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Optimizing development and operations from the project success perspective using the analytic hierarchy process

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ABSTRACT

By merging development and operation disciplines, the approach known as development and operations (DevOps) can significantly improve the efficiency and effectiveness of software development. Despite its potential benefits, successfully implementing DevOps within traditional project management frameworks presents significant challenges. This study explores the critical factors influencing the implementation of DevOps practices from the project management perspective, specifically focusing on software development projects in the Ministry of Finance. This study utilizes the analytic hierarchy process (AHP) to prioritize the critical elements of project success criteria and DevOps factors necessary for effective implementation. The findings indicate that stakeholder satisfaction, quality, and value creation are the primary criteria for project success. Moreover, knowledge and skills, collaboration and communication, and robust infrastructure are pivotal factors for facilitating DevOps within project management. The study provides actionable insights for organizations aiming to improve their project outcomes by incorporating DevOps and offers a systematic approach to decision-making using AHP. This study recognizes limitations due to its focus on specific contexts and emphasizes the need for future research in diverse organizational environments to validate and expand these findings.

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1. INTRODUCTION

In the age of digitalization, public sector organizations are increasingly leveraging software and information systems to enhance transparency and service delivery to the public [1]. This digital transformation requires swiftly adapting to changing environments and evolving citizen expectations [2]. Public sector entities, such as the Ministry of Finance of Indonesia, must adopt technological solutions that improve efficiency and ensure the delivery of high-quality public services [3], [4]. The shift towards digital platforms has led these organizations to rethink their project management approaches, making agility a crucial factor in the successful implementation and sustainability of these technologies.

The evolution of project management methodologies in system development has shifted from waterfall models to Agile methodologies [5], [6]. Agile methods provide the flexibility and faster response times that drive this transition [6]. Integrating development and operation (DevOps) with Agile practices has emerged as a powerful strategy in software development projects, enhancing the continuous delivery of software updates and new features [7], [8].

DevOps has become a transformative force, revolutionizing the execution of software development projects. DevOps combines the aspects of 'Development' and 'Operations,' which represents a cultural and technical shift that promotes a collaborative environment, enabling the building, testing, and releasing of software to occur more rapidly, frequently, and reliably [9]–[12]. The significant advantage of incorporating DevOps with project management lies in its ability to enhance the agility of development processes, thereby reducing time to market, minimizing the development lifecycle, and elevating product quality [9], [13].

Organizations increasingly adopt DevOps due to its significant benefits. Allied Market Research projects the agile software development market to expand at a compound annual growth rate of 19.50% by the end of 2026 [14], [15]. This approach has led to notable improvements in software quality and team productivity, with 42% of enterprises reporting enhanced software quality and 47% noting increased productivity. Further highlighting its efficacy, a Google Report in 2023 indicates that organizations with capabilities in continuous integration (CI) and continuous deployment (CD) can improve organizational performance by up to 2.4 times [16]. DevOps is utilized by approximately 61% of respondents in varying fields. The benefits of implementing DevOps are substantial, as evidenced by a survey highlighted in the Harvard Business Review. Respondents noted considerable enhancements in several key areas: speed to market (70%), productivity (67%), customer relevance (67%), innovation (66%), and quality of products or services (64%) [17]. Thus, it leads to better project outcomes.

However, the agility and responsiveness of DevOps do not come without challenges, especially in the public sector, where projects must adhere strictly to predefined success criteria, including time, scope, and budget constraints [18], [19]. Integrating DevOps into public sector projects requires careful consideration of these success factors to ensure that the quick development and deployment processes do not undermine the quality and reliability of the software [12]. Therefore, assessing how DevOps can meet these stringent requirements is crucial for its adoption in high-stakes environments like government ministry. To successfully implement DevOps, particularly in projects with specific requirements, organizations need to pinpoint the necessary factors that are challenging [8]. Yusuf *et al*. examined how to improve local e-government using DevOps [20]. They identified several critical success factors in implementing DevOps, including collaboration and communication, automation, continuous feedback, and the integration of tools and technology, as well as cultural shifts and skill development. A case study conducted by the Indonesian Public Health Organization revealed that the development team's mindset presents the most significant challenge that must be addressed when implementing DevOps [21].

This study proposes a structured analysis using the analytic hierarchy process (AHP) to prioritize the factors that affect the successful adoption of DevOps in software development projects, incorporating project management elements to address the challenges. The AHP offers a methodical approach to decision-making by decomposing the problem into a hierarchy of more comprehensible sub-problems for individual analysis [22]–[24]. Therefore, this study's research question is: "What factors influence the DevOps implementation from the project success perspective, and how can they be effectively prioritized using the AHP approach?". By answering this question, the study aims to provide actionable insights organizations can use to optimize their software development project by effectively integrating DevOps and project management practices.

Existing research often talks about the difficulties, benefits, or success factors of implementing DevOps in the private sector [13], [25]–[27]. However, there aren't many studies that look specifically at the responses to the critical success factors or their outcomes from a project management point of view when implementing DevOps in the public sector. This gap highlights the need for detailed case-specific analyses that investigate what project success criteria and DevOps key factors are managed. The success criteria and factors identified from the previous studies will be ranked using the AHP. This study aims to bridge the gap between DevOps's theoretical benefits and practical application and enhance project outcomes through strategic implementations [28].

2. METHOD

This study explains research chronologically, including research design, research procedure, theoretical framework, and data acquisition. This study adopts a quantitative method using the Analytic Hierarchy Process to answer the research question.

2.1. Development and operations (DevOps)

Development and operations usually consist of two different departments. In the software development process, there is a conflict between the need for change from the developer team and the fear of change from the operation team [9]. The DevOps initiative focuses on enhancing collaboration between development and operations personnel to address critical challenges like resistance to change and risky deployments [9], [29]–[31].

DevOps, a contraction of "development" and "operations," refers to the technique that combines software development and IT operations intending to cut the systems development life cycle while frequently delivering features, fixes, and updates that closely align with business goals [12], [30], [31]. The essence of DevOps is to promote collaboration and integration between the development and operations teams, which historically functioned in siloes, to improve the agility and responsiveness of the software development process [9], [28], [31]. The integration of continuous integration (CI) and CD into the DevOps methodology ensures that software can be built, tested, and released to production rapidly and with high reliability [29].

2.2. Analytic hierarchy process

The AHP is a methodical approach for arranging and evaluating complicated decisions based on mathematical and psychological principles. Saaty developed AHP in the 1970s, which assists decision-makers in establishing priorities and making optimal choices by simplifying complex decisions into pairwise comparisons and then integrating these findings [22]-[24]. AHP has been widely used across multiple disciplines, such as project management, policy, finance, healthcare, and strategic decisions, demonstrating its versatility and effectiveness in decision-making scenarios where multiple criteria are involved [24], [32], [33].

The AHP is highly effective at simplifying complex decision-making processes into a clear hierarchical structure, as demonstrated in numerous studies. It organizes decision-making criteria into a multi-tiered framework, ranging from overarching goals to specific alternatives, thus rendering the decision process more methodical [34]. This structured methodology thoroughly assesses diverse and often conflicting criteria, enhancing decision-making efficacy [35]. Furthermore, as a robust multi-criteria decision making (MCDM) tool, AHP addresses complex decision challenges by providing a coherent framework that allows for the comparative analysis of alternatives based on various factors [36]. The methodological rigor of AHP ensures that decision-makers can navigate through complex decision landscapes with clarity and efficiency, ultimately leading to optimal choices in scenarios with diverse and conflicting criteria.

2.3. Project success criteria

Project success criteria are also derived from previous studies, encompassing the triple constraint and other criteria applicable today [37]–[39]. The project success criteria are depicted in the following sub-section. From the comparison and gap analysis of previous studies, this study aims to conduct an empirical study applying AHP to prioritize the DevOps success factor from the project management perspective.

Within project management, success criteria are the standards used to measure project success [37], [38]. Traditionally, project success was measured against the "iron triangle" of scope, time, and cost [39], [40]. However, contemporary views on project success encompass broader aspects such as stakeholder satisfaction, project quality, and the overall business or public value derived from the project [10], [41]–[43].

Some literature has been identified to obtain project success criteria. The success criteria for a software development project vary for each project. Table 1 summarizes project success criteria from previous studies.

Table 1. Project success criteria

Project Success Criteia	References
Time	[10], [18], [39]-[43]
Cost	[10], [18], [41], [42], [44], [45]
Scope	[10], [18], [41], [44], [45]
Quality	[10], [41], [42], [44], [45]
Risk	[10], [41], [44], [45]
Stakeholder satisfaction	[10], [39]-[41], [43]
Value creation	[41], [43]

Table 1 represents various sources cited for different success criteria in project management. Critical software development project measures are time, cost, scope, quality, risk, stakeholder satisfaction, and value creation. The Project Management Institute (PMI) [44], Kerzner [45], and Marchewka [18] are frequently referenced across multiple criteria, highlighting their comprehensive contributions to project management literature. Adywiratama *et al*. [41] and Akbar *et al*. [10], along with others like Raharjo [42] and Takagi *et al*. [43], are cited specifically for more focused aspects such as stakeholder satisfaction and value creation, indicating specialized study in these areas within recent years.

2.4. DevOps success factors

Various studies have been conducted on the implementation of DevOps using various approaches. The study by Khan and Shameem [46] identified that the bureaucracy factor in the deployment process is the

main challenge in DevOps activities. Akbar *et al*. [11] also conducted a similar study using the fuzzy-AHP approach and revealed that the security pipeline factor, usage of orchestration systems, and organizational matrix transparency are the main factors influencing the success of DevOps implementation. The study by Akbar *et al*. [10] incorporates DevOps with the knowledge area of project management and prioritizes the success factor of each knowledge area. Several studies have identified success factors using literature reviews, such as those by Karunarathne *et al*. [47] Mishra and Otaiwi [12], and Azad and Hyrynsalmi [48]. Critical factors in implementing DevOps are obtained and incorporated from those previous studies with project success criteria.

The successful implementation of DevOps hinges on several key factors. Lwakaterte *et al*. [49] conclude that DevOps implementation success factors in cultural change, automation, lean management, measurement and monitoring, and sharing and knowledge management [49]. Based on previous studies, six factors can be identified, as shown in Table 2.

Table 2. DevOps success factors

DevOps Success Factors	References
Top management support	[27], [47]
Collaboration and communication	[27], [46], [47]
Automation	[12], [26], [27], [46], [48], [50]
Knowledge and skill	[27], [46], [47]
Infrastructure, tools, and technology	[25], [26], [47], [48], [51]
Transparency	[25], [26], [46], [47]

Top management highlights the crucial role of senior management in endorsing and supporting DevOps initiatives within an organization [27], [47]. Furthermore, effective collaboration and communication are essential in a DevOps environment, where development, operations, and other departments must work closely to achieve seamless software delivery [27], [46], [47]. Automation is one of the DevOps principles that help reduce manual work, minimize errors, and speed up the release cycles, thereby enhancing operational efficiency and enabling more frequent updates and improvements [12], [26], [27], [46], [48], [50].

The success of DevOps also depends heavily on the knowledge and skills of the team. The condition encompasses expertise in coding, system administration, integration, and tools optimization [27], [46], [47]. The role of infrastructure, tools, and technology in supporting project operations is explored by Azad and Hyrynsalmi [48] and Chen [51] among others. Finally, transparency in DevOps involves clear visibility into all processes and workflows for all stakeholders involved [25], [26], [46], [47].

2.5. Research framework

The research framework for integrating DevOps into project management involves understanding how DevOps practices can align with project management success criteria to enhance project outcomes. By applying the AHP methodology within this framework, organizations can systematically prioritize the success factors in DevOps, ensuring that the most critical aspects are addressed to optimize project success and operational efficiency. Based on the theories explained before, Figure 1 shows the research framework for this study. At the upper level of the hierarchical structure, seven elements are considered project success criteria. On the second level, six critical factors from previous studies significantly affect the implementation of DevOps.

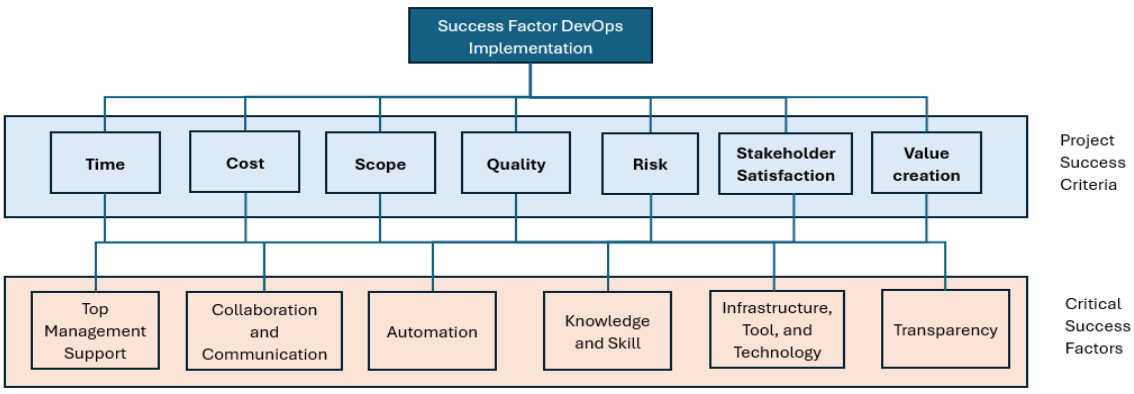

Figure 1. Research framework

2.6. Research methodology

The study employs a hybrid approach, beginning with a qualitative study followed by quantitative approaches [52]. Figure 2 illustrates the flow of this study. A literature review was conducted to derive project success criteria and DevOps success factors. Three experts validated the hierarchical structure. These experts were project managers in government and senior developers.

Four distinct stages are undertaken to rank key factors effectively using the AHP approach. The initial stage involves defining the problem and the desired solutions and constructing a hierarchical structure, as depicted in Figure 1. This stage breaks down complex issues into smaller, manageable components to establish a hierarchy.

The second stage in the AHP involves determining priority elements. At this stage, priorities are established for all elements within the hierarchy using pairwise comparisons, as illustrated in Table 3. This process begins at the criteria level and continues with the factor elements. The scale used for pairwise comparisons in the AHP is outlined in Table 4.

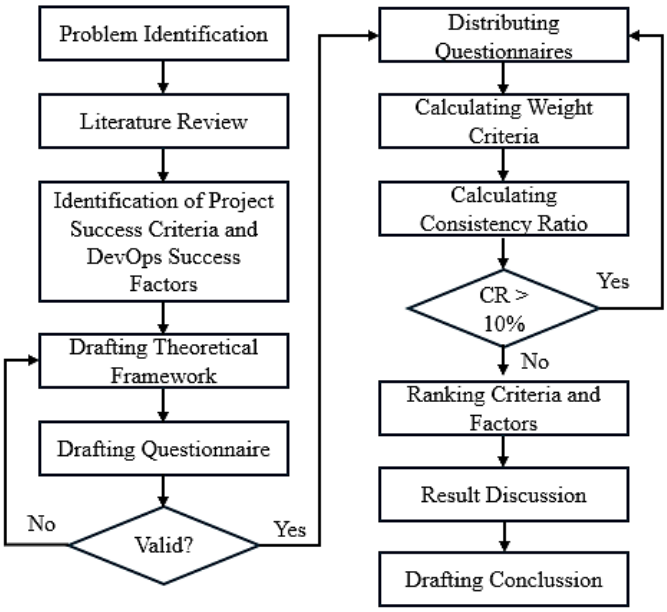

Figure 2. Research flow diagram

Table 3. Pairwise comparison

	C1	**C2**	**…**	**Cn**
C1	C11	C12	…	C1n
C2	C21	C22	…	C2n
…	…	…	…	
Cn	Cn1	Cn2	…	Cnn

Table 4. Scale for pairwise comparison

Importance Scale	Explanation
1	Both factors hold the same level of importance.
3	One factor is slightly more important than the other.
5	One factor is more important than the other.
7	One factor is substantially more important than the other.
9	One factor is more important than others.
2, 4, 6, 8	The value is between two consecutive evaluations.

Questionnaires were distributed to eight respondents to obtain data. The questionnaires were directed towards employees within the central information and communication technology (ICT) unit responsible for developing applications utilizing DevOps methodologies. The characteristics of respondents are shown in Table 5.

Table 5. Respondent characteristics

Respondent	Job Position	Experience (years)
E01	Team Leader, Senior Developer, System Analyst	22
E02	Team Leader, Senior Developer, System Analyst	13
E03	Senior Developer	13
E04	Senior Developer and IT Operation Specialist	20
E05	IT Operation Specialist	11
E06	IT Operation Specialist	11
E07	IT Operation Specialist	10
E08	IT Service Specialist	13

The third stage involves determining the eigenvector and eigenvalues. The eigenvector is used to ascertain the relative impact of each criterion and factor on the research objective [24]. The final step in AHP is calculating the consistency ratio (CR). In AHP, the CR is determined by comparing the consistency index (CI) and the reference index (RI). Saaty and Vargas [24] have established that the consistency ratio should be 10% or below. If the assessment ratio is above 10%, the assessment needs to be revised by re-evaluating until an appropriate assessment ratio is achieved. In (1) is the method to calculate the CR.

$$CR = \frac{CI}{RI} \leq 10\% \quad (1)$$

The CI value is determined using the maximum eigenvector value (λmax) obtained from the pairwise comparison matrix, as seen in (2). The RI value is a predetermined value, as depicted in Table 6.

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (2)$$

Table 6. Reference index

Matrix	1	2	3	4	5	6	7	8	9	10
RI	0,00	0,00	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,49

The stages of the AHP methodology adopted for this study provide a robust framework for examining the essential factors impacting the successful implementation of DevOps practices within project management. This approach ensures reliable and actionable findings. This approach also offering a clear path for organizations looking to integrate DevOps effectively.

3. RESULTS AND DISCUSSION

The questionnaire data from eight respondents was transformed into a pairwise matrix and managed through a form available at http://www.bpmsg.com. The website facilitates the calculation of element priorities within the pairwise comparison by applying the AHP method. The calculation output yielded priority percentages for each criterion and factor and included the value of the CR. The CR value for each individual and the combined respondents is below 10%, thus making the results of this questionnaire acceptable.

3.1. Priority of project success criteria in DevOps

Prioritizing project success criteria in DevOps is critical to managing software development projects. Eight respondents evaluated seven criteria using the AHP. Table 7 represents the priority of project success criteria.

Table 7. Priority of project success criteria

Criteria	Weight	Gap	Rank
Stakeholder satisfaction	0.271	-	1
Quality	0.219	0.052	2
Value creation	0.171	0.048	3
Risk	0.114	0.057	4
Scope	0.104	0.010	5
Time	0.083	0.021	6
Cost	0.038	0.045	7

According to the calculation results, stakeholder satisfaction emerged as the most significant criterion for project success, holding a weight value of 0.271 or 27.1%. This result differs from those found by Castro *et al*. in their study conducted in Brazil [53]. They found that while stakeholder satisfaction is considered a criterion for project success, it is not the primary factor. Project stakeholders include individuals and groups participating in or affected by a project whose interests may positively or negatively influence the project's outcomes [44]. The stakeholders are best positioned to assess the project's success [54], [55]. Therefore, it is crucial to define and manage stakeholder satisfaction as a project objective [44]. Effective stakeholder engagement hinges on maintaining ongoing communication with all involved parties to grasp their needs and expectations, swiftly resolve issues, balance conflicting interests, and ensure stakeholders are actively involved in project decisions and activities [44].

Quality criteria are ranked second with a weight value of 0.219 or 21.9%, indicating that quality is a significant criterion of project success. This finding aligns with the result of the study conducted by Lamprou and Vagiona, which considered quality to be one of the most important success criteria for projects in Greece [56]. The quality of the project can be regarded as the extent to which the expectations of project participants are met [57]. In software development using DevOps, the plan for quality control and quality management activities must be detailed and integrated [10], [44]. Senapathi and Buchan [8] explained that quickly delivering quality software is one of the critical drivers for DevOps adoption.

Thirdly, value creation has a weight value of 0.171 or 17.1%, emphasizing its importance in project outcomes. This finding aligns with a case study conducted by Adywiratama *et al*. in the Presidential Advisory Council in Indonesia [41]. This criterion reflects the project's ability to deliver substantial benefits, including innovative solutions that significantly enhance the impact of the result of the project [43]. The prioritization of value creation highlights its role in ensuring the sustainability and broader acceptance of project results, affirming that successful projects must align with business objectives and positive community impact, thus fostering long-term value beyond immediate project outputs.

On the other hand, the triple constraint (cost, time, and scope) does not emerge as the primary priority. These findings differ from the result of the study conducted by Adywiratama *et al*., which found that triple constraint remains the most important success criterion in the Presidential Advisory Council in Indonesia [41]. From a project management perspective within the public sector, this indicates a shift in focus from traditional success metrics. Public sector projects have rigorously adhered to these constraints to ensure accountability and effective use of public resources. However, this shift suggests that factors such as stakeholder satisfaction and perhaps other qualitative measures are gaining prominence over the conventional cost, time, and scope considerations. Additionally, the information system development project using DevOps is carried out in-house, so it is not strictly bound by budget and time constraints.

3.2. Priority of key success factor of DevOps implementation

The weight values of DevOps success factors for each criterion were analyzed, and a spreadsheet was subsequently used to calculate the matrix between criteria and success factors. The criteria and factors are listed in the Tables 2 and 3, respectively. These are combined to form a 6×7 matrix, as depicted in Table 8, elaborating on the weight values of each of the success factors.

Table 8. Factor and criteria matrix 6×7

Factor \ Criteria	Time	Cost	Scope	Quality	Risk	Stakeholder Satisfaction	Value Creation	Final Weight	Rank
	0.083	0.038	0.104	0.219	0.114	0.271	0.171		
Top management support	0.087	0.202	0.210	0.093	0.185	0.101	0.229	0.144724	4
Collaboration and communication	0.294	0.111	0.182	0.210	0.155	0.230	0.163	0.201411	2
Automation	0.144	0.171	0.133	0.100	0.149	0.125	0.132	0.127615	5
Knowledge and skill	0.266	0.218	0.199	0.356	0.254	0.248	0.242	0.266568	1
Infrastructure	0.150	0.207	0.194	0.182	0.172	0.161	0.152	0.169581	3
Transparency	0.059	0.092	0.082	0.060	0.086	0.136	0.082	0.090743	6

According to Table 8, knowledge and skill are at the top of the hierarchy, weighted at 26.66%, indicating that technical expertise and proficiency are the most critical elements in achieving DevOps objectives. Next, collaboration and communication follow with a 20.14% weight value, emphasizing the need for effective interaction and cooperation among team members and across departments. The infrastructure factor, which includes the tools and technology that support DevOps implementation, holds a significant

position, with a 16.96% weight, highlighting the need for a robust and adaptable technological foundation to support continuous deployment and integration processes.

Knowledge and skill emerged as the primary factors contributing to DevOps's success. This condition became the most crucial factor for creating value in cost, quality, risk, stakeholder satisfaction, and project success criteria. This result aligns with the findings of the study conducted by Khan and Shameem [46]. They stated that team members' lack of knowledge and data sharing became a significant obstacle to DevOps implementation. It is not only essential knowledge about the project or software development; members should also have a thorough understanding of DevOps tools [27], [46]. Therefore, DevOps team members can optimize the utilization of these tools.

DevOps demands a combination of development and operation knowledge and skill. For organizations, it is essential to have staff with the correct skills and expertise, as a shortage of adequately skilled staff can hinder the progress of DevOps adoption [8], [47]. Improving knowledge and skills in DevOps within an organization can be approached through various strategies. One effective method is implementing structured training and certification programs focusing on both theoretical and practical aspects of DevOps practices. This method includes courses on specific tools, software development practices, and operational procedures integral to DevOps. Another approach is to encourage collaboration and knowledge sharing among teams through regular meetings and discussion forums where team members can collectively exchange ideas and solve problems. Above all, the organization needs top management support to foster a culture of knowledge sharing.

Collaboration and communication became the second most crucial factor in DevOps implementation for software development projects, with a weight value of 20.14%. This result aligns with the findings of the study conducted by Jayakody and Wijayanayake, which identify a collaborative culture as one of the most critical success factors in DevOps implementation [58]. According to Table 8, collaboration and communication become the most critical factors from a time criteria perspective. As depicted in previous studies, collaboration and communication is a significant factor in implementing DevOps [27], [46], [47], [59], [60]. Collaboration and communication are the underlying culture of DevOps [47], [61]. Development and operations teams must share responsibilities, leading to more effective team communication [60]. Team dynamics, with knowledge and idea sharing, can improve collaboration within the team [60].

According to Table 8, infrastructure ranks third with a weight value of 16.96%. This condition aligns with previous studies that indicate implementing DevOps requires infrastructure support [48], [51], highlighting the necessity of robust infrastructure support for successful DevOps implementation. This result also aligns with Akbar *et al*., which found that tools are less critical than cultural factors [11]. Organizations looking to adopt DevOps should prioritize investments in their infrastructure, tools, and technology to ensure they can fully leverage the benefits of DevOps methodologies. Investing in scalable and flexible infrastructure solutions, such as cloud services and automated deployment tools, can facilitate more efficient workflows, enhance collaboration across teams, and ultimately lead to faster and more reliable product deliveries.

Following project success criteria, top management support plays a moderate role in DevOps success. However, top management support is the most critical factor influencing project success regarding scope criteria. Leadership plays a role in setting clear project objectives and defining project scope boundaries. With a clear understanding of the project, top management and the project team can prevent scope creep [62]. Regarding DevOps, Karunarathne *et al*. [47] stated that a lack of top management commitment slows down DevOps implementation. Top management should direct and enable the change process.

The lowest priorities are automation and transparency. This result differs from the findings of a study conducted by Rehman *et al*. which identified transparency as one of the most critical success factors in DevOps implementation [25]. Despite lower priorities, automation and transparency are also crucial in DevOps implementation. Automation streamlines processes, reducing manual intervention and enhancing efficiency, which is crucial for continuous integration and deployment practices that define DevOps. Thus, it can reduce the time needed to implement the project. On the other hand, transparency ensures that all team members have access to the same information, fostering an environment of trust and collaborative problem-solving. Though not at the top of the priority list, both elements play vital roles in maintaining the integrity and effectiveness of DevOps practices, ultimately contributing to the project's overall success.

4. CONCLUSION

This study aims to provide practical insights organizations can use to enhance their software development projects by effectively integrating DevOps and project management practices. The findings from this study reveal that the primary criterion for project success is stakeholder satisfaction, followed closely by quality and value creation. These results underscore the importance of aligning project outputs

with stakeholder expectations and emphasizing delivering high-quality products that generate substantial value. Knowledge and skills, collaboration and communication, and infrastructure emerge as crucial elements in DevOps software development projects. The proficiency and expertise of the development team in DevOps practices are vital, as is the ability to effectively communicate and collaborate across various departments. Additionally, robust infrastructure supports rapid iterations and deployments of DevOps methodologies.

From a practical standpoint, these findings suggest that organizations should focus on enhancing stakeholder engagement processes to obtain their expectations, prioritizing continuous improvement in product quality, and fostering an environment where innovation drives value creation. In theory, this study adds to what is already known by showing how the success criteria for project management and the key factors for DevOps implementation change over time. It gives a full picture of how these factors affect project outcomes.

This study's limitations include its focus on specific contexts that may not universally apply, potentially limiting the generalizability of the findings. Future work could investigate these relationships in various organizational settings or industry sectors to confirm the results' applicability. Additionally, examining the long-term impacts of these success factors and criteria in a broader range of DevOps environments could provide deeper insights and further validate the current study's conclusions. Future works can utilize another multi-criteria decision-making approach, such as PROMETHEE, fuzzy AHP, or TOPSIS.

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