate cube product development	(Budiyanto & Sari, 2024)
	SEM-PLS, questionnaire, observation, literature review.	Ready-Mix Concrete (RMC) Industry	Green Retrofitting	(Husin et al., 2023)
	SEM-PLS, questionnaire survey	Meeting, Incentive, Convention, and Exhibition (MICE) Industry	Green building project	(Sutikno et al., 2023)
	SEM-PLS, questionnaire survey	Meeting, Incentive, Convention, and Exhibition (MICE) Industry	Green building project	(Sutikno et al., 2022)
Mixed-Method	Literature review, online survey, Case study, AHP, *cost-benefit analysis*	Financial Industry	Peer-to-peer (P2P) lending platform	(Yung et al., 2024)
	Literature review, in-depth interviews, simulation	Civil and Architecture	Smart integrated workspace design	(Berawi et al., 2023)
	Interview, direct observations, questionnaire, fuzzy logic, sensory evaluation, brainstorming	Manufacturing Industry	Soymilk product development	(Sayekti et al., 2021)

Research Method		Sectors Applied	Innovation Proposed	References
	Case studies, statistical analysis	Construction Industry	Box Grider Construction on toll road projects	(Husin, Rahmawati, et al., 2021)
	Case study, archive, benchmarking, linear programming	Urban planning and transportation	Land Use Allocation of Transit-Oriented Development (TOD)	(Berawi et al., 2020)

Sectoral Distribution

The review of 18 studies reveals that VE has been applied across a diverse range of sectors in Indonesia, although the construction and infrastructure industries remain the dominant areas of focus. As summarized in Table 1, VE has also gradually expanded into urban planning, manufacturing, financial technology, and service sectors, reflecting its adaptability as a multidisciplinary approach to optimizing performance and cost efficiency.

Construction and Infrastructure Sectors

The construction industry accounts for the majority of VE applications, encompassing projects such as green buildings (Husin et al., 2022; Sutikno et al., 2022, 2023, 2024), toll road box girders (Husin, Rahmawati, et al., 2021), irrigation channels (Azis et al., 2016), and jet fuel pipeline EPC projects (Kustamar et al., 2019). These studies emphasize VE's potential to reduce project costs, improve design quality, and enhance environmental performance. A significant body of research also integrates VE with Building Information Modeling (BIM), System Dynamics, or PLS-SEM models to quantify performance outcomes. The recurrent use of Function Analysis System Technique (FAST) and Value Index calculations further illustrates methodological consistency within this sector.

Urban Planning and Transportation

VE is increasingly utilized in urban development and transportation planning, particularly within the context of Transit-Oriented Development (TOD) projects (Berawi et al., 2020; Saroji et al., 2020). These studies highlight VE's capacity to address complex, multi-stakeholder challenges by optimizing land use, public mobility, and sustainability performance. Innovative applications, such as the integration of VE with linear programming for land-use allocation and benchmarking for design improvement, demonstrate its growing relevance for smart urban governance. In a more community-based context, VE principles have been adapted to promote mutual cooperation (gotong royong) in housing development projects, enhancing social inclusion and participatory planning (Siradjuddin, 2023).

Manufacturing and Product Development

The manufacturing sector shows emerging applications of VE for product innovation and process efficiency. Studies by Sayekti et al. (2021) and Budiyanto & Sari (2024) applied VE to soy milk powder and chocolate cube product development, respectively, combining fuzzy logic analysis, sensory evaluation, and cost-benefit techniques to optimize quality and consumer satisfaction. These findings indicate VE's expanding utility in food technology and sustainable manufacturing, aligning with the broader national agenda for green industry transformation.

Financial and Service Sectors

Outside the traditional engineering domain, VE principles have been extended to the financial services industry. For instance, Yung et al. (2024) applied VE in evaluating peer-to-peer (P2P) lending platforms, integrating AHP and cost-benefit analysis to assess alternative designs for financial technology systems. Similarly, the Meeting, Incentive, Convention, and Exhibition (MICE) sector has utilized VE frameworks to enhance green building performance and reduce operational inefficiencies (Sutikno et al., 2022, 2023).

Overall, the sectoral distribution indicates that while construction and infrastructure dominate, VE research in Indonesia is progressively expanding into manufacturing, urban systems, and digital service innovation. This diversification reflects a growing recognition of VE as a strategic tool for achieving efficiency, sustainability, and innovation beyond its conventional engineering roots. However, the limited number of studies outside construction underscores the need for cross-sectoral research and policy support to fully leverage VE's multidisciplinary potential.

Discussion

Key Advantages of Applying Value Engineering in Indonesia

Value Engineering (VE) is a structured, function-oriented methodology that aims to maximize project or product value by optimizing performance relative to cost, without compromising quality (Gunarathne et al., 2022). In Indonesia, VE has been applied across diverse sectors—including construction, manufacturing, urban development, food processing, and socio-cultural projects—yielding measurable benefits in cost efficiency, sustainability, functional innovation, profitability, and socio-cultural adaptability.

Increasing Cost Efficiency

VE has been empirically proven to enhance cost and life-cycle efficiency in Indonesian construction projects. Studies confirm that VE significantly improves cost performance in green building construction (Sutikno et al., 2024) and green retrofitting projects (Husin et al., 2023). Integration with Life-Cycle Cost Analysis (LCCA) has been shown to raise cost performance by 8.66% (Husin et al., 2023), while in the MICE industry, VE implementation reduced the additional green premium cost from 7.49% to 4.69% through material substitution and energy optimization (Sutikno et al., 2023). In infrastructure projects, VE has achieved substantial savings—up to 40% in jet fuel pipeline installations (Kustamar et al., 2019) and 13.4% cost reduction plus 15% time savings in irrigation projects (Azis et al., 2016). These results collectively demonstrate VE's effectiveness in enabling comprehensive function–cost analysis that minimizes expenditure while maintaining quality and technical performance.

Enabling Environmental and Energy Sustainability

VE also serves as a key design-stage tool for achieving environmental and energy efficiency. The application of VE in Smart Home design integrates architectural and technological functions, leading to enhanced energy efficiency, safety, spatial optimization, and user satisfaction (Gunawan et al., 2024). Similarly, the Smart Integrated Workspace Design (SIWD) achieved 18% total energy savings (Berawi et al., 2023), while the adoption of Building Management Systems (BMS), photovoltaic panels, and double glazing reduced annual energy use by over 14 million kWh (Sutikno et al., 2023). These findings underscore VE's growing contribution to sustainable architecture and green technology integration.

Driving Value-Added Functional Innovation

VE fosters functional innovation by enabling reconfiguration of design, materials, and system functions. In TOD projects, VE-driven redesigns that incorporated commercial facilities—such as offices, retail areas, and hotels—enhanced land-use efficiency and increased daily ridership by up to 55% (Berawi et al., 2020). In infrastructure contexts, VE improved the utility functions of box girders, generating additional revenue up to 9.83% of total project cost (Husin, Rahmawati, et al., 2021), while in façade design, VE-based material substitution achieved 47.3% reductions in energy consumption without compromising aesthetics (Husin et al., 2022). These applications illustrate VE's potential to transform cost-driven processes into innovation-driven performance systems.

Enhancing Economic Value and Project Profitability

VE substantially enhances project profitability and financial feasibility across multiple sectors. In toll road infrastructure, VE-led design improvements increased project revenue by US$61.59 billion, improving efficiency and profitability by 624% and raising the internal rate of return (IRR) from 1.3% to 7.56% (Husin et al., 2015). Beyond construction, VE has been applied in the financial sector to optimize risk–return trade-offs in peer-to-peer (P2P) lending platforms (Yung et al., 2024), and in the food industry to balance quality and cost in product formulation—such as in chocolate cubes (Budiyanto & Sari, 2024) and soy milk products (Sayekti et al., 2021). These findings reaffirm VE's broader role in increasing economic resilience and market competitiveness.

Promoting Socio-Cultural Adaptability

VE's application in Indonesia also demonstrates strong alignment with local socio-cultural values. A notable example is the adaptation of VE principles in community-based housing projects for the Bajo community, where traditional "gotong royong" (mutual cooperation) culture was integrated into design and construction practices (Siradjuddin, 2023). This innovation reduced project costs by up to 300% without disrupting local livelihoods, illustrating how VE can preserve cultural identity while promoting economic development. By embedding local wisdom into technical solutions, VE serves as both an engineering methodology and a socio-economic empowerment mechanism.

Challenges and Barriers of Applying Value Engineering in Indonesia

As discussed in the preceding section, VE has demonstrated substantial potential to enhance functional quality, cost efficiency, and sustainability across multiple sectors in Indonesia. However, despite these advantages, the existing body of literature remains limited, and the practical adoption of VE continues to face persistent barriers. Most of these challenges are concentrated in the construction sector, while its application in other industries remains underdeveloped. The main obstacles identified include limited professional competence, low stakeholder commitment, and weak regulatory and institutional support.

The first and most significant challenge lies in the limited understanding of VE principles and methodologies among construction professionals in Indonesia (Yanita & Mochtar, 2021). Many practitioners are unfamiliar with VE's core objectives—enhancing function, reducing cost, and improving performance—which hampers effective implementation at the project level. Similar challenges have been reported internationally, such as in Saudi Arabia and South Africa, where the shortage of certified VE professionals and limited exposure to structured VE processes have constrained adoption (Sewdayal & Pellissier, 2024). This indicates that VE diffusion in developing contexts requires not only technical training but also the establishment of a professional certification and accreditation framework. Regular VE workshops and education programs for engineers, consultants, and contractors are therefore essential to strengthen capacity and professional expertise (Marsov et al., 2024).

Another critical barrier is the low awareness and weak commitment among project owners and clients to integrate VE throughout the project life cycle. VE success depends heavily on early and continuous stakeholder involvement—from planning and design to execution and post-construction phases (Alhumaid et al., 2024). In Indonesia, however, VE is often applied only during the construction phase and typically initiated by contractors, rather than by owners or regulators who should lead its integration from the planning stage (Yanita & Mochtar, 2021). A similar ad hoc pattern has been observed in South Africa, where VE is rarely institutionalized and tends to be used reactively rather than proactively (Sewdayal & Pellissier, 2024). Strengthening owner-driven engagement and embedding VE requirements in project procurement guidelines would help ensure early and consistent adoption.

A further challenge arises from the lack of a clear and enforceable regulatory framework governing VE implementation in Indonesia. Existing policies are often poorly disseminated and lack mechanisms for monitoring or enforcement (Yanita & Mochtar, 2021). Moreover, in public-sector projects, the current financial management and auditing systems do not adequately support VE principles. In some cases, cost savings achieved through VE are misinterpreted as potential financial losses to the state, creating hesitation among project managers and auditors to implement VE recommendations. This misconception mirrors findings in South Africa, where VE is still viewed merely as a cost-cutting measure, rather than as a structured process to enhance total project value (Sewdayal & Pellissier, 2024).

Overall, the absence of clear government regulations, consistent policy support, and institutional collaboration between academia, practitioners, and policymakers has constrained the mainstreaming of VE in Indonesia. Sustainable implementation requires a collaborative ecosystem involving universities, government agencies, professional associations, and private-sector stakeholders. Establishing national guidelines, integrating VE into engineering education, and linking VE practices to public procurement frameworks would create the foundation for a systematic and scalable adoption across sectors.

Future Research Opportunities of Value Engineering in Indonesia

Despite the challenges identified, the current landscape presents significant opportunities for advancing the implementation of VE in Indonesia. The increasing national focus on infrastructure development, sustainability, and digital transformation provides a conducive environment for mainstreaming VE across both public and private sectors. Drawing from the synthesis of existing studies, these opportunities can be categorized into policy and institutional advancement, technological integration, and research and capacity development.

Strengthening Policy and Institutional Frameworks

A key opportunity lies in developing a comprehensive national framework to institutionalize VE as a standard component of project management and procurement processes. The establishment of clear government regulations, guidelines, and performance indicators—similar to those adopted in the United

States and the United Kingdom—would enhance regulatory certainty and encourage consistent application across ministries and local governments. Integration of VE principles into public procurement systems could also improve accountability, reduce waste, and enhance project transparency. Moreover, collaboration with the Indonesian Value Engineering Association (HAVEI) and professional bodies such as the Institution of Engineers Indonesia (PII) can help establish certification programs and expand the pool of qualified VE professionals.

Leveraging Digital and Technological Integration

The increasing adoption of digital engineering technologies—such as Building Information Modeling (BIM), Internet of Things (IoT), and artificial intelligence (AI)—offers new pathways for enhancing VE application and precision. Integrating VE with these tools can enable data-driven decision-making, simulation-based optimization, and real-time performance evaluation. Studies by Berawi et al. (2023) and Husin et al. (2022) demonstrate that combining VE with smart design systems and life-cycle analysis can yield substantial energy and cost savings. The development of digital VE platforms would allow multi-stakeholder collaboration, automated function analysis, and improved traceability throughout the project life cycle, aligning with the national agenda for Industry 4.0 and Smart Infrastructure.

Expanding Research and Academic Engagement

Another significant opportunity lies in expanding academic research and interdisciplinary collaboration. Current studies are heavily concentrated in construction, while applications in renewable energy, manufacturing, digital services, and healthcare remain limited. Future research could focus on developing context-specific VE models that integrate sustainability metrics, risk management frameworks, and socio-economic considerations. Strengthening partnerships between universities, government agencies, and industry practitioners will be essential to promote innovation and ensure the practical applicability of VE outcomes. Incorporating VE education into engineering, architecture, and business curricula can also build long-term capacity and awareness among emerging professionals.

Promoting Socio-Economic and Sustainability Synergies

VE's holistic and function-oriented approach positions it as a powerful instrument for achieving sustainable development goals (SDGs) in Indonesia. By emphasizing resource efficiency, waste reduction, and stakeholder participation, VE can contribute to environmentally responsible growth while supporting local economic empowerment. The adaptation of VE principles to community-based projects—such as sustainable housing, rural infrastructure, and micro-industries—can enhance social equity and resilience. Encouraging research that bridges technical innovation with social value creation will expand VE's role beyond engineering optimization toward inclusive and sustainable national development.

Conclusion

This study provides a comprehensive systematic review of VE research in Indonesia, addressing three key questions related to its development, sectoral application, and the benefits, challenges, and opportunities reported in the literature. Based on an analysis of 18 peer-reviewed articles published between 2000 and 2025, the findings reveal a fluctuating yet upward trend in VE-related publications, with growing attention in recent years, particularly during 2021–2024. Although the overall volume of research remains limited, VE has emerged as a rapidly developing area of academic inquiry, supported by a small but active group of high-impact Indonesian authors publishing in reputable international journals.

Methodologically, VE studies in Indonesia employ qualitative, quantitative, and mixed-method approaches. Qualitative designs dominate exploratory and case-based analyses, while quantitative and hybrid methods—including SEM-PLS, AHP, and life-cycle cost analysis—are increasingly used for performance validation and comparative evaluation. Sectorally, VE applications remain concentrated in construction and infrastructure, though emerging studies have extended its use to urban planning, manufacturing, finance, and food industries, demonstrating VE's growing interdisciplinary relevance.

The synthesis confirms that VE delivers significant measurable benefits across Indonesian industries. Its implementation has led to cost savings of up to 40% in infrastructure projects, 8% improvements in cost efficiency for green retrofitting, and substantial energy savings in smart building applications. Beyond cost optimization, VE fosters functional innovation, environmental sustainability, economic value creation, and socio-cultural adaptability. However, these achievements are constrained by persistent barriers, including limited practitioner expertise, low owner commitment, and weak regulatory support. These challenges underscore the need for stronger policy frameworks, institutional collaboration, and professional capacity building to mainstream VE into national development practices.

The findings of this review carry several important implications for policymakers, industry practitioners, and researchers seeking to advance Value Engineering (VE) implementation in Indonesia. For policymakers, there is an urgent need to establish a national regulatory framework that mandates VE studies in major public projects and embeds VE principles within public procurement and project evaluation systems. Clear guidelines, incentives, and standardized procedures—similar to those implemented in advanced economies—would ensure consistent application and institutional accountability. Integrating VE within the regulatory, auditing, and budgeting frameworks of public infrastructure programs can also help reduce inefficiencies and promote transparent, value-based decision-making. For industry practitioners, VE should be viewed not merely as a cost-reduction tool but as a strategic approach for optimizing project performance across the entire life cycle. Strengthening professional certification programs, developing VE knowledge-sharing platforms, and embedding VE within organizational management systems would enhance technical capacity and encourage its use in early design and planning stages rather than at the construction phase alone. For academia and research institutions, the growing relevance of VE calls for more interdisciplinary and context-specific studies, integrating sustainability assessment, risk management, digital technologies, and socio-economic analysis. Expanding VE education in engineering, architecture, and business programs will help cultivate a new generation of professionals equipped to lead value-driven innovation.

Lastly, while this review provides a consolidated understanding of VE's progress in Indonesia, its scope is limited to English-language studies indexed in Scopus. Future research should broaden the evidence base by including local-language publications, grey literature, and comparative studies with other developing countries. Expanding such research will strengthen the empirical foundation for integrating VE into Indonesia's evolving infrastructure, industrial, and sustainability agendas.

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