

ISSN: 2088-7043

JURNAL SISTEM INFORMASI

JOURNAL OF INFORMATION SYSTEMS

Volume 21, Issue 2, October 2025

ISSN: 2088-7043

JOURNAL OF INFORMATION SYSTEMS

JURNAL SISTEM INFORMASI

Volume 21, Issue 2, October 2025

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Published by:

Faculty of Computer Science

Universitas Indonesia

ISSN: 2088-7043

JOURNAL OF INFORMATION SYSTEMS

JURNAL SISTEM INFORMASI

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Development of a Conceptual Framework for Implementing Learning Management System (LMS) in Higher Education: An Empirical Validation Study

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Abstract

Higher education institutions today face increasingly complex challenges in adopting and implementing Learning Management Systems (LMS) to improve student learning experiences. Although previous research regarding LMSs exists, it has not fully explored the findings of their conceptual framework through empirical studies of Critical Success Factors (CSFs). This research provides in-depth details about the development of a conceptual framework designed to guide the LMS implementation process in higher education settings. The Systematic Literature Review (SLR) method is used to identify and introduce the main elements in this conceptual framework. Furthermore, the conceptual framework was validated through a series of questionnaires distributed to experts in the fields of education and information technology. The results of this research show that the conceptual framework developed covers important stages in LMS implementation, from planning to evaluation. Empirical validation carried out involving experts proves that the conceptual framework developed is valid as an instrument for implementing LMS in a higher education environment. The conclusions of this research provide valuable guidance for LMS implementation in higher education.

Keywords: Learning Management System (LMS), Higher Education, Conceptual Framework, E-learning

* Corresponding Author

Introduction

Technological advances such as e-learning platforms, mobile applications, and digital learning media have made the world of education more affordable, accessible, and attractive for students. Rapid technological developments have changed the world of education to encourage innovation in learning (Mei et al., 2023). This technology allows educators to create interactive and personalized learning experiences, facilitates collaboration between students and educators, and provides access to extensive educational resources. With advances such as the internet, mobile devices, and digital platforms, students and educators have easier and broader access to the latest information, resources, and learning methods (Opoku et al., 2023).

Learning technology is a very important part of Higher Education Institutions. In this digital era, the use of technology has brought significant changes to learning methods in higher education (Yue et al., 2023). Through technology, higher education institutions can provide access to various resources and learning materials online, increasing flexibility for students to study according to their own schedule. Apart from that, technology also allows for better interaction and collaboration between students and lecturers through online discussion forums, e-learning platforms, and innovative communication tools such as the Learning Management System (LMS) (Cao & Jian, 2023). By utilizing this learning technology, it is hoped that higher education institutions can improve efficiency, quality of learning, and provide a more interactive and interesting learning experience for students.

LMS helps educational institutions to provide easy access and flexibility for students in accessing learning materials, assignments, and other resources. Apart from that, LMS also facilitates interaction and collaboration between students and lecturers through features such as discussion forums, virtual classrooms, and online communication tools. This allows students to actively participate in discussions, share ideas, and collaborate with other students and lecturers to promote effective learning (Strakos et al., 2023). LMS can monitor and evaluate student progress in real-time, so lecturers can provide faster feedback and more effective guidance. Not only that, LMS also helps improve the quality of institutional learning by providing better accessibility, increasing interaction and collaboration, monitoring student progress, and providing diverse learning resources (Nguyen, 2021).

The findings related to LMS implementation experienced several obstacles in terms of human resources (HR), infrastructure, and development processes. In terms of human resources, LMS implementation requires in-depth training and understanding from educators and administrative staff to be able to manage the system effectively (Renko et al., 2020). Apart from that, adequate technological infrastructure is also a problem, because LMS requires a stable internet connection and adequate hardware to be accessed properly by users (Asamoah, 2021; Van der Merwe et al., 2023). The LMS development process is also a concern because the use of technology that continues to develop requires a continuous development process so that the LMS remains relevant and effective in supporting learning. Apart from that, data security and information management issues are also a concern in LMS development (Gumasing et al., 2022).

Based on other findings regarding the implementation of LMS such as Moodle, several fundamental problems were found related to methodological factors. One of them is related to infrastructure and development processes (Shaame et al., 2023). This research found that factors such as accessibility, flexibility, and personalization from the learner's perspective were crucial in influencing satisfaction and continued intention to use an LMS (Lavidas et al., 2023). However, the fundamental problem that arises is related to the technological infrastructure, which may be inadequate to support effective use of the LMS (Shaame et al., 2023). In addition, the LMS development process can also be problematic, especially in terms of customization, interactivity, and personalization desired by students (Masrani et al., 2023).

Moreover, previous research on LMS has not investigated the findings of their framework in an empirical study of success factors (Alkarney & Albraithen, 2018; Allam et al., 2024; Al-Nuaimi & Al-Emran, 2021). Therefore, this research aims to fill this gap by conducting an in-depth analysis and designing a rigorous conceptual framework, which will be empirically tested. As such, this research aims to provide a more comprehensive understanding of the factors that contribute to the successful

implementation of an LMS and make a significant contribution to developing our understanding of the use of educational technology in the modern era.

This writing aims to create a conceptual framework as a form of understanding LMS implementation. This conceptual framework provides direction and guidance for educational institutions that wish to implement LMS in the learning process. In this writing, various aspects related to LMS implementation will be discussed, such as selecting an appropriate LMS platform, developing effective learning content, optimal teaching strategies, and evaluating LMS performance. By using this conceptual framework, it is hoped that educational institutions can optimize the potential of LMS to improve the quality of learning, increase interaction between students and lecturers, and increase efficiency in overall learning management. This research provides practical guidance and solutions that can be implemented flexibly according to the needs and goals of educational institutions.

Theoretical Background

Implementation of Learning Management System

The implementation of LMS in higher education has emerged as a critical strategy for facilitating digital transformation, supporting both online and blended learning environments. LMS platforms serve as centralized systems that manage, deliver, and evaluate educational content, offering opportunities for institutions to enhance instructional quality and operational efficiency ([Abogamous, 2022](#)).

The need for a structured framework is underscored by findings that LMS adoption involves both technological and human dimensions. Factors such as perceived usefulness, ease of use, and user satisfaction strongly influence user acceptance and continued usage of LMS tools ([Qendraj et al., 2022](#)). Moreover, successful LMS frameworks must account for diverse learning environments, technological innovations, and evolving pedagogical models ([Alotaibi, 2024](#)).

Related Work

Previous research has provided valuable insights into LMS usage in higher education, particularly around usability, learner satisfaction, and system quality. For instance, frameworks using Fuzzy VIKOR and ISO standards have been applied to assess LMS quality across multiple criteria ([Ayouni et al., 2021](#)). Studies have also emphasized the role of LMS in supporting innovation policies in universities, where LMS platforms like Moodle are seen as drivers of both pedagogical and managerial innovation ([Zabolotniaia et al., 2020](#)).

However, a key gap in the literature lies in the lack of empirical validation of the proposed frameworks. Many studies stop at the theoretical stage without testing the effectiveness of their models in real-world institutional contexts ([Veseli et al., 2025](#)). In addition, with the emergence of AI-integrated LMS platforms, there is a growing need to explore how these technological innovations influence personalization, assessment, and student engagement, while also addressing ethical and data security concerns ([Alotaibi, 2024](#)).

This study aims to address these gaps by developing a conceptual framework for LMS implementation that not only synthesizes insights from prior theoretical models but also empirically validates its effectiveness in a higher education setting. In doing so, the research contributes a practical tool that institutions can use to enhance LMS adoption and promote sustainable digital transformation in education.

Methodology

The systematic literature review (SLR) was the first step of this research to thoroughly understand LMS implementation in the higher education context. SLR is carried out by identifying and reviewing relevant literature, with a focus on key success factors and challenges in implementing LMS in higher education. The SLR method used is the approach of Barbara Kitchenham. The Kitchenham Method provides a systematic and structured framework for identifying, evaluating, and synthesizing scientific literature with the goal of gaining an in-depth understanding of a research topic. [Figure 1](#) shows that

there are three stages in using the Kitchenham method, namely planning, implementation, and reporting (Kitchenham & Charters, 2007).

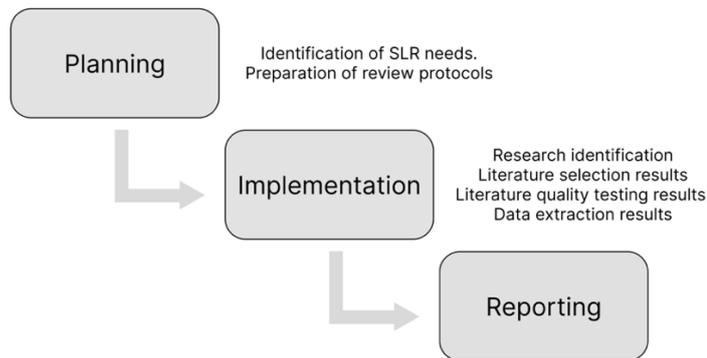


Figure 1. SLR Methodology

Planning

In the Kitchenham method, the first stage is planning. At this stage, a research design is carried out, such as creating a background, PICOC (Population, Intervention, Comparison, Outcome, and Context), and research questions. At this stage, we also determine the inclusion and exclusion criteria to be used to test the quality of the paper. The PICOC formula for this study is presented in Table 1.

Table 1. PICOC Formula

| | |
|---------------------|--|
| Population | Higher Education Academic Portal users are involved in implementing the Knowledge Management System (KMS). |
| Intervention | Implementation of a Knowledge Management System in Higher Education Academic Portals. |
| Comparison | - |
| Outcome | Evaluation of the effectiveness of the Knowledge Management System is related to the influence of KMS in the tertiary environment and the challenges faced in implementing KMS in tertiary institutions. |
| Context | The research context includes the university academic environment. |

Based on the PICOC formula, as previously mentioned, we formulated keywords for database searches. A literature search will then be carried out based on the keywords that have been determined. The search string is as follows: (“Knowledge Management Systems” OR “KMS”) AND (“Higher Education” OR “College”) AND (“Implementing” OR “Implementation”). We have selected five databases for our investigation, namely Scopus, Emerald Insight, IEEE Xplore, and ACM Digital Library. Consequently, we will explore relevant literature pertaining to our topic from these sources. Next, we formulated inclusion and exclusion criteria to be used for selecting papers obtained from the database search results. These criteria, shown in Table 2, will help ensure that only relevant and suitable papers are included in our analysis, thus maintaining the integrity and focus of our research.

After the selection process of titles, abstracts, and full texts, the next step involved quality assessment, which comprised eight quality indicators. A threshold value of 5 was set for the quality assessment. Hence, papers scoring below five were eliminated from further consideration. This rigorous quality evaluation ensured that only studies meeting the predefined quality standards were included in our analysis, thereby enhancing the reliability and robustness of our research findings.

Table 2. Inclusion and Exclusion Criteria

| Step | Criteria Inclusion | Criteria Exclusion |
|--|---|--|
| Initiation Stage | - Matches with search keywords - English - Publication year 2019-2024 | - Languages other than English - Year of publication excluding 2019-2024 |
| Stage 1 (Title and abstract selection) | - Discussing Knowledge Management - Research in higher education | - Papers that discuss topics other than the topic of Knowledge Management - Duplicate paper - Review paper |
| Stage 2 (full-text selection) | Open access paper | - The paper doesn't have full-text |

Implementation

At this stage, the selection process is conducted based on the protocol selection and review established during the planning phase. The implementation stage involves several steps, namely the Initiation Stage, Title and abstract selection, Full-text selection, and Quality Assessment. These four steps culminate in the generation of the final paper. The detailed workflow of these steps can be observed in [Figure 2](#) below.

**Figure 2. Papers Screening Steps**

Reporting

At the reporting stage, extraction and synthesis will be carried out from data obtained from the literature. Kitchenham emphasized that it should provide a summary of findings, identify patterns or trends, and examine similarities between the papers that have been reviewed ([Kitchenham & Charters, 2007](#)).

After that, the final SLR report is presented. The report must include all important elements found. In this research, the main findings refer to the influencing factors and challenges in implementing knowledge management systems in higher education. Kitchenham recommends that this research be written clearly and concisely, with complete references ([Kitchenham & Charters, 2007](#)).

From the results of the SLR analysis, three main stages in the LMS implementation process in higher education were identified. The following are the stages of LMS implementation in higher education: (a) Planning, (b) Implementation, and (c) Evaluation. From the SLR results, at the planning stage, the indicators found at that stage were identified, including: (a) Institutional Support Factor ([Mohammadi et al., 2021](#); [Sulaiman, 2023](#)), (b) ICT Infrastructure Factor ([Singh et al., 2023](#); [Sulaiman, 2023](#)) and (c) Human Resources Factor ([Singh et al., 2023](#); [Theresiawati et al., 2020](#)). Meanwhile, at the implementation stage, the identified indicators include: (a) Business Requirement ([Azarov & Mayboroda, 2020](#)), (b) System Design ([Kuadey et al., 2023](#); [Sulisworo et al., 2021](#)), (c) Development and Unit Testing ([Ean Heng et al., 2021](#)), (d) User Acceptance Test ([Ean Heng et al., 2021](#)), and (e) Implementation ([Meskhi et al., 2019](#); [Syed et al., 2021](#)). For the final stage, namely evaluation, the indicators identified are: (a) Support Training Factor ([Habib, 2023](#); [Sulaiman, 2023](#)) and (b) Maintenance Factor ([Habib, 2023](#)).

Based on the results of the SLR, a gap was identified, namely that the LMS is also part of the Information System (IS). Many LMS implementation processes only focus on the student, instructor, and institutional support aspects. There is a need to add the IS context aspect (development method). Moreover, previous research on LMS did not examine its framework findings in empirical studies of CSF findings. In this way, this research provides a framework for LMS implementation in higher education. This framework includes the key elements identified during the SLR. This conceptual

framework describes the structure and key elements that need to be considered in designing and implementing an LMS in higher education.

The developed framework was validated with four experts. The selection of four experts was based on pragmatic constraints, particularly the limited availability of qualified experts in the field of LMS implementation and accessibility within the scope and timeline of the study. These experts include academics with LMS expertise, practitioners who have experience implementing LMS in higher education, and educational technology experts. The validation process uses a questionnaire given to experts. The answer choices provided are in the form of a 1 to 4 Likert scale with the answer choices (a) Not Valid, (b) Fairly Valid, (c) Valid, and (d) Very Valid. For validated framework instruments, see [Table 3](#).

Table 3. Success Factors of Implementation of LMS

| No | Implementation Process | Indicators | References |
|----|------------------------|------------------------------|--|
| 1 | Planning | Institutional Support Factor | (Mohammadi et al., 2021 ; Sulaiman, 2023) |
| | | ICT Infrastructure Factor | (Singh et al., 2023 ; Sulaiman, 2023) |
| | | Human Resources Factor | (Singh et al., 2023 ; Theresiawati et al., 2020) |
| 2 | Implementation | Business Requirement | (Azarov & Mayboroda, 2020) |
| | | System Design | (Kuadey et al., 2023 ; Sulisworo et al., 2021) |
| | | Development and Unit Testing | (Ean Heng et al., 2021) |
| | | User Acceptance Test | (Ean Heng et al., 2021) |
| | | Implementation | (Meskhi et al., 2019 ; Syed et al., 2021) |
| 3 | Evaluation | Support training Factor | (Habib, 2023 ; Sulaiman, 2023) |
| | | Maintenance | (Habib, 2023) |

The study employed a mixed-method approach, combining a qualitative SLR with quantitative expert validation. The SLR was used to deeply explore existing theories and frameworks related to LMS implementation, while the quantitative phase ensured the empirical validation of the proposed framework through expert consensus. This approach was chosen to balance theoretical depth with practical relevance, making the framework both evidence-based and applicable in real-world contexts. Framework validation criteria for LMS implementation in higher education can be seen in [Table 4](#). Validation criteria adapted from ([Akbar, 2013](#); [Ratumanan & Laurens, 2006](#)).

Table 4. Validation Criteria for the LMS Implementation Framework in Higher Education

| Score | Value | Information |
|-------------|--------------|----------------------------------|
| 3.51 – 4.00 | Very Valid | Very good to use |
| 2.51 – 3.50 | Valid | Can be used with minor revisions |
| 1.51 – 2.50 | Fairly Valid | Can be used with major revisions |
| 1.00 – 1.50 | Not Valid | Must not be used |

Results and Discussion

Based on research conducted by [Alkarney and Albraithen \(2018\)](#), the implementation stage of the LMS in higher education has three phases, namely Pre-implementation, During-implementation, and Post-implementation. This research adopts the scheme in the formation of its framework, which also includes three phases, namely planning, implementation, and evaluation. By referring to this framework, this research aims to identify and analyse key aspects in each stage of LMS implementation in order to improve the effectiveness and success of the system as a whole.

The following conceptual model is presented in [Figure 3](#). This model comprises three distinct phases: planning, implementation, and evaluation, each of which delineates the crucial stages of the LMS implementation process. What sets our model apart is the incorporation of IS as an integral aspect. This addition is driven by the recognition that previous research has often overlooked the inclusion of IS within its models, thereby underscoring the significance of its role in ensuring a comprehensive understanding of LMS implementation dynamics ([Alkarney & Albraithen, 2018](#)).

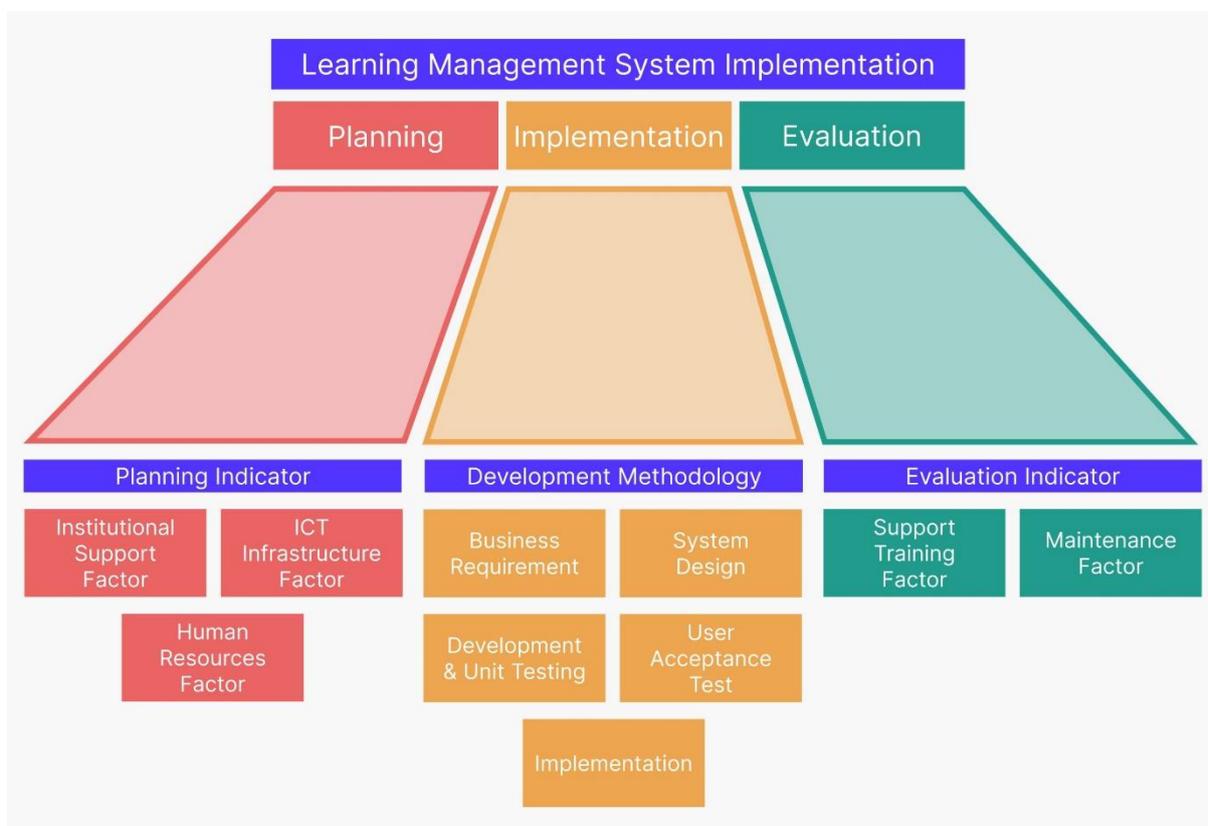


Figure 3. Conceptual Model Implementation LMS

The three phases outlined in our model depict a sequential flow that is crucial for the successful implementation of an LMS. The first phase, planning, serves as the foundational cornerstone of the entire process. In this phase, meticulous preparations are made, encompassing institutional support, infrastructure development, and human resource allocation. Planning is critical because it lays the groundwork for subsequent stages.

The implementation stage will explain how the framework development process takes place. We use an approach called System Development Life Cycle (SDLC) because LMS is basically an IS ([Alkarney & Albraithen, 2018](#)). This approach is inspired by knowledge that has been gathered from previous research on the success of information systems in business contexts. We refer to this business research because previous research on LMS Critical Success Factors (CSF) in higher education is still limited. In the business world, research has investigated a wider range of issues. As expressed by Alkarney & Albraithen, "e-learning systems are a specific type of information system".

The final aspect is evaluation, which includes a post-implementation stage involving ongoing training and routine maintenance efforts. These steps are critical to ensuring that the system is not only used as intended but also operates smoothly and efficiently according to established guidelines.

The validation of this framework was carried out by four experts who are experienced in the field of education. The first expert is a professor from the University of Indonesia who has in-depth knowledge in e-learning and Human Computer Interaction (HCI). The second and third experts come from the State University of Malang, both of whom are professors who have expertise in Vocational Learning Strategy Development in the fields of Informatics and Information Systems Management, as well as Learning Media Development. The final expert is a staff practitioner at the Ministry of Education and Culture who is responsible for managing the LMS. With the presence of these experts, framework validation can be carried out in depth and accurately.

After going through a validation test process by experts, the data that has been collected will be processed by calculating the average for each existing question indicator. The results of this average calculation will then be used to obtain the final score. Then the final score is converted into criteria according to [Table 5](#), which has been set. Thus, the data processing process will provide a clear picture of the results of the research that has been carried out.

[Table 6](#) is the result of validation by experts, which is very important in this research. Based on the final scores found in the table, it can be concluded that the validation test results by experts show a value of “valid”. This indicates that the framework used meets the required standards. However, there are several comments and suggestions for improvement from experts that can be taken into consideration for future improvements. Details regarding comments and improvements provided by experts can be found in [Table 7](#). Thus, the results of validation by these experts provide a strong foundation for the use of this framework, while continuing to improve it based on input from experts.

Table 5. Description of Indicators

| Indicators | Description |
|------------------------------|---|
| Institutional Support Factor | Institutional Support Factors include management commitment, budget allocation, and understanding of institutional needs. |
| ICT Infrastructure Factor | ICT Infrastructure Factors include e-learning content, connectivity, hardware, and software. |
| Human Resources Factor | The Human Resources Factor involves the training needs of lecturers and staff to maximize the benefits of the LMS, user readiness, and determining the roles and responsibilities of the implementation team. |
| Business Requirement | Define business requirements, including required features and functionality. |
| System Design | Designing systems based on previously established business needs and requirements. |
| Development and Unit Testing | Build the LMS based on the design that has been created and carry out unit testing to ensure each component functions properly. |
| User Acceptance Test | Involve end users to test the system and ensure that the LMS meets their expectations and needs. |
| Implementation | Execute formal LMS implementation, including data migration, system configuration, and operational rollout. |
| Support training Factor | Provide ongoing support to LMS users, including advanced training and supporting resources. |
| Maintenance | Ensure continuity and sustainability of the LMS through routine maintenance, software updates, and addressing emerging issues. |

Input provided by experts is of primary concern to researchers in order to make necessary improvements. Referring to [Table 7](#), this input includes various valuable comments related to the existing framework. The experts also provided recommendations regarding further implementation, corrections to existing stages, and suggestions regarding the flow of the framework being developed. This input will be an important basis in efforts to improve and refine the framework so that it can provide better results and meet the needs of this research.

Table 6. Results of Validating the Conceptual Framework for LMS Implementation

| Items | Experts | | | | Average |
|------------------------------|---------|----|-----|----|---------|
| | I | II | III | IV | |
| Institutional Support Factor | 3 | 3 | 4 | 4 | 3.5 |
| ICT Infrastructure Factor | 3 | 3 | 4 | 4 | 3.5 |
| Human Resources Factor | 3 | 3 | 4 | 3 | 3.25 |
| Business Requirement | 3 | 3 | 4 | 4 | 3.5 |
| System Design | 3 | 4 | 4 | 3 | 3.5 |
| Development & Unit Testing | 3 | 3 | 4 | 4 | 3.5 |
| User Acceptance Test | 3 | 3 | 4 | 3 | 3.25 |
| Implementation | 3 | 4 | 4 | 3 | 3.5 |
| Support Training Factor | 3 | 4 | 4 | 4 | 3.75 |
| Maintenance Factor | 3 | 4 | 4 | 4 | 3.75 |
| Average | | | | | 3.5 |

Table 7. Expert Recommendations Regarding the Conceptual Framework for LMS Implementation

| Experts | Suggestions |
|------------|--|
| I | It is necessary to see to what extent this proposed conceptual framework intersects with existing frameworks, such as Khan's e-Learning framework, as well as information system implementation frameworks in general. |
| II | It's good enough; it needs to be implemented in several agencies. |
| III | It would be better if there were a design stage before implementation. |
| IV | Having described the implantation process, it would be good to provide arrows to illustrate the flow from the start of the process to the end. |

Limitations and Future Research

This study, like any other study, has several limitations that need to be noted. The first limitation is the scope of the research, which only focuses on creating frameworks in higher education environments, without considering other levels of education. These limitations may imply that the research results cannot be fully applied to different educational contexts. Furthermore, another limitation lies in validation. Validation in this research mainly focuses on the conceptual results of the framework developed. Therefore, other potentially relevant aspects, such as practical validity, have not been explored in depth. In planning future research, it is important to consider and overcome these limitations so that research results are more comprehensive and generalizations can be made more precisely.

This research provides important recommendations regarding future research directions. First, further research should focus on providing empirical validation in other relevant aspects, such as implementation aspects and the relationship between variables in the framework that has been developed. This will help strengthen the empirical foundations of the framework and explain in more detail how it can be applied in practical situations.

Furthermore, to further enrich the research findings, future research can be explored further at other educational levels. This will help in understanding how this framework can adapt and provide benefits in a variety of different educational contexts. Thus, these recommendations provide important guidance for researchers who wish to continue this study and take this research as a starting point for further development of knowledge in this area.

Conclusion

This research succeeded in developing a conceptual framework from the literature study that was carried out. Indicators identified in the literature study regarding success factors in implementing LMS in higher education include institutional support factors, ICT infrastructure factors, human resources factors, business requirements, system design, development and unit testing, user acceptance tests, implementation, training support factors, and maintenance factors. This conceptual framework can be used to implement LMS in higher education. These findings provide insight into the factors that need to be considered in designing a conceptual framework according to the needs of higher education.

After the conceptual framework was formed, an expert validation procedure was designed using a questionnaire to assess the suitability and feasibility of the LMS implementation framework in the higher education environment. Expert validation confirmed that the developed framework complies with the indicators required for the implementation of a learning LMS in higher education. Even with good results, slight revisions to the conceptual framework need to be made. In addition, input from experts will be a valuable contribution to future research.

This research succeeded in achieving its main objective, namely, developing a conceptual framework for implementing LMS in higher education. The results of expert validation are the main pillars that strengthen the validity and feasibility of the framework developed. This validation process involves experts who have expertise and experience in the field of higher education and learning technology.

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How to cite:

Akhsan, R. R., Putra, D. L. S., Sensuse, D. I., Hidayat, D. S., & Purwaningsih, E. H. (2025). Development of a Conceptual Framework for Implementing Learning Management System (LMS) in Higher Education: An Empirical Validation Study. *Jurnal Sistem Informasi (Journal of Information System)*, 21(2), 1–12.

Exploration of Barriers and Strategies for Implementing Green Information System at the Directorate of Information Technology Universitas Brawijaya

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Abstract

This study explores user perceptions of Green Information Systems (GIS) at the Directorate of Information Technology (DTI), Universitas Brawijaya, and identifies strategies for enhancing GIS adoption using the Persuasive System Design (PSD) framework. Data were collected through semi-structured interviews with four employees from various roles, including system administrators and managerial staff. Using thematic analysis and coding processes (open, axial, and selective), findings reveal positive perceptions of GIS, particularly in energy management through server virtualization, document digitalization, and e-waste management. However, challenges such as the absence of formal policies, central regulations hindering digitalization, and a lack of automated energy monitoring persist. Recommended strategies include automated sleep modes integrated with cybersecurity education, regulatory advocacy for digitalization, and campaigns on e-waste management. The integration of Green IS with cybersecurity offers an innovative approach to accelerate GIS adoption while improving data protection, supporting sustainable IT operations at DTI Universitas Brawijaya.

Keywords: Green information system, persuasive system design, power management, document digitization, electronic waste management

Introduction

Universitas Brawijaya has positioned itself as a “Green Campus,” with various initiatives focused on expanding green open spaces and conserving biodiversity. Studies indicate that Universitas Brawijaya’s

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open spaces meet the criteria for a Green Campus, contributing to CO₂ reduction and environmental sustainability (Selaniar, 2014). Additionally, Universitas Brawijaya has introduced several environmental policies, such as biodiversity conservation and the establishment of an environmental research laboratory (Universitas Brawijaya, 2024a). However, despite these physical sustainability efforts, Green Information Systems (GIS) adoption at Universitas Brawijaya remains underdeveloped. There are no specific policies addressing sustainable GIS practices, such as energy-efficient infrastructure, e-waste management, or paperless digitalization initiatives. This gap highlights the lack of a comprehensive GIS strategy, despite its potential to enhance environmental sustainability and institutional efficiency. The adoption of GIS often faces challenges such as user resistance, lack of supportive regulations, and the need for adequate infrastructure (Rahkonen & Dietrich, 2023).

Globally, many universities have begun integrating Green Information Systems (GIS) into their sustainability strategies. Research suggests that GIS involves the environmentally conscious use of information systems and has been widely implemented in leading institutions worldwide (Sukarman, 2018). However, in Indonesia, GIS adoption remains limited, facing challenges such as technological complexity, infrastructure constraints, and weak regulatory support (Murugesan, 2008). Previous research highlights several critical factors related to GIS implementation. Kirchner-Krath et al. (2024) observed that user resistance to GIS is triggered by a lack of understanding of its benefits, concerns about changes to work habits, and perceived incompatibility with existing systems. Pal (2023) emphasized the importance of staff training, investment in green infrastructure, and interdisciplinary approaches to support the success of green technology in higher education. Meanwhile, Shevchuk and Oinas-Kukkonen (2020) proposed using the Persuasive Systems Design (PSD) framework to enhance GIS adoption through persuasive and user behaviour-based system approaches.

This study aims to explore user perceptions of GIS at the Directorate of Information Technology (DTI) Universitas Brawijaya and identify PSD-based strategies to enhance GIS adoption. This approach is expected to address major barriers and make GIS implementation more effective in supporting sustainable IT operations in higher education institutions. Figure 1 illustrates the organizational structure of the DTI at Universitas Brawijaya.

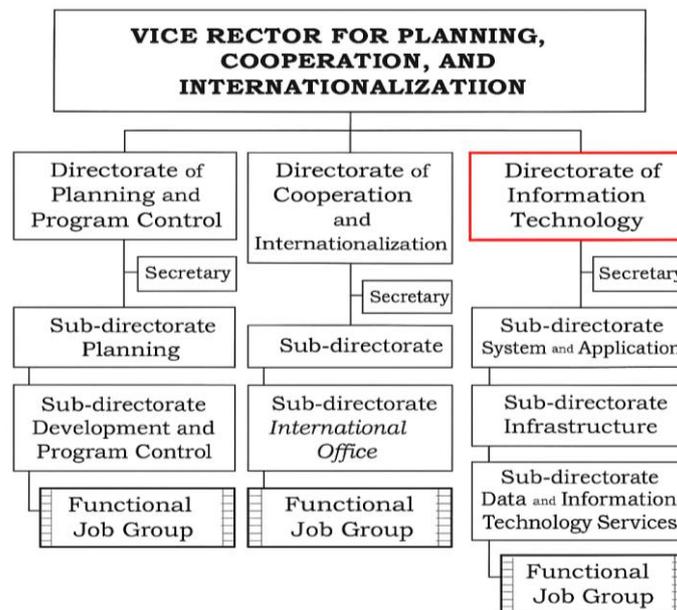


Figure 1. Organizational Structure of DTI Universitas Brawijaya (Universitas Brawijaya, 2024c)

The DTI at Universitas Brawijaya operates under the Vice Rector for Planning, Cooperation, and Internationalization. It comprises three key sub-directorates: Systems and Applications, Infrastructure, and Data and Information Technology Services. These divisions reflect the unit's organizational structure and focus areas in managing technology and information services. Beyond developing IT

infrastructure, DTI ensures optimal service delivery through its sub-directorates, emphasizing its strategic importance in supporting education and research at Universitas Brawijaya.

Literature Review

GIS focuses on the efficient and environmentally friendly use of information and communication technology. According to [Murugesan \(2008\)](#), GIS involves practices such as reducing energy consumption, using energy-efficient devices, and effectively managing electronic waste. In Indonesia, data from the Ministry of Environment and Forestry (KLHK) shows that electronic waste amounts to 1.3 million tons annually. The primary variables in this study are the level of awareness and adoption of Green Information Systems practices. This study will employ a qualitative thematic analysis to explore four aspects of GIS: power management, paper usage, data storage (server), and waste management.

[Kirchner-Krath et al. \(2024\)](#) focus on the challenges of GIS adoption within organizational contexts, employing theories such as Activity Theory, Innovation Diffusion Theory, and Technology Adoption Theory to explore adoption barriers at various stages. Their research highlights dilemmas such as social pressure, company regulations, and extrinsic environmental influences that impact GIS adaptation. This research intersects with the study of GIS in educational settings, offering insights into improving administrative efficiency in educational institutions.

[Pal \(2023\)](#) emphasizes the importance of staff training, investment in green infrastructure, and interdisciplinary approaches to integrating sustainable technology into higher education. Their findings point out challenges such as financial constraints, institutional resistance, and the need for digitalization to promote sustainability. This supports the relevance of continuous training and digitalization strategies in GIS adoption at Universitas Brawijaya.

[Shevchuk and Oinas-Kukkonen \(2020\)](#) explore Persuasive Systems Design (PSD) as a framework to enhance GIS adoption through user behavior-based design. They suggest that a well-structured PSD framework can assist in integrating regulations and solving daily challenges faced by employees in the education sector. This research highlights the potential for applying PSD principles to overcome resistance and regulatory obstacles in GIS implementation at DTI Universitas Brawijaya.

[Figure 2](#) illustrates that the Persuasive Systems Design (PSD) model offers a three-stage approach to system development: understanding fundamental issues influencing persuasive system design, analyzing the persuasion context, including intentions, events, and strategies, and designing or evaluating system quality and features to achieve persuasive goals. In this research, the problem formulation focuses on the context of persuasion (Analyzing the Persuasion Context), which aims to enhance GIS adoption at DTI Universitas Brawijaya. To achieve this, four main pillars are necessary: primary task support, dialogue support, system credibility support, and social support ([Oinas-Kukkonen & Harjumaa, 2009](#)).

Primary Task Support simplifies complex tasks into manageable steps with seven principles. Reduction simplifies tasks, Tunnelling guides users through processes, Tailoring ensures relevant information, and Personalization offers personalized content for better engagement. Self-monitoring allows users to track their progress, simulation demonstrates cause-and-effect relationships, and Rehearsal provides a practice environment. Dialogue Support enhances communication through seven principles, including Praise for positive behaviour, Rewards for achievements, Reminders for goal tracking, and Suggestions for relevant recommendations. Similarity and Liking create user engagement, while Social Role serves as a mentor figure for additional support.

System Credibility Support builds trust through principles such as Trustworthiness for accurate information, Expertise for reliable knowledge, Surface Credibility for a professional impression, and Real-world Feel for human or organizational presence. Authority, Third-party Endorsements, and Verifiability are used to strengthen system credibility. Social support leverages social influence to encourage behaviour with seven principles, including Social Learning, Social Comparison, Normative Influence, and Cooperation, while Competition and Recognition motivate behaviour through comparison and public acknowledgment.

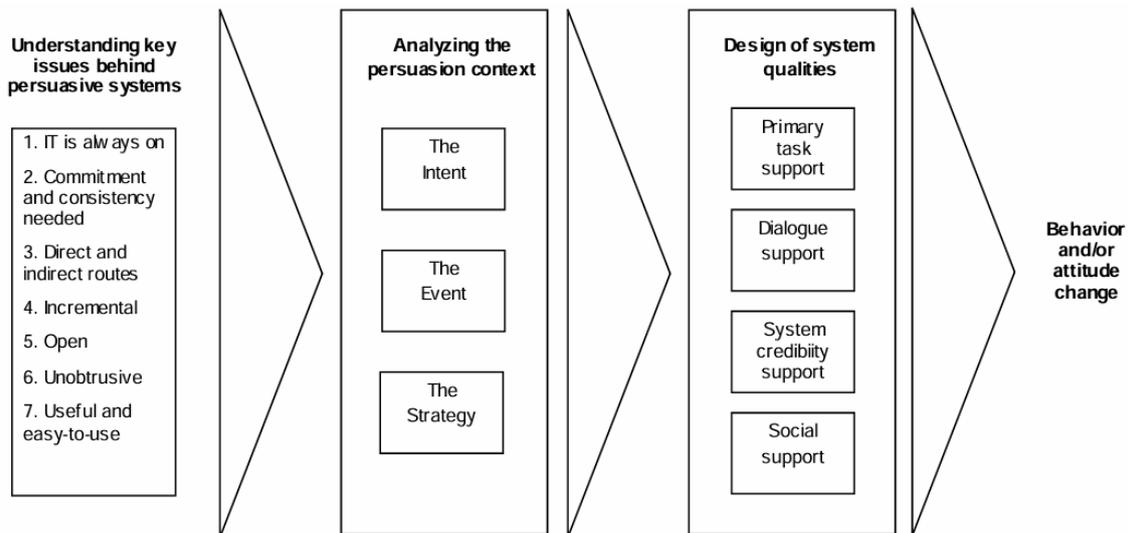


Figure 2. Persuasive Systems Design (PSD) Framework
([Oinas-Kukkonen & Harjumaa, 2009](#))

Methodology

This study employs a qualitative approach using a case study method, with data collection conducted through interviews to identify factors influencing perceptions and the adoption of GIS at the DTI at Universitas Brawijaya. Primary data was collected through semi-structured interviews with four respondents directly involved in GIS implementation. Respondents were selected from various levels, ranging from directors to sub-directorate staff, to ensure a comprehensive representation of work experiences related to the research topic. Respondent selection was conducted through purposive sampling to maximize the relevance of the obtained data.

Data processing will be carried out using Coding principles. Coding is a crucial step in the research process involving the organization of collected data by grouping or simplifying the data into more manageable categories ([Charmaz, 2006](#), in [Yukhymenko et al., 2014](#)). Coding consists of three main stages: open coding, axial coding, and selective coding, which are used to derive findings from the research ([Corbin & Strauss, 2008](#), in [Vollstedt & Rezat, 2019](#)).

The first stage in the coding process is open coding. Open coding involves breaking down, analyzing, comparing, conceptualizing, and categorizing data into specific groups ([Corbin & Strauss, 2008](#), in [Vollstedt & Rezat, 2019](#)). The second stage, axial coding, focuses on connecting main categories with subcategories and reorganizing categorized data to support the analysis being conducted ([Charmaz, 2006](#), in [Yukhymenko et al., 2014](#)). The final stage, selective coding, integrates the identified categories and organizes them into a systematic narrative or model ([Corbin & Strauss, 2008](#), in [Vollstedt & Rezat, 2019](#)).

Data validation was carried out through source triangulation and expert triangulation. First, interview results were consistently compared among respondents to ensure no bias or information inconsistencies. Second, validity sheets were sent back to respondents for direct verification with signatures. This layered triangulation ensures that the research findings are highly accurate and credible, providing deep insights into the implementation of GIS at DTI Universitas Brawijaya.

Thematic analysis results were aligned with the PSD framework, consisting of four main pillars: Primary Task Support, Dialogue Support, System Credibility Support, and Social Support. Each finding in this study was categorized under the principles of the PSD framework to generate relevant practical recommendations.

Results

The results of this study are derived from a thematic analysis of interviews conducted at the DTI, Universitas Brawijaya, following the coding process (open coding, axial coding, and selective coding) and aligned with the PSD framework. This section presents the analysis based on four key aspects: power management, paper usage, data storage, and electronic waste management. Interviews were conducted with four (4) employees at DTI Universitas Brawijaya, consisting of system administrators and managerial staff. After transcription, the data were analyzed to identify recurring themes, allowing for a structured exploration of the challenges and opportunities in GIS adoption at DTI Universitas Brawijaya. The following subsections detail these findings, supported by direct quotes from respondents for authenticity.

Regarding power management, DTI Universitas Brawijaya does not have a formal policy on energy efficiency. Instead, power-saving measures, such as turning off devices (lights, air conditioning, and monitors) after working hours, are only practiced as informal habits rather than enforced regulations. This results in inconsistent implementation across different units. One respondent stated, *“There is no written regulation; everything is based on habit.”* (Respondent 4). While server virtualization has reduced the number of physical devices and improved energy efficiency, capacity adjustments are still managed manually due to the unreliability of past automation attempts. As one respondent noted, *“So far, it has been done manually because when we tried automation, it did not meet expectations.”* (Respondent 1). Additionally, certain servers must remain operational 24/7 to support university services, creating a challenge in optimizing power consumption. *“Some PCs must remain on continuously because they are connected to university services.”* (Respondent 3). Another major issue is the absence of external energy audits, meaning there is no standardized benchmark for energy consumption efficiency.

In terms of paper usage, digitization efforts through *Pendapa*, an application for document processing and e-signatures, have significantly reduced paper consumption in administrative processes. *“We try to digitize as much as possible. The Pendapa application allows us to create and send documents without needing to print them.”* (Respondent 2). However, central regulations still mandate the physical printing of financial documents and certain certificates, limiting the full transition to paperless operations. *“The central office in Jakarta requires printed documents with physical signatures and stamps.”* (Respondent 1). Another challenge is the lack of standardized policies for digital documents across external organizations, making electronic certificates and documents less widely accepted. *“We anticipate that many companies still prefer conventional certificates instead of digital ones.”* (Respondent 2). Despite these obstacles, DTI UB continues to promote paperless workflows, aiming to cut costs, minimize paper waste, and improve bureaucratic efficiency. *“Going paperless helps reduce costs and improve productivity by eliminating bureaucratic delays.”* (Respondent 2).

For data storage, DTI Universitas Brawijaya primarily uses on-premise storage due to security concerns, cost efficiency, and improved access speeds. Storing large volumes of data on the cloud is considered expensive and raises security risks. One respondent highlighted, *“Since our data is already very large, moving it to the cloud would be more costly.”* (Respondent 1). Additionally, *“For security reasons, we prefer to store data in our own data center.”* (Respondent 1). Cloud services, such as Google Drive, are only used for specific purposes, while most university services remain on-premises to ensure better control over data. *“Some services, like Google Drive, are available for all users, but other major services remain on-premise.”* (Respondent 3). Furthermore, energy monitoring at the data center helps optimize operations and bandwidth allocation, reducing latency and improving performance. *“Because data is stored locally, bandwidth usage is more optimized, and latency is reduced.”* (Respondent 1).

In the case of electronic waste management, DTI Universitas Brawijaya manages e-waste using SIMASTER, an asset management application that tracks and stores damaged electronic equipment before disposal. *“For disposal, we follow internal regulations. We also have a storage facility for damaged items.”* (Respondent 2). Devices that are still functional but outdated are often redirected to other units, such as the university library. *“Instead of immediate disposal, we transfer old but usable devices to other units, like the library.”* (Respondent 1). The most frequently upgraded devices are access points, as they need to support an increasing number of users and evolving technological

demands. “Access points are frequently replaced to improve capacity and serve more users.” (Respondent 2). Additionally, the procurement of new equipment is managed through SIREKA, an application that ensures that technical specifications meet operational requirements. “We use SIREKA, an information system for procurement planning, to ensure that technical specifications are clearly defined and prevent mismatches.” (Respondent 2).

Thematic analysis findings were then mapped onto the Persuasive Systems Design (PSD) framework. In the Primary Task Support category, DTI Universitas Brawijaya has implemented the principle of Reduction through the *Pendapa* application, which simplifies paper management and improves administrative efficiency. However, Tunneling has not been systematically applied, as there is no structured step-by-step guide for users to adopt environmentally friendly behaviors. Tailoring is evident through server virtualization based on service needs, but Personalization remains minimal since the system does not offer customized experiences for users. Moreover, Self-monitoring is absent, as there are no tools to track individual energy consumption or carbon footprints.

In the Dialogue Support category, Reminders exist through verbal instructions to turn off electronic devices, but Praise and Rewards are not integrated into the system, meaning users do not receive recognition for environmentally friendly actions. Suggestions are also lacking, as the system does not proactively offer energy-saving recommendations. Similarly, Social Role elements, such as mentoring features, are absent, reducing opportunities for guided sustainability efforts.

Regarding System Credibility Support, DTI Universitas Brawijaya demonstrates Trustworthiness through accurate and transparent monitoring systems and SIMASTER, which enhance trust in IT management. Expertise is evident in the implementation of server virtualization, reflecting the institution’s technical capabilities. However, Surface Credibility and Real-world Feel are underdeveloped, particularly in the professional representation and visibility of GIS initiatives. Third-party Endorsements and Verifiability are also lacking, as there is no external validation or certification supporting DTI Universitas Brawijaya’s sustainability efforts.

In the Social Support category, GIS adoption at DTI Universitas Brawijaya remains limited. Social Learning and Social Comparison are not yet implemented, meaning users cannot compare their sustainability efforts with peers. Normative influence is weak, as no institutionalized social norms promote sustainable IT practices. Social Facilitation and Cooperation exist informally, particularly in shared efforts to turn off unused devices, but these initiatives are not embedded in the GIS system. Competition and Recognition mechanisms are absent, despite their potential to encourage participation through incentives and awards for energy-saving efforts.

Therefore, DTI Universitas Brawijaya has adopted some GIS principles, particularly in Reduction (paperless workflows), Reminders (verbal energy-saving habits), and Trustworthiness (accurate system monitoring). However, most PSD principles remain underdeveloped, particularly in Self-monitoring, Rewards, Social Learning, and Competition. To enhance GIS adoption, DTI Universitas Brawijaya should establish formal energy policies, introduce automated energy monitoring tools, develop incentive programs, and integrate PSD-based feedback mechanisms to encourage sustainable behavior. These improvements will help create a more persuasive and effective system to support environmentally responsible IT practices at Universitas Brawijaya.

The findings of this study align with existing literature in several areas. For instance, the challenge of inconsistent user behavior in energy-saving practices due to the absence of formal policies at DTI Universitas Brawijaya mirrors findings by Kirchner-Krath et al. (2024), who emphasized that user resistance often stems from unclear internal regulations and a lack of structured incentives. The server virtualization efforts at DTI Universitas Brawijaya resemble the strategies proposed by Meenakshi et al. (2020), which highlight the effectiveness of local data storage optimizations in reducing energy consumption. Similarly, DTI Universitas Brawijaya’s difficulty in achieving a fully paperless environment due to external regulations is consistent with Ahmad et al. (2013), who identified the need for a uniform policy and organizational awareness for successful digital transformation. Moreover, the integration of document digitization at DTI Universitas Brawijaya echoes the approach outlined by Anuradha (2024), who stressed the importance of internal digitization practices in fostering sustainability. However, DTI Universitas Brawijaya has yet to implement comprehensive Persuasive

Systems Design (PSD) mechanisms such as simulation, competition, and rewards—an area where Shevchuk and Oinas-Kukkonen (2020) argue significant improvements can be made to increase user engagement and behavioral change.

Discussion

Users at DTI Universitas Brawijaya recognize the importance of power efficiency, particularly through server virtualization, which has significantly reduced energy consumption. However, the absence of formal energy policies has resulted in inconsistent implementation of power-saving practices, such as sleep time automation and unused device management. While some staff members turn off devices after working hours, these efforts remain informal and unregulated. According to [Wen & Hung \(2007\)](#), implementing dynamic sleep time intervals through measured power management can improve efficiency. Similarly, [Fan et al. \(2017\)](#) highlight that integrating multi-level sleep modes via GreenSleep can further optimize power savings. Unlike previous studies that emphasize energy-saving automation, DTI Universitas Brawijaya still relies on manual interventions, which may lead to inefficiencies. Thus, adopting a measurement-based sleep time mechanism, combined with formalized internal energy policies, could help standardize power-saving behaviors. Additionally, Self-monitoring features should be integrated to allow users to track energy consumption in real-time, aligning with findings from [Kirchner-Krath et al. \(2024\)](#), which suggest that monitoring tools enhance user engagement with sustainability initiatives.

Beyond energy efficiency, the integration of cybersecurity measures into automated sleep modes could provide dual benefits: reducing power consumption while safeguarding sensitive data. Research by [Shevchuk & Oinas-Kukkonen \(2020\)](#) suggests that PSD can improve adoption by incorporating elements like Reminders and Self-monitoring. For instance, a notification system that alerts users about prolonged device inactivity could serve as a gentle reminder while also reinforcing cybersecurity measures. To further incentivize energy-saving behavior, DTI Universitas Brawijaya could implement a Rewards system, where teams that consistently reduce energy consumption receive institutional recognition or benefits. The digitalization of administrative systems at DTI Universitas Brawijaya, including electronic document management and digital signatures, has led to significant reductions in paper usage and improved process efficiency. However, regulatory barriers remain, particularly the requirement for physical signatures on certain financial documents, which hinders a full transition to paperless operations. Research by [Anuradha \(2024\)](#) highlights that digital transformation is a key component of environmentally friendly practices, yet [Ahmad \(2013\)](#) argues that successful adoption depends on collective awareness and uniform policies. DTI Universitas Brawijaya's experience aligns with these findings, as inconsistent national regulations on digital documents have limited its ability to implement a fully paperless system.

To strengthen Dialogue Support, DTI Universitas Brawijaya could introduce institutionalized education campaigns that highlight the security and efficiency benefits of digitalization. Additionally, System Credibility Support can be improved by securing third-party endorsements, such as ISO certification for digital document security, to build greater trust and legitimacy in the institution's paperless initiatives. Expanding Social Support mechanisms—such as creating a knowledge-sharing platform where staff members can exchange best practices on digitalization—could further facilitate acceptance of digital transformation efforts. While DTI Universitas Brawijaya has made significant strides in implementing Green IS principles, critical gaps remain in Self-monitoring, Competition, and Rewards. Introducing real-time monitoring dashboards for power usage, institution-wide sustainability competitions, and incentive programs can enhance user engagement and accelerate adoption. By integrating these Persuasive System Design elements, DTI Universitas Brawijaya can move beyond informal sustainability efforts toward a structured, long-term Green IS strategy that is both effective and scalable.

On-premise data storage at DTI Universitas Brawijaya is valued for its cost efficiency and enhanced security, especially for large-scale data. Despite the global shift toward cloud services for lower carbon footprints, on-premise solutions remain crucial due to data characteristics and security concerns. [Arya et al. \(2020\)](#) propose strategies like proxy and power management to enhance local data storage

efficiency. [Rahkonen & Dietrich \(2023\)](#) suggest hybrid storage models combining on-premise and cloud to balance security and carbon reduction. Implementing automated energy monitoring systems could further optimize DTI Universitas Brawijaya's data center operations. Primary Task Support has been implemented by DTI Universitas Brawijaya, proven by opting for on-premise storage solutions tailored to specific needs. However, the lack of Self-monitoring for energy consumption management limits efficiency. Introducing a hybrid approach with automated energy monitoring, supported by System Credibility Support through Verifiability, will help maintain data security while improving sustainability. Furthermore, educating users on data security and energy efficiency is crucial to enhancing the effectiveness of these storage solutions.

Waste management at DTI Universitas Brawijaya is regarded as effective through the use of SIMASTER, which provides systematic tracking and reuse of electronic equipment. However, increasing awareness of sustainable waste management remains a challenge. [Anuradha \(2024\)](#) emphasizes the importance of circular economy approaches, where reuse and recycling are prioritized. [Ahmad et al. \(2013\)](#) highlight that social awareness and education can drive better waste management practices. DTI Universitas Brawijaya can further enhance these efforts by launching internal campaigns and providing incentives for sustainable electronic waste management. This analysis highlights that DTI Universitas Brawijaya utilizes Primary Task Support through the SIMASTER application for electronic waste management, adhering to the Reduction principle. Yet, the absence of Simulation features to visualize the impact of recycling limits the effectiveness. Enhancing Dialogue Support with rewards for units excelling in waste management can promote better adoption. Integrating education on electronic waste management with cybersecurity awareness ensures a more comprehensive approach to Green IS, aligning with both Security and Normative Influence principles.

Implications

This study contributes to the growing body of knowledge on GIS implementation by demonstrating how user perceptions and institutional practices interact within a higher education setting in Indonesia. Unlike many previous studies that focus on Western or corporate contexts, this research offers insights from a public university environment where regulatory, infrastructural, and cultural limitations shape sustainability efforts. From a theoretical perspective, this study reinforces the relevance of the PSD framework in analyzing GIS adoption. It expands upon the framework by applying it not only to individual user behavior but also to institutional policy gaps, offering a broader lens for interpreting persuasive design elements in organizational settings.

Practically, this study informs university policymakers and IT directors about critical areas for intervention, such as the need for formal energy efficiency policies, reward systems, and digital document standardization. By connecting GIS practices with cybersecurity and digital administration, this research advocates for an integrated sustainability strategy. These findings can serve as a roadmap for similar institutions seeking to transition toward sustainable IT practices without significant infrastructural overhaul. This study also points to a promising direction for future research exploring the relationship between cybersecurity and Green IS, particularly in the context of automated energy-saving features such as sleep modes. Investigating how these two domains can complement each other, ensuring both operational sustainability and data security, may lead to the development of more holistic system designs tailored for educational and public sector institutions.

Conclusion

This study reveals that user perceptions of the benefits and challenges of Green IS practices at the DTI Universitas Brawijaya are generally positive, despite notable obstacles. Power management has demonstrated efficiency through server virtualization, yet the lack of formal policies, such as automated sleep mode mechanisms, remains a challenge. Paper usage has been minimized through digitalization, but central regulations mandating the use of physical documents continue to be a hindrance. On-premise data storage is deemed suitable for DTI Universitas Brawijaya's needs, although energy monitoring audits and cloud integration require further development. Electronic waste management has been

systematically conducted using the SIMASTER application, but increasing user awareness of sustainability still needs enhancement.

Strategies to enhance the adoption of Green IS practices at DTI Universitas Brawijaya can leverage PSD principles. These include educating users about power management through posters, reminders, and formalizing internal policies (Social Support and Normative Influence) related to sleep mode procedures for idle computers or laptops (System Credibility Support). Continuous advocacy for paperless practices across all units interacting with DTI, including central financial policymakers (Dialogue Support), is essential. Conducting specific internal audits to evaluate Green IS behavior, covering both user habits and server performance (System Credibility Support), should be prioritized. Additionally, implementing education and reward systems for sub-directorates that successfully maximize the use of tools before replacement (Third-party Endorsements, Rewards) is recommended to foster sustainable practices.

To further promote Green IS adoption, DTI Universitas Brawijaya should establish formal policies related to power management, including education and formal regulations for implementing automatic sleep mode integrated with cybersecurity measures. Continued advocacy with central financial authorities is necessary to support the adoption of digital document standards and address regulatory barriers. User education on electronic waste management needs to be reinforced through targeted educational campaigns and reward programs. This study is limited by its small sample size and focus on a single institution. Future research should explore larger-scale implementations and the intersection between GIS and cybersecurity.

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How to cite:

Yustan, R., Maghfiroh, I. S. E., & Aknuranda, I. (2025). Exploration of Barriers and Strategies for Implementing Green Information System at the Directorate of Information Technology Universitas Brawijaya. *Jurnal Sistem Informasi (Journal of Information System)*, 21(2), 13–22.

Cross-Border Data Security: Analysis of High-Profile Violations and Mitigation Strategies

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Abstract

This study investigates patterns of large-scale data breaches at Facebook (2019), SolarWinds (2020), Tokopedia (2020), and LinkedIn (2021) using a qualitative descriptive case study method. Data were obtained from credible media sources, academic articles, and official publications and analyzed using the CIA Triad paradigm (Confidentiality, Integrity, Availability). Results show that confidentiality is the most frequently violated dimension, mainly due to weak Application Programming Interface (API) controls and inadequate encryption. Integrity and availability also emerge as major issues in supply chain cases. The analysis follows technical, administrative, and physical controls outlined in ISO/IEC 27002 and NIST SP 800-Rev. 1. This study highlights the importance of integrating technical safeguards with global regulatory frameworks, including the European General Data Protection Regulation, China's Personal Information Protection Law, and Indonesia's Personal Data Protection Law. Theoretically, it validates the CIA Triad as a risk classification tool and proposes mitigation strategies to strengthen cybersecurity resilience across jurisdictions.

Keywords: Cross-border data security, data breaches, CIA Triad, encryption, API protection, cybersecurity policy

Introduction

The surge in cross-border data transfer has led to increased data breaches spanning multiple jurisdictions. This trend is exacerbated by the lack of standardized international regulations and the uneven levels of data protection among various locations (Feys et al., 2023; Liu et al., 2024). State and non-state entities are increasingly executing data breaches for objectives such as espionage, economic harm, and propaganda dissemination. Prominent examples include the SolarWinds breach, which targeted the cybersecurity of the US government and companies. Other significant occurrences encompass violations of governmental websites and extensive cyber intrusions, such as the Unique Identification Authority of India (UIDAI) breach (Mone et al., 2024; Yang et al., 2022). In 2015, a significant data breach transpired, notable for its magnitude and extent: the Office of Personnel Management (OPM) infiltration. A group of Chinese hackers executed the theft of 21.5 million federal employee background records and 5.6 million fingerprints (Gootman, 2016). The growing dependence

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on digital data, cloud computing, and mobile devices has broadened the attack surface for hackers. Organizations frequently have difficulties in safeguarding data at rest, in use, and in transit, resulting in increased breaches ([Ameen et al., 2021](#); [Botha et al., 2017](#)).

Privacy leaks have emerged as a critical security concern that complicates the administration and authentication of personal information, thus hampering communication efficiency between various entities ([Guo et al., 2018](#)). As a virtual entity, Facebook has surpassed the combined population of the three countries with the largest populations: China, India, and the United States ([Lee, 2021](#)). It has repeatedly faced public scrutiny due to significant data privacy scandals. In 2018, the Cambridge Analytica case revealed how personal data from approximately 87 million users was harvested without consent through a third-party quiz app and later used to influence political campaigns ([Isaak & Hanna, 2018](#)). A year later, in 2019, another serious breach occurred when malicious actors scraped data from 533 million users across 106 countries by exploiting Facebook's contact importer feature. Although Facebook fixed the vulnerability in August 2019, the leaked data, which included phone numbers, full names, Facebook IDs, emails, and other profile information, was only publicly circulated on hacker forums by April 2021 ([Sun, 2023](#)). Several official sources, including Meta, acknowledged this incident, confirming that scraping practices had extracted data from its platform prior to September 2019 ([Clark, 2021](#)). Despite the massive scope of exposure, empirical findings show that news of Facebook data breaches during 2016-2019 did not consistently significantly affect the company's share value ([Hinds et al., 2020](#)). In light of the extensive exposure, Facebook opted not to inform the impacted users, eliciting criticism from regulators and privacy activists about its management of the breach and its deficiency in openness.

In addition to reputational damage, as illustrated by the Facebook scandal, the increases in data breaches also impose significant financial burdens, underscoring the economic pressure organizations face and eroding user trust ([Ayyagari, 2020](#); [Bansal, 2018](#)). Long-term consumer impact can hinder business operations, cause revenue loss, and worsen a company's reputation ([Rahman & Nemati, 2024](#); [Shahul Ikram, 2024](#)). In a cross-border context, data breaches exacerbate cyber risks such as ransomware and advanced persistent threats (APTs) involving sophisticated and difficult-to-detect attack methods ([Hamid & Huda, 2025](#); [Teoh & Mahmood, 2017](#)). Although cyber threats are becoming increasingly complex, the effectiveness of technology management and implementation remains a determining factor in mitigating their impact ([Li et al., 2023](#)).

Following various data breaches, one of the most systemic attacks with widespread impact occurred in the SolarWinds incident, which, according to [Oladimeji & Kerner \(2023\)](#), was one of the most significant cybersecurity incidents in 2020. It not only impacted a single company but triggered a comprehensive supply chain attack that compromised over 18,000 clients, including multiple levels of the US government. SolarWinds, a major software company, inadvertently distributed a malicious update to its Orion IT monitoring platform, enabling attackers to covertly implant malware onto users' systems. This incident significantly compromised the integrity and confidentiality of thousands of networks and organizations ([Lazarovitz, 2021](#); [Sterle & Bhunia, 2021](#)). [Bulgurcu & Mashatan \(2024\)](#) underscore that this breach revealed fundamental deficiencies in incident response coordination and third-party risk management across several industries. The New York State Department of Financial Services (DFS) also noted that the attack revealed the failure of many institutions to classify Orion as a critical vendor despite its broad system access ([New York State Department of Financial Services, 2015](#)). Meanwhile, the Cybersecurity and Infrastructure Security Agency ([Cybersecurity and Infrastructure Security Agency, 2021](#)) and the United States Government Accountability Office ([US Government Accountability Office, 2022](#)) have recognized this occurrence as a critical moment for implementing Zero Trust Architecture and the enhancement of national-level supply chain resilience.

Given the scale and complexity of breaches like SolarWinds, governments worldwide have responded by enforcing more rigorous legislation to enhance openness and accountability in data management. One of the most comprehensive frameworks is the European Union's General Data Protection Regulation (GDPR), which mandates breach disclosure within 72 hours under Article 33 and imposes significant penalties for noncompliance ([Zhuo et al., 2021](#)). This regulation has increased breach reporting and pressured organizations to improve data management processes ([Mackie et al., 2017](#);

[Malatras et al., 2017](#); [Yan, 2024](#)). However, the effectiveness of such regulations varies across jurisdictions.

The Cambridge Analytica Facebook scandal in 2018 clearly illustrates the weakness of regulations in protecting personal data in the digital age. An estimated 87 million user profiles were exploited to manipulate political campaigns without informed consent ([Foeking et al., 2021](#)). The Federal Trade Commission (FTC) imposed a record fine on Facebook and mandated sweeping privacy reforms ([Bendix & Mackay, 2022](#); [Federal Trade Commission, 2019](#)). Similarly, the UK's Information Commissioner's Office (ICO) published a detailed investigation into unlawful data use in political advertising ([Carroll, 2021](#); [Information Commissioner's Office, 2019](#)). The New York Department of Financial Services (NYDFS) highlighted Facebook's insufficient transparency and weak user data protections in its 2021 report ([New York State Department of Financial Services, 2015](#)). The Ministry of Communication and Informatics (Kominfo), Republic of Indonesia, responded to Facebook's hack by requesting clarification and promoting national data privacy legislation ([Agustini, 2021](#)). These examples highlight global concern over data privacy and uneven enforcement practices across nations.

Reflecting this global trend, Indonesia, in the Southeast Asian context, has introduced its comprehensive framework, the Personal Data Protection (PDP) Law (Law No. 27/2022) ([Government of Indonesia, 2022](#)), which marks a national commitment to align with global standards on privacy and data security. Following the 2020 breach affecting 91 million user accounts, Kominfo compelled Tokopedia to conduct internal audits and notify affected users ([Riskinaswara, 2020](#)). The compromised data allegedly contained user ID, email, name, date of birth, gender, and encrypted password ([CNBC, 2020](#)). [Indrawati & Putri \(2021\)](#) observed that this violation marked a pivotal moment in trust management within Indonesia's digital marketplace.

One large-scale data breach that exposed Application Programming Interface (API) security weaknesses occurred on the LinkedIn platform, where unknown actors extracted and sold more than 700 million user profiles on the dark web, compromising personal information such as geolocation, salary, email, and phone numbers ([Share, 2021](#); [CNN Indonesia, 2021](#)). Although LinkedIn officially denied the occurrence of a breach and claimed it had only used public data ([LinkedIn Corporate Communications, 2021](#)), cybersecurity experts argue that this poses a serious privacy risk due to unauthorized data scraping ([Nicko, 2021](#)). [Gibson et al. \(2021\)](#) categorized the incident as an API-level vulnerability and emphasized the need for stronger authentication and anti-bot mechanisms.

These incidents underscore a broader issue: the digital ecosystem is rapidly evolving, bringing forth complex security challenges impacting diverse sectors and stakeholders. Cybercriminals use more complicated techniques, like Advanced Persistent Threats (APTs), designed to be undetected for extended periods while stealing important information ([Bhardwaj, 2024](#); [Preethi et al., 2024](#)). Integrating AI-powered defense systems has become crucial to modern cybersecurity frameworks ([Rangrez et al., 2024](#)). Nonetheless, the advancement of intelligent technologies has also introduced new forms of vulnerabilities, particularly in the convergence of cyber and AI-related threats ([Fauzi & Sembiring, 2023](#)). Emerging technologies like quantum computing pose risks to existing encryption mechanisms, while blockchain offers novel methods for securing digital transactions ([Radanliev, 2024](#)).

To deal with these complicated threats, strong cybersecurity measures and flexible strategies are necessary to keep digital assets safe and private, as shown by different real-life events ([Sharma & Zamfiroiu, 2023](#)). The core components of cybersecurity include encryption and access control ([Firmansyah, 2024](#)). Advanced Encryption Standard (AES) and Secure Sockets Layer/Transport Layer Security (SSL/TLS) are two widely adopted encryption standards for securing communications between devices and servers ([Arunkumar & Kousalya, 2018](#); [Goluboff, 2015](#)). Cloud computing environments commonly use a load balancer to manage high traffic volumes ([Ajagbe et al., 2022](#)). In addition, Amazon Web Services (AWS) offers API-driven infrastructure that enhances agility, automates the infrastructure management lifecycle, and allows flexible experimentation with scalable architectures ([Campbell, 2020](#)).

One major challenge in global cybersecurity lies in regulatory fragmentation, as different countries have different data protection regulations. For example, the European Union's General Data Protection Regulation (GDPR), California Consumer Privacy Act (CCPA), China's Personal Information

Protection Law (PIPL), Japan's Personal Information Protection Act (APPI), and South Korea's Personal Information Protection Act (PIPA) serve as examples of data protection legislation ([Lim & Oh, 2025](#)). New EU members from Central and Eastern Europe (CEE) typically exhibit greater efficiency in transposing EU regulations than their Western counterparts ([Zhelyazkova et al., 2017](#)). The GDPR, in contrast to the norms of the United States and Canada, operates under distinct jurisdictions; nonetheless, all frameworks consider situational risks and threats to individual data subjects and promote encryption ([Heimes, 2016](#)). Divergences in national data regulatory frameworks present issues for other nations, exacerbating the fragmentation of the global regulatory landscape, fostering uncertainty, and escalating compliance costs for enterprises ([Shelepov, 2022](#)). The European Union supplements the GDPR with data protection agreements involving non-EU nations, and considers the EU-US Privacy Shield agreement as having the most significant practical effect ([Veit, 2022](#); [Yan, 2024](#)).

The different ways countries handle data protection show much inconsistency in global rules, especially when countries rely solely on ISO-based standards. This practice can result in gaps in complying with GDPR regulations. Such a situation requires the integration of information governance (IG) and enterprise architecture management (EAM) to bridge these gaps ([Zaguir et al., 2024](#)). In business-to-government data sharing, an accountability gap frequently exists. Corporate digital responsibility (CDR) can function as a conduit between accountability frameworks grounded in public law and those based on data protection law ([Schneider, 2022](#)). Enforcing data protection requirements such as GDPR necessitates substantial organizational and technical modifications, posing challenges for firms, particularly within the IT sector ([Poritskiy et al., 2019](#)). Companies must cultivate a data protection culture instead of prioritizing swift compliance to avoid penalties. This cultural transformation may result in more sustainable and efficient execution of data protection procedures ([Lugati & de Almeida, 2022](#)).

On the other hand, several global data protection frameworks, such as the GDPR and China's PIPL, aim to mitigate cross-border risks by enforcing encryption, breach notification, and data transfer assessment. Article 32 of the GDPR mandates security measures to ensure confidentiality and integrity, which has led to improved compliance among EU-based organizations ([Zhuo et al., 2021](#)). The evaluation suggests that GDPR enforcement has improved compliance practices among EU-based companies ([Buckley et al., 2022](#)). The Tokopedia breach exemplifies a failure to uphold such standards, with 91 million records exposed due to insufficient encryption. Likewise, the Facebook Cambridge Analytica case reveals access control and data governance weaknesses. Although Indonesia's Personal Data Protection Law (PDP Law; Law No. 27/2022) lacks extraterritorial reach, it incorporates global best practices such as breach notification and accountability. These efforts reflect a broader move to harmonize cybersecurity policies and establish enforceable norms across jurisdictions.

Various cybersecurity policy and system design fields have successfully implemented the CIA Triad approach. In cloud-based systems, the CIA concept helps create honeypots to detect attacks, demonstrating its effectiveness in monitoring threats ([Subhash et al., 2024](#)). These findings are consistent with incidents at Tokopedia and LinkedIn, where cloud configuration errors threatened data confidentiality and availability. In the public sector, Kenya and the United States have adopted CIA principles in their electoral systems through biometric and blockchain technologies ([Irungu & Girma, 2023](#)). A similar approach should also be applied in other large systems. For example, the data breach incident at Facebook (2019) and the supply chain attack on SolarWinds (2020). Another study used the CIA Triad to evaluate 45 UAV communication scenarios, but the results vary significantly depending on the context and methodology ([Shoufan & Damiani, 2017](#)). The study showed that while the CIA Triad is flexible, its application still requires a systematic and standardized approach.

On the other hand, most previous research has focused on technological solutions such as artificial intelligence, blockchain, and identity management ([Khare & Raghuvanshi, 2024](#); [Rangrez et al., 2024](#); [Souabni et al., 2022](#)) without directly linking them to the effectiveness of cross-border data protection regulations. Few studies have explored how integrating technology strategies and regulatory frameworks can mitigate cross-border data security risks ([Ameen et al., 2021](#); [Xu et al., 2025](#)). Many organizations adopt standards such as ISO/IEC 27001 or NIST SP 800-53 for Information security management practices ([Zaguir et al., 2024](#)). However, various studies highlight the challenges of

implementing these frameworks, including resource limitations, dependence on organizational culture, and high administrative burdens—especially for MSMEs ([Longras et al., 2018](#); [Mera-Amores & Roa, 2024](#)). Meanwhile, the CIA Triad is also influenced by organizational context ([Shojaie et al., 2016](#)). However, it offers a more straightforward and flexible classification framework for mitigation strategies across jurisdictions ([Rahman & Nemati, 2024](#)).

Regarding regulation, the European Union, China, and Indonesia have adopted policies such as the GDPR, PIPL, and the Personal Data Protection Law to strengthen cross-border data privacy protection. However, the effectiveness of these policies in mitigating global data security risks has rarely been analyzed in an integrated manner ([Lim & Oh, 2025](#)). Existing studies remain sectoral and do not systematically link technical vulnerabilities with mitigation policies.

Most data breach studies—such as the LinkedIn, Facebook, and SolarWinds cases—have also not used standardized evaluation frameworks ([Bulgurcu & Mashatan, 2024](#); [Foecking et al., 2021](#); [Gibson et al., 2021](#)). For example, the Tokopedia study emphasizes reputation responses and national policies without direct links to structured mitigation strategies ([Indrawati & Putri, 2021](#); [Wibowo et al., 2024](#)). Thus far, only a limited number of studies have systematically applied frameworks such as the CIA Triad to classify vulnerabilities and evaluate the effectiveness of data protection policies across different jurisdictions.

Therefore, this study proposes using the CIA Triad as an integrated evaluation framework to assess the effectiveness of cross-jurisdictional data protection policies. This research seeks to fill a gap in the literature that has not yet systematically examined the relationship between vulnerability classification and cross-border data mitigation policies. This study covers (1) applying the CIA Triad framework to case studies of real-world significant data breaches, (2) evaluating the effectiveness of global data protection regulations in mitigating security risks, and (3) developing mitigation strategies that integrate technological and political approaches. This study seeks to contribute to a more cohesive, actionable, and globally relevant approach to cross-border data protection, offering practical insight for policymakers and cybersecurity professionals alike.

Literature Review

Concept of Data Protection Crossing Borders

In the digital era, data transmission is an essential element of globalization and worldwide collaboration. Nonetheless, data privacy and security difficulties persist, with limited solutions available for safeguarding personal data during cross-border transmission due to the complexities of managing sensitive information across many countries and regions ([Liu et al., 2024](#); [Peng et al., 2023](#)). Cross-border data flows encompass international economic concerns and pose challenges to personal information protection, national data security, and the jurisdiction of legal and law enforcement authorities ([Liu, 2022](#)). Safeguarding personal information constitutes a significant contemporary regulatory challenge ([Yan, 2024](#)). In the realm of globalization, transnational data flow presents numerous problems to international investment law ([Wang, 2024](#)). At present, there exists no globally recognized standard for data protection ([Alekseenko, 2022](#)).

The CIA Triad model, a prevalent architecture in cybersecurity, comprises three essential components: confidentiality, integrity, and availability ([de Oliveira Albuquerque et al., 2014](#)). This methodology offers a systematic framework for enterprises to evaluate and alleviate cybersecurity hazards. Confidentiality safeguards sensitive data from unauthorized access, a significant issue exemplified by incidents including Facebook (2019), Tokopedia (2020), and LinkedIn (2021), during which malicious actors compromised user data. Integrity ensures that data remains unmodified and reliable, pertinent to events such as the SolarWinds (2020) breach, where assailants compromised software supply chains. Availability guarantees that information systems are functional and accessible when required, a vital consideration for enterprises dependent on cloud and internet services ([Bulgurcu & Mashatan, 2024](#); [Gibson et al., 2021](#); [Indrawati & Putri, 2021](#); [Sun, 2023](#)). Among the major incidents compromising confidentiality, the 2019 Facebook scraping case stands out due to its vast international scope, affecting over 500 million users across multiple jurisdictions. Although the 2018 Cambridge Analytica case

remains the most widely cited in academic discourse, the 2019 incident presents a distinct example of large-scale data exposure via API vulnerabilities, making it particularly relevant within the CIA Triad framework.

In contemporary global competitiveness and collaboration, digital trade regulations focused on transnational movement have emerged as a competitive advantage for a country ([Chin & Zhao, 2022](#)). A practical legal framework for cross-border data transfer is crucial to balancing national security, commercial interests, and individual privacy ([Tan, 2024](#)). Since digital trade often includes personal data agreements from the World Trade Organization (WTO) and bilateral and regional trade agreements, it is important to understand how policies limiting the free movement of information between countries affect this table ([Marengo, 2020](#)).

Trends and Patterns of Data Violation

Data breaches have been on the rise since 2005, with a marked increase in the number and impact of breaches yearly ([Fleury-Charles et al., 2022](#); [Holtfreter & Harrington, 2015](#); [Stottler, 2024](#)). For example, from 2010 to 2018, there were 2,529 violations affecting 194.74 million individual records ([Hossain & Hong, 2019](#)). Data breaches in the public sector are also significant, with contextual government factors impacting the incidence and level of violations ([Hamid & Huda, 2025](#); [Joseph, 2018](#)). Investors react negatively to data breaches, perceiving them as indicators of internal deficiencies within affected companies ([Juma'h & Alnsour, 2021](#)). Mega breaches, involving the loss of a million records or more, have been a significant concern. These large-scale breaches often result from compromised internal structures and systems ([Fritz & Kaefer, 2017](#); [Hossain & Hong, 2019](#)).

The impact of data breaches can vary significantly depending on the type of information stolen, with sensitive personally identifiable information (SPII) breaches leading to higher costs and more class-action lawsuits ([Poyraz et al., 2020](#)). The CIA Triad framework facilitates the analysis of breaches by assessing the compromise of confidentiality, integrity, and availability in significant data occurrences. For instance, attackers frequently exploited insufficient access restrictions (confidentiality), introduced harmful code (integrity), or disrupted services (availability), underscoring persistent vulnerabilities in cybersecurity systems.

Regulations and Data Security Standards

The introduction of regulations like GDPR has imposed severe penalties for data breaches, pushing organizations to adopt better data protection measures ([Tachepun & Thammaboosadee, 2020](#)). Understanding the factors contributing to breaches, such as human error and internal vulnerabilities, is crucial for developing effective cybersecurity strategies ([Portalatin et al., 2021](#)). The General Data Protection Regulation has elevated privacy to a status commensurate with security in data protection ([Treacy et al., 2020](#)). To mitigate data protection problems, global authorities and standards organizations have issued numerous pieces of legislation, guidelines, and software controls applicable to cloud data ([Joshi et al., 2020](#)). Complete frameworks delineating technical, administrative, and legal standards are essential for safeguarding important systems and sensitive information ([Volchkova, 2019](#)).

Security includes assessing at-risk data, evaluating data vulnerabilities, and analyzing strategies to mitigate threats to an acceptable risk level ([Mary, 1999](#)). The emphasis is on the secure management of data to guarantee the privacy of client information and the protection of company data ([Bajaj, 2012](#)). The General Data Protection Regulation (GDPR) will be implemented in the European Union (EU) in May 2018 to address contemporary difficulties concerning personal data protection and to standardize data protection throughout the EU ([Tikkinen-Piri et al., 2018](#)). Regulation has escalated expenses and internal administrative procedures. Little case law results in ambiguity ([Buckley et al., 2022](#)).

Trust-Minimization Models in Cyber Risk Prevention

Zero trust (ZT) is a way of thinking and planning that helps cybersecurity teams create secure areas and improve data safety by carefully using new technologies, managing risks, and understanding threats

([Wang et al., 2022](#)). The organization lacks data on the quantitative assessments of ZTA's pros and cons ([Adahman et al., 2022](#)). Zero trust posits that all trust points must undergo scrutiny and mitigation, security measures will protect individual resources, and the network will not serve as the primary basis for trust. This approach restricts threat mobility and mitigates harm ([Simpson, 2022](#)). Access is granted based on the minimum permissions required for a user to perform their job, reducing the risk of unauthorized access ([Seaman, 2023](#)).

The financial repercussions of data breaches are substantial for organizations and society. Organizations can gain advantages by comprehending the fundamental elements that affect the probability and consequences of a data breach ([Bobbert & Timmermans, 2023](#)). Companies and government entities consistently implement Zero Trust security to validate cybersecurity protocols ([Kroculik, 2024](#)). However, organizations frequently encounter difficulties evaluating their advancement in Zero Trust Architecture (ZTA) implementation ([Ilyas et al., 2024](#)). Adopting Zero Trust Architecture must consider scalability, user experience, and operational complexity ([Verma et al., 2024](#)). The findings indicate that adopting Zero Trust Architecture (ZTA) leads to an average decrease of \$684,000 in risk impact over four years for small- to medium-sized enterprises and large organizations ([Adahman et al., 2022](#)). Although Zero Trust Security Architecture has become the dominant approach to replacing traditional perimeter-based network security models, this approach is not entirely free from weaknesses. The control center and authentication database in the Zero Trust architecture create new vulnerabilities that are susceptible to centralized attacks. Additional security systems are necessary to strengthen ZT ([Guo et al., 2022](#)).

In addition to Zero Trust, threat modeling techniques such as STRIDE (Spoofing, Tampering, Repudiation, Information Disclosure, Denial of Service, and Elevation of Privilege) from Microsoft are esteemed techniques employed to detect security vulnerabilities in software systems. In an empirical study, 57 computer science students assessed the costs and efficacy of STRIDE ([Scandariato et al., 2015](#)). It has been applied in various domains, including healthcare, smart homes, and automotive infotainment systems, demonstrating its versatility and effectiveness in different contexts ([Ben-Nakhi et al., 2023](#); [Das et al., 2024](#); [Hossain & Hasan, 2023](#); [Viswanathan & Prabhu, 2021](#)). Both models contribute to a trust minimization paradigm that supports proactive threat mitigation, especially in cross-border and multijurisdictional systems.

Empirical Study on ISO/IEC 27001 Standards, NIST Framework, and GDPR Compliance

Information security and privacy compliance have recently become increasingly complex due to escalating regulatory constraints, evolving legislation, and heightened public awareness ([Anwar & Gill, 2020](#)). Bringing together the ISO 27001:2013 and ISO 9001:2015 standards into a company's Information Security Management System (ISMS) and Quality Management System (QMS) makes it even more important to safeguard Information and Communication Technologies (ICT) ([Hasibovic & Tanovic, 2024](#)). ISO/IEC 27001 is an international standard that provides a structural framework for establishing, implementing, and maintaining an information security management system (ISMS), offering comprehensive guidelines for auditors and implementers. Its application supports governmental or corporate organizations in systematically managing information security risks and ensuring the continuous protection of data assets ([Putra et al., 2021](#)). Recognized globally, ISO/IEC 27001 is one of the most widely adopted and authoritative benchmarks in information security ([Malatji, 2023](#)).

Adherence to the General Data Protection Regulation (GDPR) or analogous legislation by enterprises may necessitate organizational and technological modifications ([Zaguir et al., 2024](#)). Following the implementation of the General Data Protection Regulation (GDPR) in the EU, organizations must modify their business operations and implement suitable technical and organizational safeguards to safeguard the personal data they handle ([Diamantopoulou et al., 2020](#)). There is alignment between the security controls in ISO/IEC 27001:2013 and the data protection requirements set out in the GDPR. Therefore, it is necessary to implement security control measures based on ISO/IEC 27001 to fulfill data protection obligations under GDPR provisions. Further identification and mapping of organizations implementing ISO/IEC 27001 is important to ensure their readiness to comply with GDPR ([Diamantopoulou et al., 2020](#)).

Cybersecurity Governance Challenges in the Global South

Developing nations frequently lack robust national cybersecurity frameworks. African countries confront distinct issues, notably the swift expansion of internet access coupled with a deficiency in cybersecurity skills, rendering them more susceptible to cybercriminal activities ([Von Solms, 2019](#)). Jamaica's establishment of a National Cybersecurity Framework (JNCF) underscores the necessity of integrating international standards and best practices to safeguard national information ([Dennis et al., 2014](#)). South Africa's critical role within the BRICS bloc underscores the necessity for synchronized cybersecurity initiatives to capitalize on the advantages of international collaboration ([Mitrovic & Thakur, 2019](#)). Cybersecurity training and education are essential for enhancing digital trust and confidence. South African students reported substantial alterations in their online protective habits throughout the epidemic, highlighting the significance of cybersecurity knowledge ([Tick et al., 2021](#)).

Developing nations encounter distinct issues regarding cybersecurity ([Jacobs et al., 2016](#)). Standard cybersecurity maturity models from wealthy nations often do not meet the unique needs of developing countries because of differences in their development, politics, society, and economic environments ([Lee et al., 2025](#)). Least Developed Countries (LDCs) necessitate cybersecurity plans that tackle their specific issues, such as restricted technical progress and insufficient policy frameworks. An integrated approach utilizing modern technology, extensive policy measures, and capacity-building activities can improve national cybersecurity ([Hamidi & Singh, 2024](#)). Studies comparing the cybersecurity postures of countries like Pakistan and Indonesia highlight the need to enhance legal frameworks, invest in technical infrastructure, and increase regional and international cooperation ([Sadat et al., 2025](#)).

The Role of Artificial Intelligence in Cyberthreat Detection and Prediction

The ability to find and reduce cybersecurity risks, like network breaches, attacks from bad actors, and unknown vulnerabilities, has dramatically improved with AI, especially through machine learning and deep learning ([Dhanushkodi & Thejas, 2024](#)). Artificial intelligence (AI) and machine learning (ML) techniques represent the latest developments in computing, including approaches inspired by biological systems such as deep neural networks, which mimic the way the human brain's neural networks work ([Nijim et al., 2022](#)). In the context of defense, AI contributes significantly to enhancing protection strategies, system resilience, adaptability, and efficiency through responses to environmental dynamics ([Kumar & Ranganathan, 2023](#)).

The use of large language models (LLMs) in cybersecurity offers both opportunities and risks, necessitating mitigation strategies to ensure their development and implementation are conducted securely ([Kucharavy et al., 2024](#)). In cloud computing environments, important aspects of data security include node authentication, mutual authentication, the use of digital certificates, and the implementation of strict access controls ([Jonnala et al., 2023](#)).

Some examples of AI applications in cybersecurity include cyber threat intelligence (CTI), an innovative AI-based methodology for collecting, analyzing, and handling ongoing and potential attacks that could harm an organization's digital assets ([Alguliyev et al., 2023](#)). Additionally, quantum cryptography offers a promising defense against threats from quantum computing, providing high-level encryption based on the principles of quantum physics ([Sharma et al., 2024](#)).

Another method is a routing system that relies on trust and uses machine learning to find harmful nodes during Distributed Denial of Service (DDoS) attacks and data packet issues, which improves network security ([Ahmed et al., 2023](#)). However, we must design robust and understandable AI models to ensure system trust and reliability. Significant challenges remain, including large-scale data management and real-time processing requirements ([Dhanushkodi & Thejas, 2024](#)). So, creating hybrid models, making real-time explanations possible, and using standard ways to measure and ethical guidelines are important for improving AI-based cybersecurity in the future ([Mohale & Obagbuwa, 2025](#)).

Technology Approach to Data Security Mitigation

As part of the mitigation approach, technologies such as artificial intelligence (AI)-based anomaly detection have become complementary elements in modern cyber defense frameworks. Risk

management in information technology (IT) can no longer be viewed solely as a technical task but as a crucial managerial function in ensuring the security and sustainability of organizational processes (Alshahrani et al., 2022). A layered security framework is essential in environments such as the Industrial Internet of Things (IoT). This approach includes preventive measures such as anomaly and intrusion detection systems and responsive measures such as incident response plans and data backup strategies (Vetrivel et al., 2024). Proactive cybersecurity strategies, like checking for risks, setting up strict rules, using multi-factor authentication, and regularly updating systems, are important for lowering weaknesses (Berki et al., 2018). Additionally, ongoing training programs and users' comprehension of security tools play a critical role in improving compliance behavior and fostering digital resilience (Adams & Liu, 2021).

The integration of AI-based cybersecurity solutions, such as machine learning-powered anomaly detection, has gained significant attention recently. However, the adoption of such technologies also introduces new risks, including the potential for adversarial attacks and ethical challenges in their implementation (Abbo & Tchomte, 2024). Therefore, ensuring the integrity and confidentiality of data across various platforms remains a critical priority (Pigola & de Souza Meirelles, 2024). Compliance with international standards and regulatory frameworks is essential to maintaining the long-term effectiveness of information security systems (Mizrak & Reyhan Akkartal, 2024). Prevention remains the most effective approach to addressing cyber threats, as history has shown that no regulation has yet succeeded in eliminating data security breaches globally.

Methodology

This research adopts a qualitative case study methodology to examine data vulnerabilities in four major incidents: Facebook (2019), SolarWinds (2020), Tokopedia (2020), and LinkedIn (2021). These cases were selected based on their prominence, cross-sectoral nature, and representation of core vulnerabilities across the CIA Triad dimensions. Data were collected from academic literature, official publications, regulatory documents, and credible news media. Cross-validation between sources is performed to ensure data reliability and consistency.

Figure 1 shows the CIA Triad framework (Confidentiality, Integrity, Availability) was used to identify the main weakness in each incident and help create a plan to reduce risks according to international standards. Along with the CIA Triad as the main framework, this study also includes important parts of the ISO/IEC 27001 and NIST SP 800 series to understand the technical, administrative, and physical controls that were present or missing in each case. These standards were not applied as standalone evaluation models but were used to identify common best practices and implementation gaps, as reflected in the comparative matrix of analyzed incidents.

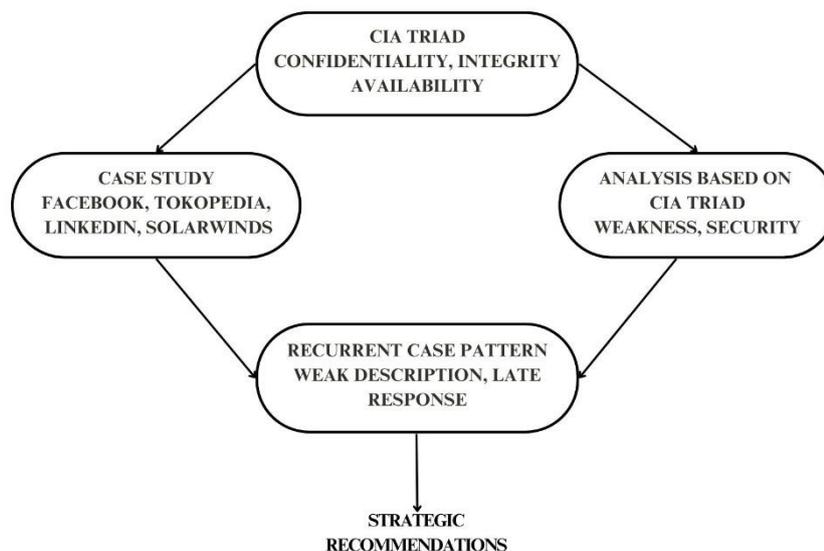


Figure 1. Conceptual Framework of the Study

Results

The following section illustrates the complexity and common patterns of cross-border data breaches. This study analyzes four large-scale data breaches that occurred between 2019 and 2021. The four cases—Facebook, LinkedIn, Tokopedia, and SolarWinds—were selected because they represent technical vulnerabilities and caused significant impacts on millions of users across various jurisdictions. Each case is analyzed based on the security vulnerabilities exploited, the impact caused, and the organization’s response following the incident.

1. Facebook’s (2019) weakness: scraping that exploited public system features, especially the contact importer. The impact: 533 million user data exposed, including personal information such as name, ID, and location or address. Organizational response: Facebook did not admit any system violations but did fix the server settings.
2. SolarWinds (2020), weakness: Malware inserted in software updates, exploiting the supply chain. The impact: 18,000 organizations affected, including government agencies. Organizational response: changing their software development procedures
3. Tokopedia (2020), weakness: Insufficient encryption for Tokopedia user data leaves 91 million users susceptible to data leakage. The impact: The leakage of personal information puts Tokopedia account users’ privacy at risk. The organization responded by confirming that payment data was secure.
4. LinkedIn (2021), weakness: The poorly protected API allows data scraping by unauthorized parties who want to misuse LinkedIn user data. The result was the theft and sale of 700 million user records on the dark web. The organization responded by stating that there was no direct hack.

[Figure 2](#) shows a visualization of the general patterns of weaknesses, impacts, and responses in the four data breaches that were analyzed. This diagram is designed to show the interrelationships between elements and reinforce the identification of recurring patterns. This visualization forms the basis for developing relevant and cross-case mitigation recommendations. It also emphasizes the need for a systematic and standardized mitigation approach.

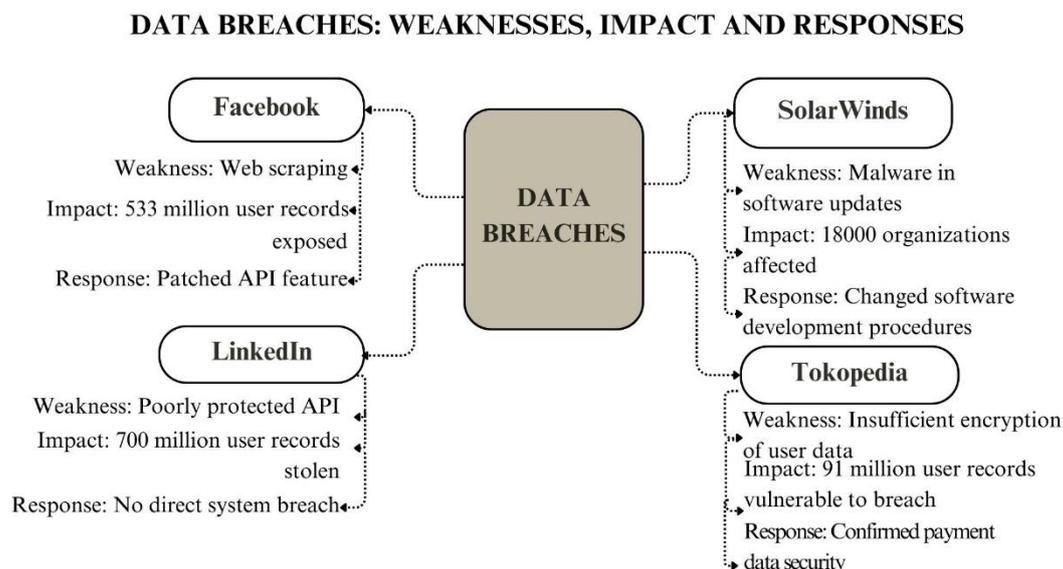


Figure 2. Case Analysis of Data Breach Incidents

[Figure 3](#) illustrates the exploitation of system vulnerabilities and corresponding organizational responses across the four analyzed cases. The analysis identifies three recurring technical weaknesses: (1) insufficient encryption of user data, (2) poor API protection allowing mass data scraping, and (3) supply chain compromise via malware injection in software updates.



Figure 3. Cybersecurity Breach Response Flow Chart

These vulnerabilities were exploited through distinct mechanisms. In the Facebook case (2019), the weakness was the absence of access restrictions on the contact importer API, which enables massive scraping of public metadata. In the Tokopedia case (2020), user data was not properly encrypted. LinkedIn (2021) demonstrated a lack of strong API authentication. Meanwhile, in the SolarWinds (2020) case, software integrity was compromised due to the injection of malicious code in system updates, highlighting vulnerabilities in the IT supply chain.

Organizational responses are generally reactive, such as fixing system configurations or confirming breaches after incidents occur. However, the responses often lack adequate transparency or long-term mitigation strategies. This pattern reflects limitations in the implementation of proactive controls in line with the principles of confidentiality, integrity, and availability (CIA Triad) and is not yet fully integrated with international frameworks such as ISO/IEC and NIST.

Based on the observed vulnerabilities, the following mitigation strategies are formulated using the CIA Triad security framework and aligned with ISO/IEC 27002 and NIST SP 800-12 Rev. 1. Each strategy addresses confidentiality, integrity, and availability through a layered control model:

1. Confidentiality is strengthened through technical controls such as modern encryption protocols (e.g., TLS 1.3, end-to-end encryption) and access governance at the API level, supported by administrative controls like identity-based access policies and role-based permission structures.
2. Integrity is addressed through technical mechanisms such as blockchain-based record verification and cryptographic hash functions (e.g., SHA-256), combined with administrative controls such as secure software development practices and audit logging (audit trails), as demonstrated in the SolarWinds case.
3. Availability is improved by using technical methods like API throttling and automatic failover mechanisms, physical controls such as backup systems, and administrative measures such as incident response planning and DDoS attack mitigation policies.
4. This study creates a clear and organized security framework that organizations can follow to lower risk and improve their ability to handle cyber threats by linking each risk-reduction strategy to the CIA Triad dimensions and ISO/NIST control categories.

Discussion

Mapping Technical Vulnerabilities to CIA Triad

This section organizes the four case studies of data breaches according to the CIA Triad (Confidentiality, Integrity, and Availability) to show how this framework can help assess security weaknesses and responses to regulations in each data breach case. [Figure 4](#) highlights recurring security weaknesses from four major data breaches: insufficient encryption (Tokopedia), weak API protection (LinkedIn and Facebook), and compromised supply chain integrity (SolarWinds). These findings align with the CIA Triad: Confidentiality was compromised due to public data exposure and weak access controls. Integrity is threatened by compromised software updates. Availability is impacted by delayed responses and service disruptions. This pattern also indicates broader systemic issues such as delayed threat detection, lack of transparency, and inconsistent application of security standards. In response to the weaknesses, the recommended mitigation strategies include:

1. Tokopedia: Enhancing data encryption during both storage and transmission
2. Facebook: Restricting API access based on user identity and enforcing stricter API management policies
3. LinkedIn: Strengthening API authentication and applying AI-based anomaly detection
4. SolarWinds: Implementing AI-driven supply chain monitoring and conducting regular software code reviews.

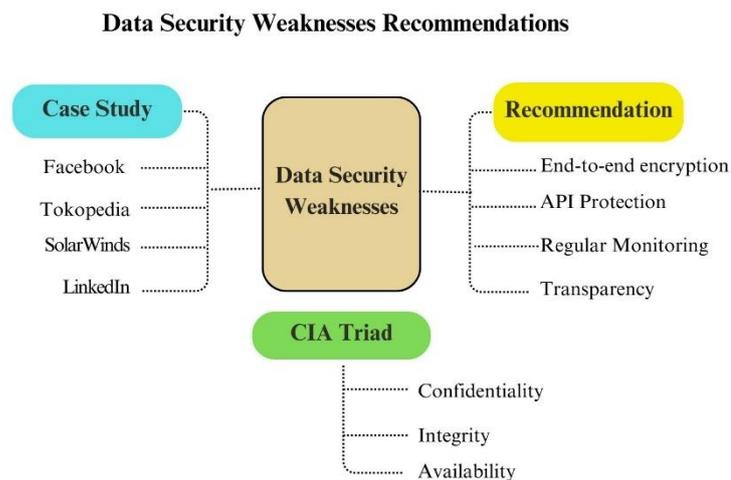


Figure 4. Data Security Weaknesses with CIA Triad

These recommendations align with the CIA Triad framework, underscoring the need to enhance confidentiality, integrity, and availability in a coordinated manner. From a regulatory perspective, the CIA Triad is also relevant to global compliance mandates: confidentiality relates to Article 32 of the GDPR and the principle of data minimization in Article 5; integrity supports accountability as regulated in Indonesia's PDP Law and China's PIPL; and availability reflects the importance of service continuity and incident reporting procedures.

Although legal frameworks such as the GDPR, PDP Law, and PIPL are in place, this study shows that their implementation still faces challenges such as enforcement gaps and differences in reporting standards. Therefore, the CIA Triad serves not only as a technical classification tool but also as a framework for evaluating readiness and compliance in the context of cross-jurisdictional data protection.

Strategic Recommendations and Preventive Measures

[Table 1](#) presents a structured analysis of four high-profile data breaches: Facebook (2019), LinkedIn (2021), Tokopedia (2020), and SolarWinds (2020), using the CIA Triad dimensions: Confidentiality, Integrity, and Availability. Each case is evaluated based on the presence and effectiveness of technical,

administrative, and physical controls, drawing from international standards such as ISO/IEC and NIST SP 800-12 Rev. 1.

The findings indicate that confidentiality breaches are the most widespread, particularly those resulting from insufficient API controls and a lack of encryption mechanisms, as seen in the Facebook and LinkedIn cases. These weaknesses allowed for unauthorized access and mass data scraping, underscoring identity and access management vulnerabilities.

Table 1. CIA Triad Analysis with ISO/NIST Controls and Implementation Gaps

| CIA Dimension | Case | Technical Control | Administrative Control | Physical Control | Implementation Gap |
|-----------------|-----------------|----------------------------|---------------------------|--|---|
| Confidentiality | Facebook (2019) | Transport encryption (TLS) | Access control policies | Perimeter secured, but restricted | No restrictions on API for importing contacts |
| | LinkedIn | API access tokens | API security protocols | No explicit physical security record | Mass data scraping of user data |
| Integrity | Tokopedia | End-to-end encryption | Data handling guidelines | Server access restricted, but standard | Lack of encryption for user data |
| | SolarWinds | Cryptographic hashing | Software integrity checks | Physical security measures | Service outages in response to breach |
| Availability | SolarWinds | Cloud-based load balancing | DDOS mitigation planning | Backup power systems | Service outages in response to breach |

In the case of integrity, the SolarWinds incident demonstrates how compromised software integrity and supply chain trust can lead to system-wide infiltration despite the presence of cryptographic hashing and physical security controls. Similar to Tokopedia, it highlights how inadequate encryption standards and data handling guidelines weakened the integrity of stored user information.

While availability was less directly affected in some scraping-related events (e.g., LinkedIn), the SolarWinds attack significantly disrupted service delivery, revealing shortcomings in load balancing, DDOS mitigation planning, and backup systems. These gaps underscore the need for more resilient infrastructure, especially in critical service providers.

Furthermore, the analysis also reveals that beyond technical shortcomings, these cases expose systemic gaps in regulatory enforcement and breach transparency, for example, despite the existence of frameworks like GDPR, PIPL, and Indonesia's PDP Law, inconsistent implementation and weak enforcement.

Involving Models in Strengthening CIA Principles

The CIA Triad, augmented by ISO and NIST standards, established a foundational framework for categorizing and addressing security vulnerabilities. However, its conventional implementation often centers on reactive measures. In contrast, Zero Trust Architecture (ZTA) offers a proactive approach that assumes breaches by default, continuously verifies identities, and enforces least privilege access. This section explores how ZTA principles could have mitigated the key vulnerabilities identified in the review of data breach cases.

For instance, in the Facebook incident, where public profile data was harvested through the contact importer API, ZTA's enforcement of strict access limitations and continuous verification could have constrained data exposure by implementing request thresholds and detecting abnormal access patterns. In the LinkedIn case, similar protection might have been achieved through real-time identity verification and adaptive, risk-based access controls to detect and limit non-human interaction patterns.

During the Tokopedia breach, when user data was compromised, ZTA would require device authentication and strong endpoint protection prior to granting data-level access—potentially preventing large-scale internal downloads. Meanwhile, the SolarWinds compromise illustrates how ZTA's assume-breach model necessitates validation of all software updates, including internal ones, through code integrity checks and user-aware access controls, thereby impeding lateral movement by attackers. Overall, ZTA signifies a paradigm shift from static perimeter defense to dynamic, continuous protection informed by the user's device and application environment.

Complementing this approach, threat modeling frameworks such as STRIDE, which covers spoofing, tampering, repudiation, information disclosure, denial of service, and privilege escalation, provide a structured way to identify vulnerabilities early in the system design process. STRIDE reinforces Zero Trust by enabling organizations to anticipate threat vectors aligned with the dimensions of the CIA Triad.

Comparative Analysis with Previous Studies

This study offers a different contribution from previous research on large-scale data breaches. Research on Facebook, such as by [Isaak & Hanna \(2018\)](#), [Hinds \(2020\)](#), and [Foecking \(2021\)](#), focuses more on privacy issues, public perception, and market reactions, without systematically discussing the classification of technological risks. Studies on Tokopedia by [Indrawati & Putri \(2021\)](#) and [Wibowo \(2024\)](#) highlight that customer trust and national policies do not evaluate technical vulnerabilities. In the case of LinkedIn, Gibson (2021) discusses API scraping vulnerabilities, but their approach is limited to technical aspects and ignores regulatory frameworks. For SolarWinds, analyses by [Lazarovitz \(2021\)](#), [Sterle & Bhunia \(2021\)](#), [Yang \(2022\)](#), and [Bulgurcu & Mashatan \(2024\)](#) address technical and institutional aspects but have not yet adopted an integrated approach that incorporates theory, security standards, and cross-national regulations.

This study complements previous research by integrating technical vulnerability analysis based on the CIA Triad principles and risk classification using ISO/NIST standards. Additionally, this approach simultaneously compares global data protection regulations such as GDPR, PIPL, and PDP Law, unlike partial approaches that focus on technical, institutional, or policy aspects separately, by unifying technical, governance, and policy dimensions across jurisdictions within a single evaluative framework. As a result, this research expands understanding of the dynamics of global data breaches. It offers a mitigating model applicable to cross-border policy and security system development.

Implications

Theoretical Contributions

This study contributes theoretically to the development of a cybersecurity framework by demonstrating the potential effectiveness of the CIA Triad approach integrated with control standards such as ISO/IEC 27002 and NIST SP 800-12 Rev. 1. By applying it to four large-scale data breach cases, this approach offers a practical initial framework for identifying and assessing vulnerabilities based on the dimensions

of confidentiality, integrity, and availability. The study also proposes using proactive defense models such as the Zero Trust Architecture and STRIDE threat modeling as relevant advanced approaches to strengthen information security systems. It opens the door for further research to empirically test these models' effectiveness.

Previous studies on Facebook have generally focused on public perception, privacy, and market impact, while analyses of LinkedIn have emphasized technical vulnerabilities such as API scraping. Studies on Tokopedia have highlighted customer trust and the national policy context, while studies related to SolarWinds have discussed institutional barriers and security system design. However, these approaches tend to be limited to one technical, institutional, or regulatory dimension. This research complements the discourse by integrating CIA Triad-based analysis, ISO/NIST standard risk classification, and cross-regulatory comparisons such as GDPR, PIPL, and PDP Law. The main theoretical contribution of this study lies in developing a holistic and cross-domain evaluative framework that can be used to assess and mitigate data security risks in increasingly complex and fragmented global digital systems.

Practical Contributions

In practical terms, the findings of this study provide strategic guidance for organizations in improving their information security systems, particularly for entities that manage sensitive data across systems and jurisdictions. This approach can be used to develop mitigation measures such as strengthening encryption, managing API access, and monitoring digital supply chain risks. Findings from the case studies reveal common weaknesses in confidentiality and integrity aspects that require reinforcement with technical controls and consistent internal audits. Implementing measurable, risk-based minimum security standards is essential to promote digital resilience while supporting compliance with applicable regulations.

Policy Implications

The findings in this study also have policy relevance, especially in the context of strengthening the law enforcement system for cross-jurisdictional data breaches. The inconsistency in the application of regulations such as GDPR, PIPL, and PDP Law indicates the need for synchronization that can strengthen accountability across jurisdictions and improve the protection of user rights in the global digital ecosystem.

Conclusion

The analysis identified persistent security issues across four high-profile cases: lack of encryption (Tokopedia), weak API access control (Facebook and LinkedIn), and supply chain integrity failures (SolarWinds). These findings highlight a recurring neglect of fundamental cybersecurity principles, particularly data confidentiality and integrity. CIA Triad-based analysis confirms that confidentiality is the most vulnerable dimension, integrity is largely dependent on third-party trust, and while availability is not always compromised, breaches continue to affect service continuity and user trust. Additional issues, such as delayed detection, lack of transparency, and inconsistent implementation of standards, emphasize the need for systemic improvements in information security management.

This study uses the CIA Triad framework, supported by ISO/IEC 27002 and NIST SP 800-12 Rev. 1 standards, to identify technical, administrative, and physical weaknesses in four major incidents: Facebook, Tokopedia, LinkedIn, and SolarWinds. The application of this framework revealed that confidentiality breaches were the most prevalent, mainly due to weak API controls and insufficient encryption in three out of four cases. In the SolarWinds case, the integrity and availability were significantly affected due to supply chain compromises and post-attack service disruptions. This analysis demonstrates the value of integrating the CIA Triad with ISO/NIST controls to systematically identify critical weaknesses and corresponding mitigation strategies. It also recommends the future application of Zero Trust Architecture and STRIDE threat modeling to enhance proactive security measures by enabling continuous monitoring and early threat detection.

Although regulations such as GDPR, Indonesia's PDP Law, and China's PIPL provide comprehensive data protection frameworks, their real-world implementation in large-scale breach scenarios remains inconsistent and limited. While companies like Facebook have faced substantial penalties, regulatory enforcement overall has failed to ensure deterrence or cross-jurisdictional compliance. Ongoing challenges include a lack of transparency, delayed reporting, and insufficient legal coordination. These findings suggest the urgent need to reinforce implementation mechanisms, harmonize international data policies, and demand greater accountability from digital service providers.

The study is limited by its descriptive approach and narrow focus on four cases without empirical testing of mitigation strategies. Future research could adopt experimental designs to evaluate technical effectiveness and explore the role of emerging technologies, such as artificial intelligence and blockchain, in fostering cross-sector cyber resilience. Research could also develop security assessment models for public cloud environments, monitor the long-term impact of cross-border incident reporting mandates, and examine how evolving regulatory frameworks influence cybersecurity improvements in critical sectors like fintech and digital health. By addressing the fragmented nature of prior studies, this integrative approach aims to open new avenues for evaluating and mitigating data breach risks across platforms and jurisdictions.

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How to cite:

Lutfiah, R. N., & Sulaksono, T. (2025). Cross-Border Data Security: Analysis of High-Profile Violations and Mitigation Strategies. *Jurnal Sistem Informasi (Journal of Information System)*, 21(2), 23–46.

Combating Malaria Through E-SISMAL: How Perceived Quality, Perceived Ease of Use, and Perceived Usefulness Impact Performance? A Case of West Papua Province

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Abstract

Malaria remains a serious health threat in Indonesia, particularly in the West Papua Province. To address this, the Indonesian Ministry of Health developed the Malaria Surveillance Information System (E-SISMAL) to monitor and prevent the disease. However, the effectiveness of this system needs to be evaluated to determine how well it performs in addressing the intended problem. This study aims to investigate the system's performance by integrating the Task-Technology Fit (TTF), Technology Acceptance Model (TAM), and DeLone & McLean Information Systems (D&M IS) Success models. Data from 108 government health clinics in West Papua Province were collected using questionnaires and analyzed using a partial least squares structural equation model (PLS-SEM). The findings revealed that both service quality ($p = 0.035$) and ease of use ($p = 0.014$) significantly influenced user satisfaction ($R^2 = 38.4\%$), which subsequently affected system performance ($p < 0.000$, $R^2 = 11.6\%$). However, information quality and usefulness were not primary concerns for the health clinics in this context. Given these results, it is unsurprising that malaria prevention efforts in this region remain challenging. These findings raise questions about the alignment of the developed system with its objectives, suggesting that it may need reassessment and reconfiguration to achieve its overarching goals. The study concludes with implications and future research directions.

Keywords: E-SISMAL, Information System, Perceived Quality, Impact of Performance, Technology Acceptance Model

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Introduction

Malaria remains one of the leading causes of disease and death worldwide, particularly in tropical and subtropical regions. In 2019, an estimated 229 million malaria cases were recorded across 87 endemic countries. Children under the age of five accounted for approximately 67% of malaria-related deaths globally ([Asmiani et al., 2021](#)). This alarming statistic has made malaria a persistent global health challenge, prompting international commitments such as the 2007 World Health Assembly (WHA) resolution and the 2015 Asia-Pacific Regional Commitment to accelerate malaria elimination.

Indonesia is one of the countries where malaria is endemic, with indigenous cases still prevalent in various regions. In 2021, the country reported a malaria case fatality rate of 10 per 100,000 population at risk ([Asmiani et al., 2021](#)). The burden is especially concentrated in the eastern part of the country, including provinces such as Papua, West Papua, East Nusa Tenggara (NTT), Maluku, and North Maluku. Malaria has wide-ranging impacts beyond health, contributing to high infant and under-five mortality rates, and hindering national development due to its social and economic consequences.

In West Papua Province, malaria remains a serious public health issue. Although the Annual Parasite Incidence (API) declined from 31.29 in 2015 to 7.75 in 2018, this figure still places the region in the High Case Incidence (HCI) category, defined as an API greater than 5 ([Erawati et al., 2021](#)). Despite the reduction, the data indicate that malaria transmission remains a significant threat, particularly in remote areas with limited access to healthcare and surveillance infrastructure.

To support malaria prevention and surveillance efforts, the Indonesian Ministry of Health developed the Electronic Surveillance Information System for Malaria (E-SISMAL). This system is designed to improve the validity and efficiency of malaria case recording and reporting. The Ministry of Health has also developed E-SISMAL, with the latest version, E-SISMAL V2, introduced in 2018 and in full use since 2019, with over 9,155 health facilities reporting malaria data through this system. The system enables timely input of patient data, classification of malaria cases, documentation of interventions, and access to real-time information dashboards to support policy decisions. Despite its potential, challenges remain in data completeness, accuracy, and user capacity—especially in regions like West Papua ([Sitompul et al., 2022](#)).

This study examines the influence of Perceived Quality on E-SISMAL Performance in malaria prevention efforts, by integrating Task-Technology Fit (TTF), TAM, and the DeLone & McLean IS Success Model. Different from previous studies, this research also adds an external variable, namely user satisfaction as a mediator, to understand how system quality impacts the work effectiveness of health workers. By analyzing this relationship, this study can provide more comprehensive insight into the effectiveness of health information systems in supporting malaria surveillance programs and provide recommendations for improving the quality of E-SISMAL services in Indonesia.

Several previous studies have examined the E-SISMAL Information System in Indonesia. For example, a study by [Asmiani et al. \(2021\)](#) aimed to evaluate the effectiveness of malaria vector control strategies using retrospective data from the Electronic Malaria Surveillance Information System (E-SISMAL), using the HOT-Fit (Human, Organization, Technology-Fit) model. In addition, a study by [Indrayana & Ariawan \(2022\)](#) focused on evaluating the implementation of the Malaria Surveillance Information System (SISMAL) within the jurisdiction of the Malang City Health Office, using the CIPP (Context, Input, Process, Product) Evaluation Model. These previous studies have primarily focused on the operational and organizational challenges in E-SISMAL implementation, including limited human resources, lack of structured training, and suboptimal data reporting mechanisms. However, these studies did not explicitly investigate how users' perceptions of system quality, perceived ease of use, and perceived usefulness affect performance outcomes. For example, [Asmiani et al. \(2021\)](#) identified challenges in cross-sector collaboration and funding limitations, but did not assess user-perceived quality or system impact on performance. Similarly, [Indrayana & Ariawan \(2022\)](#) noted that users found SISMAL helpful and simple but lacked frequent use and formal training, with no analysis of how these factors influence work effectiveness. Additionally, both studies were conducted in relatively low-endemic areas, limiting the generalizability to high-burden settings. Therefore, to address this gap, a quantitative analysis was conducted on the relationship

between perceived quality, perceived ease of use, perceived usefulness, and user performance in the context of West Papua, which faces distinct infrastructural and epidemiological challenges.

Theoretical Background

This research focuses on the influence of Perceived Quality on E-SISMAL Performance in malaria prevention efforts. Digital-based information systems, such as E-SISMAL, play an important role in managing public health data, especially in monitoring and controlling infectious diseases such as malaria. However, the effectiveness of these systems depends not only on their existence, but also on the extent to which users perceive the system to be of good quality (Perceived Quality) and how this impacts the performance of the system in supporting the tasks of health workers.

According to various theories in the field of information systems, good information system quality will increase user satisfaction and performance, which in turn will have an impact on the effectiveness and sustainability of using the system. To understand the relationship between Perceived Quality and E-SISMAL Performance, this study refers to three main models, namely Task-Technology Fit (TTF), Technology Acceptance Model (TAM), and DeLone & McLean IS Success Model.

Electronic Surveillance Information System for Malaria (E-SISMAL)

Electronic Surveillance Information System for Malaria (E-SISMAL) is a web-based information system developed by the Indonesian Ministry of Health to support malaria control and elimination efforts. This system is designed to record and monitor malaria case data nationwide through core features such as inputting case data based on classification (local, imported, relapse), reporting laboratory results, documenting treatment and intervention measures, and visualizing epidemiological data through an interactive dashboard ([Sitompul et al., 2022](#)). Additionally, E-SISMAL provides location-based tracking that enables the mapping of endemic areas and identification of transmission clusters ([Asmiani et al., 2021](#)).

The main users of this system include surveillance officers at community health centers (Puskesmas), clinics, hospitals, district and provincial health offices, as well as national-level malaria program managers. In practice, E-SISMAL has proven effective in improving the accuracy and speed of case reporting compared to previous manual methods, while also enhancing data coverage and consistency ([Herawati et al., 2023](#)). Nevertheless, the system still faces challenges, particularly regarding limited internet access in remote areas, varying levels of user capacity, and the need for integration with other health information systems ([Indrayana & Ariawan, 2022](#)).

Task-Technology Fit (TTF)

Task-Technology Fit (TTF) theory, introduced by [Goodhue \(1998\)](#), posits that the effectiveness of a technology is determined by how well it supports the tasks its users need to perform. In the context of this study, E-SISMAL must align with the daily operational tasks of healthcare workers, particularly in recording, classifying, and reporting malaria cases. If the system offers functionalities that facilitate these tasks—such as structured data input, real-time case tracking, and epidemiological dashboards—then it can be considered to have a high level of task-technology fit. [Tam and Oliveira \(2016\)](#) assert that TTF is widely used in evaluating whether information systems improve individual and organizational performance. This alignment becomes crucial, especially in settings like Papua Barat, where the effectiveness of public health interventions depends on the speed and accuracy of data.

In this study, the effectiveness of E-SISMAL is evaluated using the variable Impact of Performance (IOP), which measures how system use translates into improved task outcomes for healthcare workers. IOP reflects whether the system contributes to faster, more accurate, and more efficient completion of malaria-related duties, such as entering lab results, stock data, and responding to outbreaks. Several empirical studies validate the link between TTF and performance impact. [Yen et al. \(2010\)](#) found that a strong fit between technology and task promotes better adoption and integration of systems into daily workflows. Similarly, [Franque et al. \(2021\)](#) emphasized that when users perceive a system as supportive of their tasks, they are more likely to use it consistently and

productively. In addition, [Saputra et al. \(2024\)](#) showed that in digital public service contexts, perceived task fit significantly enhances not only system usage but also satisfaction and outcome performance. Therefore, the inclusion of IOP in this study is essential to capture the practical, work-related benefits of E-SISMAL and to understand how well the system supports malaria prevention in Indonesia.

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), developed by [Davis \(1989\)](#), explains that user acceptance of a technology is primarily determined by two key beliefs: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). PU refers to the degree to which an individual believes that using a specific system enhances job performance. In the context of this study, health workers must perceive E-SISMAL as beneficial in improving the accuracy, speed, and efficiency of malaria case reporting and data management. When users believe that the system contributes directly to their effectiveness, they are more likely to consistently use it. This aligns with findings from [Hermawan and Paramita \(2021\)](#), who showed that PU significantly influences user satisfaction and the intention to continue using m-health applications in Indonesia. Similarly, [Sitompul et al. \(2022\)](#) highlighted the strategic role of E-SISMAL in aiding decision-making for malaria control, reinforcing the perception of its usefulness among frontline healthcare staff.

Meanwhile, PEOU relates to the extent to which users find a system free of effort to learn and operate. For E-SISMAL to be integrated effectively into health workers' routines—especially in resource-limited areas like Papua—it must offer a user interface and workflow that are intuitive and accessible. If users perceive the system as too complex or burdensome, they are unlikely to adopt it fully, regardless of its potential usefulness. Research by [Herawati et al. \(2023\)](#) demonstrated that E-SISMAL's web-based, mobile-friendly design was crucial in enabling healthcare workers in remote areas to perform digital reporting with minimal training. Further, [Inan et al. \(2022\)](#) found that ease of use strongly predicts user acceptance of mobile technology in service sectors, while [Setiawati et al. \(2024\)](#) observed that in regions with low digital literacy, PEOU plays a more dominant role than PU in influencing users to continue using the technology. In this study, PU and PEOU are modeled as antecedents to user satisfaction, offering a pathway to evaluate how E-SISMAL's perceived design quality shapes its perceived effectiveness and continued use.

DeLone & McLean Information System (IS) Success Model

The DeLone & McLean Information System (IS) Success Model, developed by [DeLone and McLean \(2003\)](#), offers a comprehensive framework to evaluate the success of information systems through six interconnected dimensions: system quality, information quality, service quality, system use, user satisfaction, and net benefits. In this study, the focus is on perceived quality, encompassing three critical components: system quality (e.g., speed, stability, and usability), information quality (e.g., accuracy and relevance), and service quality (e.g., training and technical support). These elements are key in shaping user satisfaction and perceived system effectiveness. [Franque et al. \(2021\)](#) found that perceived quality strongly influences continued usage of mobile-based technologies. In the health context, [Tam and Oliveira \(2016\)](#) also noted that digital systems with high usability and relevance improve user performance. Similarly, [Herawati et al. \(2023\)](#) emphasized that the readiness of services and technical infrastructure supports efficient reporting in Indonesian health centers.

In the E-SISMAL context, health workers need to experience the system as reliable, helpful, and easy to operate to maintain consistent use, especially in remote regions such as West Papua. The system must provide accurate and timely malaria data, function smoothly across various levels of infrastructure, and offer accessible technical support. When these dimensions are met, users are more likely to be satisfied and continue using the system, contributing to better surveillance and decision-making in malaria control. [Setiawati et al. \(2024\)](#) supported this by showing that in areas with limited digital literacy, service quality often plays a more influential role than technical sophistication in driving system adoption. As such, the IS Success Model provides a valuable lens to understand how

E-SISMAL's design and support structure can influence satisfaction and ultimately enhance its effectiveness in disease prevention programs.

Research Model and Hypotheses Development

This study uses quantitative research methods. Quantitative method is a research method that uses numerical and statistical data to measure, analyze, and explain the phenomenon or variable under study (Anjani et al., 2024; Hair et al., 2014). This study integrates three key models—Task-Technology Fit (TTF), the Technology Acceptance Model (TAM), and the DeLone & McLean Information System (IS) Success Model—to form a comprehensive framework for evaluating the performance of the E-SISMAL system in supporting malaria prevention efforts in West Papua. The DeLone & McLean model is used to assess perceived quality through three core dimensions: information quality, system quality, and service quality, all of which are designed to influence user satisfaction. The TAM model explains effectiveness and continued use through the constructs of perceived ease of use and perceived usefulness, which also affect user satisfaction. Meanwhile, the TTF model contributes by emphasizing the alignment between the tasks performed by healthcare workers and the capabilities of the system, measured by the variable “Impact of Performance”. In this framework, user satisfaction functions as a mediating variable that connects perceived quality to the system's performance outcomes.

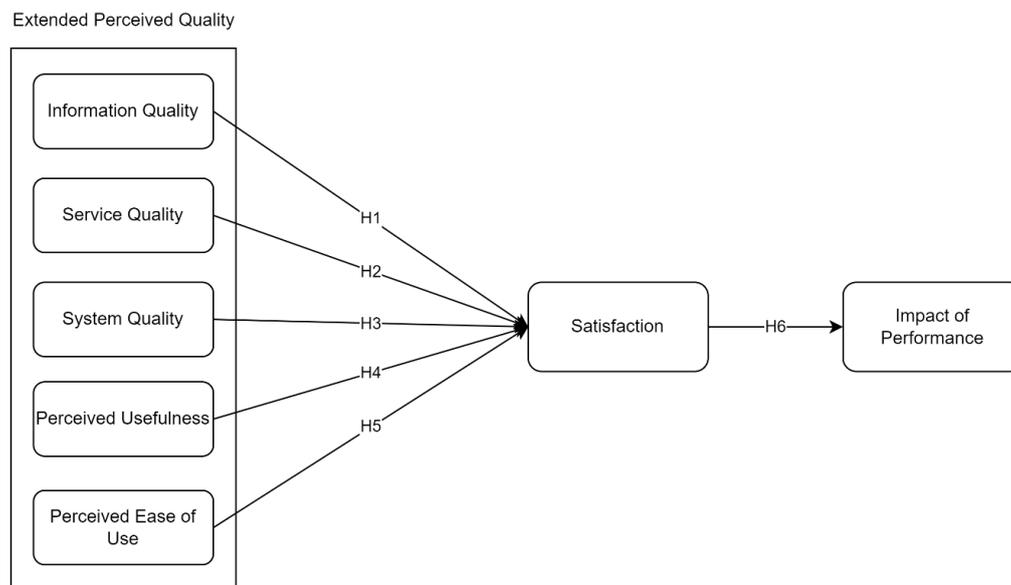


Figure 1. Research Model

Based on [Figure 1](#), each variable is interconnected. Information quality is one of the key components of an information system that influences user satisfaction. According to a study by Franque et al. (2021), information quality encompasses aspects such as completeness, accuracy, relevance, and timeliness, all of which contribute to users' perceptions of the system. In the context of E-SISMAL, a study by [Asmiani et al. \(2021\)](#) showed that delays and inaccuracies in malaria reporting often occur due to a lack of clarity in the information and confusing system features for field users. This reduces the satisfaction of surveillance officers with the system. Additionally, [Indrayana and Ariawan \(2022\)](#) also found that the completeness and accuracy of data reporting in E-SISMAL play a crucial role in supporting decision-making for malaria control. In this study, E-SISMAL is used to collect, manage, and report malaria surveillance data, making high-quality information essential for effective decision-making by healthcare professionals. If the system provides clear, up-to-date, and accurate data, it can enhance users' trust in the system and their satisfaction with its use. Therefore, hypothesis one is raised, namely:

H1: Information quality has a positive effect on user satisfaction in using the E-SISMAL Health Information System.

Service quality refers to the level of support users receive from the system provider, including responsiveness, reliability, technical competence, and empathy of the information system ([Franque et al., 2021](#)). In the context of E-SISMAL, a study by [Asmiani et al. \(2021\)](#) revealed that many surveillance officers experienced difficulties accessing technical support during reporting disruptions, along with slow responses from the system management team. This reduced users' comfort and satisfaction with the system. Furthermore, a study by [Herawati et al. \(2023\)](#) found that technical support services and the clarity of E-SISMAL user instructions significantly influenced the satisfaction levels of surveillance officers in using the system. In this study, where E-SISMAL is implemented in public health facilities, the technical support provided to healthcare workers—such as assistance with troubleshooting, training, or responding to user feedback—is crucial for ensuring smooth operations. Timely and helpful support services can have a significant impact on the user experience and overall satisfaction with the system. Thus, hypothesis two is:

H2: Service quality has a positive effect on user satisfaction in using the E-SISMAL Health Information System.

System quality reflects the technical functionality of an information system, such as speed, reliability, ease of navigation, and user interface design ([Franque et al., 2021](#)). In the context of E-SISMAL, a study by [Indrayana and Ariawan \(2022\)](#) stated that E-SISMAL has a fast response time and a comprehensive menu of options, although it features an outdated design; this can still enhance user satisfaction with the system. Additionally, research by [Herawati et al. \(2023\)](#) indicated that although E-SISMAL is web-based, issues such as the low usage of Population Identification Number/Nomor Induk Kependudukan (NIK) or International Classification of Diseases (ICD) codes, lack of integration with other systems, and data storage problems highlight the system's low quality in certain aspects. To ensure E-SISMAL's effectiveness, especially in remote or resource-limited areas, the system must be accessible, stable, and user-friendly. If healthcare workers find the system easy to operate and reliable, they are more likely to feel satisfied using it in their daily reporting and surveillance tasks. Therefore, hypothesis three is raised, namely:

H3: System quality has a positive effect on user satisfaction in using the E-SISMAL Health Information System.

[Hermawan and Paramita \(2021\)](#) describe perceived usefulness as the extent to which users believe that a system enhances their job performance. A study by [Herawati et al. \(2023\)](#) stated that E-SISMAL is used for routine reporting and serves as a key support tool in malaria elimination efforts. The system is considered to have strategic value for policy-making at various levels, which can enhance the perceived usefulness and, in turn, user satisfaction. Furthermore, research by [Sitompul et al. \(2022\)](#) noted that the main objective of E-SISMAL is to improve data visualization and analysis, as well as support decision-making, strongly reflecting the system's usefulness to its users, which can also contribute to higher satisfaction. In the case of E-SISMAL, when users perceive that the system helps them manage malaria data more efficiently—such as through quicker data entry, easier data retrieval, and improved monitoring—they are more likely to be satisfied with the system. Based on this, the following is hypothesis four:

H4: Perceived usefulness has a positive effect on user satisfaction in using the E-SISMAL Health Information System.

According to [Hermawan and Paramita \(2021\)](#), perceived ease of use refers to the extent to which a system is easy to learn and operate without significant effort. In the context of E-SISMAL, a study by [Herawati et al. \(2023\)](#) showed that the system is designed to be easily operated in remote areas, is available in a web-based version, and supports mobile-friendly reporting. This strengthens the perception of ease of use, which can influence user satisfaction. Additionally, research by [Sitompul et al. \(2022\)](#) stated that E-SISMAL was developed to simplify online data entry, aiming to ensure that the system can be used more efficiently by all users. E-SISMAL is used by healthcare workers with varying levels of technological literacy, so an intuitive interface and streamlined functions are crucial for reducing the learning curve. If users find the system simple and straightforward to use, this will contribute positively to their satisfaction. Based on this, the following is hypothesis five:

H5: Perceived ease of use has a positive effect on user satisfaction in using the E-SISMAL Health Information System.

[Franque et al. \(2021\)](#) define performance impact as the measurable improvement in user or organizational performance resulting from the use of a system. A study by [Herawati et al. \(2023\)](#) stated that system readiness and availability are key determinants of the success of malaria programs. In other words, the use of E-SISMAL, when accompanied by user satisfaction, can improve reporting accuracy, response speed, and malaria elimination efforts. Furthermore, research by [Indrayana and Ariawan \(2022\)](#) showed that satisfied users experienced improved performance and work efficiency through the use of E-SISMAL. In the case of E-SISMAL, high user satisfaction may lead to more consistent and effective system use, which can enhance data accuracy, timeliness of malaria reporting, and responsiveness to outbreaks. Consequently, the system's contribution to improving public health outcomes will be more significant. Based on this, the following is hypothesis six:

H6: User satisfaction has a positive effect on the performance impact of the E-SISMAL Health Information System.

Research Methodology

Sample

The target population of this study is all health workers in all hospitals, health centers, and health services in West Papua Province who use the E-SISMAL application in carrying out their duties. This approach was used because it was necessary to ensure that respondents met the criteria mentioned earlier. Respondent data was collected using a questionnaire (via Google Form) with statements regarding the use of the E-SISMAL application. The sample was determined using non-probability sampling, and respondents were willing to provide data; then the research data was processed using PLS- SEM ([Hair et al., 2014](#)). The authors also used the G*Power tool to assess the validity of the analysis. Setting the effect size at 0.15, alpha significance level at 5%, power of analysis at 95%, and using nine predictor variables, the minimum sample size required is 75 respondents ([Kock & Hadaya, 2018](#)). However, we collected more than enough data, namely 108 respondents' data.

The survey and data collection process were carried out for three months from October to December 2024, in all health work units in West Papua Province, with a total of 108 valid respondents. Demographic data collected included gender, age, highest level of education, and work unit. The explanation can be seen in [Table 1](#). The work units are not shown in [Table 1](#) because the respondents are health workers from various hospitals, health centers, and health offices throughout West Papua Province (there are many work units).

Table 1. Demographic Description of Respondents

| Category | Item | Total | Percentage |
|----------------|--|-------|------------|
| Gender | Male | 43 | 33,3% |
| | Female | 85 | 66,7% |
| Age | 18-35 Years | 51 | 47,2% |
| | 36-50 Years | 67 | 52,8% |
| | > 51 Years | - | - |
| Last Education | High School/Vocational School/Equivalent | - | - |
| | Diploma (D1/D2/D3) | 44 | 40,7% |
| | Bachelor's Degree (S1) | 64 | 59,3% |
| | Master's Degree (S2) | - | - |

Analysis Method

In the previous section, it was explained that this research uses the Structural Equation Modeling-Partial Least Squares (SEM-PLS) method with the SmartPLS application. This method was chosen because it is capable of analyzing complex research models even with a relatively small sample size and non-normally distributed data. In this section, the characteristics of the respondents who participated in the research are described.

Results

Measurement Model Evaluation

The measurement model analysis in this study was carried out with validity and reliability tests. To assess convergent validity, the Loading Factor (LF) test is used. In the outer loading test, we analyze the loading factor or the relationship between the indicator score and the intended construct. A factor loading is considered valid if the indicator value is greater than 0.7 (Inan et al., 2022). Then the Average Variance Extracted (AVE) value must be 0.5 or greater (Hair et al., 2014). An AVE value of 0.5 or more indicates that the construct can explain more than 50% of the indicator variation (Sarstedt et al., 2020). Then, the reliability test on each variable is carried out using two methods, namely Cronbach's Alpha (CA) and Composite Reliability (CR). All indicators of each variable are considered reliable if the CA and CR values are greater than 0.70 (Inan et al., 2022; Sayyida, 2023). In this study, the confirmatory analysis of the variables is presented in Table 2.

Table 2. Confirmatory Variable Results

| Construct | Statement | Code | LF |
|--|--|--------|-------|
| Information Quality (IQ) (Saputra et al., 2024) CA, CR, AVE = 0.817, 0.890, 0.730 | I feel that the information obtained from the E-SISMAL Application is reliable. | IQ1 | 0.811 |
| | I feel that the information obtained from the E-SISMAL Application is up-to-date. | IQ2 | 0.942 |
| | I find it easy to understand the information obtained from the E-SISMAL Application. | IQ3 | 0.783 |
| Service Quality (SQ) (Franque et al., 2021) CA, CR, AVE = 0.817, 0.890, 0.730 | I find the information system services of the E-SISMAL Application reliable. | SQ1 | 0.867 |
| | I believe in the ability of the E-SISMAL Application to provide quality services. | SQ2 | 0.883 |
| | I feel that the data of the E-SISMAL Application can be updated easily and quickly. | SQ3 | 0.811 |
| System Quality (STQ) (Franque et al., 2021) CA, CR, AVE = 0.814, 0.845, 0.650 | I find the E-SISMAL Application easy to use. | STQ1 | 0.731 |
| | I find the E-SISMAL Application easy to learn. | STQ2 | 0.709 |
| | I feel that I have no problems whatsoever when using the E-SISMAL Application. | STQ3 | 0.955 |
| Perceived Ease Of Use (PEOU) (Yen et al., 2010) CA, CR, AVE = 0.778, 0.870, 0.692 | I find the E-SISMAL Application easy to use to enter patient malaria test results data, drug stock data, and cadre monitoring. | PEO U1 | 0.868 |
| | It is very easy for me to understand how the E-SISMAL Application works to enter examination data, drug stock, and others. | PEO U2 | 0.866 |
| | I find it easy to enter test results data and drug stock using the E-SISMAL Application. | PEO U3 | 0.757 |
| Perceived Usefulness | The E-SISMAL Application helps me complete my work | PU1 | 0.908 |

| Construct | Statement | Code | LF |
|---|---|------|-------|
| (PU) (Franque et al., 2021) CA, CR, AVE = 0.867, 0.918, 0.788 | without obstacles. | | |
| | The E-SISMAL Application makes it easier for me to enter the results of malaria disease examinations. | PU2 | 0.856 |
| | The E-SISMAL Application is very helpful for me to enter patient malaria test results and drug stock quickly and easily. | PU3 | 0.899 |
| Satisfaction (ST) (Inan et al., 2023) CA, CR, AVE = 0.835, 0.900, 0.751 | The E-SISMAL Application improves the quality of the patient malaria test result data that I collect. | ST1 | 0.875 |
| | I am satisfied with the performance of the E-SISMAL Application. | ST2 | 0.856 |
| | I have no difficulty in carrying out my duties using the E-SISMAL Application. | ST3 | 0.868 |
| Impact Of Performance (IOP) (Tam & Oliveira, 2016) CA, CR, AVE = 0.771, 0.866, 0.683 | I feel that the functions of the E-SISMAL Application make users feel satisfied when completing tasks because it is fast and easy. | IOP1 | 0.784 |
| | The E-SISMAL Application makes it easier for me to enter patient malaria test results and drug stock data, so I can work faster and more efficiently. | IOP2 | 0.887 |
| | The E-SISMAL Application makes me work faster and more efficiently in completing my tasks related to malaria test result reports. | IOP3 | 0.805 |

After the confirmatory test shows that the data used in this study are good and meet the criteria for testing convergent validity and reliability, the next criterion is to assess discriminant validity. The purpose of discriminant validity is to measure that each construct is unique and is used to represent phenomena that are not represented by other constructs ([Inan et al., 2023](#)). In this study, to assess Discriminant Validity, the Heterotrait-Monotrait Ratio (HTMT) test was conducted, which compares the relationship between different latent variables with the relationship between indicators in the same variable. The HTMT value meets the criteria if the value is <0.85 or <0.9 ([Sarstedt et al., 2020](#); [Setiawati et al., 2024](#)). The results of the HTMT test in this study show a good value and can be seen in [Table 3](#). From [Table 3](#), it can be seen that the Discriminant Validity value using the HTMT test is accepted, because it meets the previously mentioned value criteria, which is <0.9 .

Table 3. Discriminant Validity (HTMT)

| | IOP | IQ | PEOU | PU | SQ | ST | STQ |
|------|-------|-------|-------|-------|-------|-------|-----|
| IOP | | | | | | | |
| IQ | 0.421 | | | | | | |
| PEOU | 0.464 | 0.435 | | | | | |
| PU | 0.199 | 0.121 | 0.219 | | | | |
| SQ | 0.277 | 0.561 | 0.552 | 0.163 | | | |
| ST | 0.404 | 0.345 | 0.634 | 0.326 | 0.554 | | |
| STQ | 0.527 | 0.230 | 0.314 | 0.258 | 0.120 | 0.184 | |

Structural Model Evaluation

After evaluating the construct measurement model, the next step is to evaluate the structural model. Structural Model Evaluation is a model that explains and predicts the relationship between one variable and another in a study. For the internal structural model, a collinearity test must be performed

before running the hypothesis test to ensure that the Variance Inflation Factor (VIF) value does not exceed or equal 5. The construct values associated with $VIF \geq 5$ and ≤ 0.2 indicate that they have a collinearity problem (Inan et al., 2023). Based on the results of data processing in Table 4, it can be seen that the VIF value of each construct has a prediction > 0.2 and < 5 , which means there is no collinearity problem.

Table 4. Variance Inflation Factor (VIF)

| | IOP | IQ | PEOU | PU | SQ | ST | STQ |
|------|-------|----|------|----|----|-------|-----|
| IOP | | | | | | | |
| IQ | | | | | | 1.475 | |
| PEOU | | | | | | 1.363 | |
| PU | | | | | | 1.099 | |
| SQ | | | | | | 1.573 | |
| ST | 1.000 | | | | | | |
| STQ | | | | | | 1.143 | |

There is also a hypothesis test. The purpose of hypothesis testing is to determine whether the data obtained is strong enough to reject the null hypothesis and accept the alternative hypothesis. This process is carried out by comparing the T-statistics and P-values through the bootstrap method. The hypothesis is considered accepted if the T Statistic values > 1.96 and P Values < 0.05 (Inan et al., 2020; Saputra et al., 2024). The following are the results of the structural model evaluation of the hypothesis testing that has been carried out and presented in Table 5. Of the six hypotheses proposed, three hypotheses have T-statistic values > 1.96 and P-values < 0.05 , which indicates that the hypothesis is accepted. Meanwhile, the other three hypotheses have T-statistic values < 1.96 and P-values > 0.05 , which indicates that the hypothesis is rejected.

There is also a coefficient of determination test. According to Furdantin (2018), the coefficient of determination (R-Square) is a tool used to measure the extent of the influence of the independent variable on the dependent variable. The R-Square value is expected to be between 0 and 1. An R-Square value of 0.75 indicates that the model has good power, while a value of 0.50 reflects moderate model power. On the other hand, a value of 0.25 indicates that the model is relatively weak (Inan et al., 2023; Risdiyanto et al., 2024).

Table 5. Hypothesis Test Results

| Hypothesis | Variables | T Statistics | P Values | Description |
|------------|-----------------------|--------------|----------|-------------|
| H1 | IQ \rightarrow ST | 1.199 | 0.231 | Rejected |
| H2 | SQ \rightarrow ST | 2.117 | 0.035 | Accepted |
| H3 | STQ \rightarrow ST | 0.465 | 0.642 | Rejected |
| H4 | PEOU \rightarrow ST | 2.455 | 0.014 | Accepted |
| H5 | PU \rightarrow ST | 1.952 | 0.052 | Rejected |
| H6 | ST \rightarrow IOP | 4.261 | 0.000 | Accepted |

Based on Table 6, it can be seen that the R-square value for the Satisfaction variable is 0.384, which shows that the Information Quality, Service Quality, System Quality, Perceived Ease of Use, and Perceived Usefulness variables affect the Satisfaction variable by 38.4% and have moderate predictive power on satisfaction. Furthermore, the R-Square value for the Impact of Performance variable is 0.116, which shows that the Satisfaction variable can explain the influence on the Impact of Performance variable by 11.6% and has a weak predictive power on Impact of Performance.

Table 6. Determinant Coefficient (R-Square)

| | R Square | Description |
|-----|----------|-------------|
| ST | 0.384 | Moderate |
| IOP | 0.116 | Weak |

Discussion

Based on the hypothesis test results in [Table 5](#), Information Quality (H1) does not significantly affect satisfaction (t-statistic = 1.199, p-values = 0.231). This result contradicts the findings of a previous study by [Franque et al. \(2021\)](#), in which information quality was found to have a positive influence on user satisfaction. This may be due to users perceiving the provided information as sufficient or standardized, thereby reducing its overall impact on user satisfaction. As for Service Quality (H2), it has a significant effect on satisfaction with a t-statistic > 1.96 and p-values is < 0.05 (t-statistic = 2.117, p-values = 0.035), where this hypotheses contradict with previous research by [Franque et al. \(2021\)](#). It can be concluded that information quality does not have much impact on user satisfaction, but service quality significantly influences user satisfaction when using the E-SISMAL health information system.

However, System Quality (H3) does not significantly affect satisfaction (t-statistic = 0.465, p-values = 0.642). This result is consistent with the findings of a previous study by [Franque et al. \(2021\)](#), which suggests that users have adapted to the system or have relatively low expectations, thereby minimizing the role of system quality in shaping satisfaction. Likewise, Perceived Usefulness (H5) does not significantly affect satisfaction (t-statistic = 1.952, p-values = 0.052). This result contradicts the findings of a previous study by [Hermawan and Paramita \(2021\)](#), which shows that perceived usefulness has a positive influence on user satisfaction. This suggests that, while users may view the system as useful, the perceived usefulness may not be strong or consistent enough to significantly impact their satisfaction. This indicates that system quality and perceived usefulness do not significantly influence user satisfaction in using the E-SISMAL information system.

Additionally, Perceived Ease of Use (H4) has a significant effect on satisfaction with a t-statistic > 1.96 and p-values is < 0.05 (t-statistic = 2.455, p-values = 0.014), which is in line with previous research by [Hermawan and Paramita \(2021\)](#). As for, Satisfaction (H6) significantly affects Impact of Performance (t-statistic = 4.261, p-values = 0.000), consistent with [Franque et al. \(2021\)](#). Overall, factors such as service quality, perceived ease of use, and satisfaction positively influence user adoption of the E-SISMAL Health information system. While information quality, system quality, and perceived usefulness do not significantly influence user intention to use the E-SISMAL Health information system.

In terms of predictive power, an R^2 value for satisfaction is 0.384, indicating a moderate level of predictive power. This suggests that the variables in the current model—information quality, system quality, service quality, perceived ease of use, and perceived usefulness—moderately explain 38.4% of user satisfaction with the E-SISMAL system. The remaining 61.6% may be explained by other variables not examined in this research model.

In contrast, the R^2 value for Impact of Performance is 0.116, which shows that the Satisfaction variable can explain the influence on the Impact of Performance variable by 11.6%, reflecting weak predictive power and indicating that a substantial portion of the variance in system performance remains unexplained. This suggests that, although user satisfaction contributes to system performance, the remaining 88.4% may be explained by other variables not examined in this research model. These findings underscore the need to further investigate external and organizational factors that may influence the actual performance impact of E-SISMAL, particularly within the unique healthcare context of West Papua.

Implications

Theoretical Implications

This study contributes to the theoretical advancement of information systems by integrating three prominent models (Task-Technology Fit (TTF), the Technology Acceptance Model (TAM), and the DeLone & McLean IS Success Model) to examine the factors that influence user satisfaction and system performance in the context of E-SISMAL. The integration of these models provides a more comprehensive framework for understanding how system-related factors and user perceptions affect the effectiveness of digital health systems.

The results indicate that service quality and perceived ease of use have a significant positive effect on user satisfaction, which in turn enhances system performance. Conversely, information quality, system quality, and perceived usefulness did not significantly influence satisfaction. These findings challenge some prior research and highlight the importance of contextual factors in shaping user perceptions and system success.

Moreover, the study highlights the importance of user satisfaction as a mediating variable, emphasizing that the effectiveness of a system is influenced not only by its technical capabilities but also by the quality of user experience and the ease of system interaction. This finding provides an extension to the TAM framework by indicating that perceived ease of use may have a more substantial impact than perceived usefulness, especially in healthcare environments with limited infrastructure.

In addition to the role of user satisfaction highlighted through TAM, the conceptual foundation of Task-Technology Fit (TTF) also plays an important part in understanding the outcome of system usage in this study. Although TTF is not modeled as a standalone construct in the analysis, it conceptually underpins the relationship between user satisfaction and performance impact. TTF emphasizes that a system's success depends not only on user perceptions but also on how well it supports the completion of specific tasks. In this study, performance improvement—captured through the Impact of Performance variable—reflects the degree of alignment between the system and the tasks of healthcare workers. The significant effect of user satisfaction on performance impact reinforces the importance of task-technology alignment, particularly in resource-limited settings like West Papua.

In conclusion, the findings offer a theoretical foundation for developing more context-sensitive models in evaluating the success of information systems, particularly in the public health sector. Prioritizing usability and service support in system design is crucial to enhancing user satisfaction and ensuring the system functions effectively and sustainably in real-world settings.

Practical Implications

Improving the quality of service in E-SISMAL is essential to increase user satisfaction. System managers need to ensure a quick response to user complaints, improve system reliability, and provide easily accessible technical support. Implementation of a 24/7 helpdesk or regular training for health workers can help improve service quality and ensure continued use of the system. With better service support, health workers will be more confident in using the system, resulting in more accurate and efficient data reporting.

In addition, the ease of use of E-SISMAL should be a major focus in its development. Simpler interface design, intuitive navigation, and automation features can reduce the workload of health workers in entering data. Providing tutorials or short training can also improve users' understanding of the system, making them more comfortable in using it. If the system is easy to use, health workers will be more productive in carrying out their duties, which ultimately contributes to the effectiveness of malaria prevention programs.

User satisfaction has a direct impact on the effectiveness and performance of E-SISMAL in supporting malaria prevention. Therefore, regular evaluation of user feedback is necessary to improve the most needed features of the system. With increased user satisfaction, health workers will be more

motivated to use the system consistently, thereby improving the accuracy and completeness of the data collected. This will strengthen data-driven decision-making in malaria control programs.

In conclusion, to improve the performance of E-SISMAL in malaria prevention, system managers should focus on improving service quality, ensuring ease of use, and paying attention to user satisfaction so that this system can function optimally in the real world.

Conclusion

This study evaluated how perceived quality, perceived ease of use, and perceived usefulness affect the performance of the E-SISMAL system in West Papua, using the TTF, TAM, and DeLone & McLean IS Success models. Findings show that service quality and perceived ease of use significantly impact user satisfaction, which in turn improves system performance. Conversely, information quality, system quality, and perceived usefulness did not show a notable effect, highlighting the greater importance of usability and service responsiveness.

Theoretically, this research confirms user satisfaction as a key mediator between system perceptions and performance impact. Perceived ease of use was more influential than perceived usefulness—especially in areas with infrastructure limitations. The low R^2 value for performance impact also indicates that other factors, like digital skills and institutional support, should be included in future studies.

From an implementation standpoint, the results point to the need for better service support, training, and user-friendly system design. Enhancing ease of use and providing accessible assistance can boost satisfaction and consistent usage. Regular feedback should also guide future system improvements to align with user needs.

In conclusion, while E-SISMAL holds potential in malaria control, its performance is currently limited by service and usability issues. Addressing these through targeted improvements can enhance its effectiveness. Future research should consider broader contextual and organizational factors to provide a fuller understanding of system success.

Limitations And Future Research Directions

This study has several limitations. The scope of the study only focuses on health workers in West Papua Province, so the results have limitations in generalizing to other regions with different infrastructure conditions. In addition, the quantitative approach with PLS-SEM used in this study does not allow exploration of qualitative aspects, such as users' subjective experiences and perceptions of E-SISMAL, which cannot be explained in depth. Furthermore, this study only considers Perceived Quality as the main factor affecting satisfaction and system performance, without taking into account external factors such as government policies, infrastructure readiness, and organizational support. Then, one of the main limitations in this study is the low R-Square value of the variables tested, such as the R-square value of 0.116 for Impact of Performance. These factors can play an important role in the effectiveness of health information systems, so they need to be considered in future research.

Future research should cover a wider area to obtain more representative results. In addition, a mixed-method approach that combines quantitative and qualitative analysis can be used to gain deeper insights into user challenges and experiences in using E-SISMAL. Then, the relatively low R^2 value for Impact of Performance (0.116) suggests the presence of other influential variables not captured in the current model. Future studies should consider incorporating constructs such as organizational support, infrastructure readiness, leadership involvement, training quality, and digital literacy. These variables may provide a more comprehensive explanation of how health information systems like E-SISMAL affect performance outcomes in malaria prevention programs.

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How to cite:

Kandami, C. L., Inan, D. I., Juita, R., & Indra, M. (2025). Combating Malaria Through E-SISMAL: How Perceived Quality, Perceived Ease of Use, and Perceived Usefulness Impact Performance? A Case of West Papua Province. *Jurnal Sistem Informasi (Journal of Information System)*, 21(2), 47–61.

Users' Switching Intention from Social Media Freemium to Premium

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Abstract

To date, social media platforms offer many exclusive or special features for making payments on these premium platforms. This study aims to identify the push, pull, and mooring factors that influence users' intention to switch from freemium to premium social media in Indonesia, drawing on the push-pull-mooring (PPM) theory. An online questionnaire involving 507 social media users in Indonesia and in-depth interviews with 30 users were conducted, with the qualitative data analyzed using content analysis to enrich the quantitative findings. The results show that functionality, advertising intrusiveness, relative advantage, price value, switching cost, and social influence influence switching intention. Theoretically, this study contributes to the PPM framework and the concept of switching intention by extending them to the context of user transitions from freemium to premium social media platforms in Indonesia, a context that has not been previously explored. Practically, the findings provide guidelines for social media platforms to improve premium features and enhance service offerings.

Keywords: social media, freemium, premium, push-pull-mooring, switching intention, Indonesia

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Introduction

The development of internet technology has also expanded the role of social media in various aspects of life, including education, business, and social movements, making it an integral part of the modern digital ecosystem. The use of social media is now not only for entertainment but also supports productive activities, such as digital marketing, e-commerce, and online community development. One of the key business developments in social media is the rise of social media subscriptions (Kim et al., 2018). Previously, social media platforms leveraged the results of advertising services that were already personalized using user data (Li et al., 2024). Other companies pay social media platforms to advertise, and those ads are displayed to users based on the results of the user's data analysis (Kannen et al., 2024).

Recently, subscription models have emerged as a new business model in which users pay to access exclusive features and content that are not available to free users (Hayes & Graybeal, 2011). Users are required to pay repeatedly for a specified period, whether monthly or annually (Li et al., 2024). As part of these subscription models, many social media platforms employ freemium strategies, which combine "free" and "premium" service tiers (Li et al., 2024). Freemium services offer a free version with limited functionalities, while premium services are the enhanced versions sold to consumers after they are persuaded by the free version (Tyrväinen & Karjaluoto, 2024). Premium models typically offer a more exclusive, ad-free experience and come with a range of advanced features that enhance the user experience (Majeed et al., 2022). For example, social media platforms like YouTube and Instagram implement freemium models by providing free access to core functionalities while offering premium subscriptions for features such as ad-free viewing, exclusive content, and verification badges (OOSGA, 2023). The primary objective of the premium model is to support content creators directly and offer a more immersive and personalized experience to customers (Kim et al., 2018).

Several previous studies have provided valuable insights into user behavior, monetization strategies, and psychological factors in the context of the freemium business model. Regarding user behavior, Mäntymäki et al. (2020) found that factors such as enjoyment, price value, ubiquity, and the discovery of new content have a significant impact on the intention to upgrade in the context of streaming services, while social connectivity has a slight adverse effect on the intention to retain. From the perspective of monetization strategies, Tyrväinen and Karjaluoto (2024) analyzed approaches adopted in freemium services, while, Geyer (2024) introduced the concept of the social media subscription model, which refers to the shift of business models from those that previously relied on ad-based revenue to paid subscription models, as implemented by Facebook and X (Li et al., 2024). Focusing on psychological factors, Lin et al. (2013) found that perceived value and service quality positively influence consumers' willingness to pay for online music services, while a strong "free mentality" can hinder users from switching to paid services, indicating that perceived value and quality can encourage subscription intentions despite the barriers posed by a preference for free services.

Although previous studies have explored the adoption of premium services (Geyer, 2024; Li et al., 2024; Lin et al., 2013; Mäntymäki et al., 2020; Tyrväinen & Karjaluoto, 2024), there is currently no study that analyzes the factors influencing social media users' intentions to switch from freemium to premium services in Indonesia. This study offers a unique contribution by explicitly examining the factors influencing social media users' intentions to switch from freemium to premium services across multiple platforms within the context of a developing country with high demographic diversity. While prior studies have primarily focused on single-platform transitions or developed country contexts, this study analyzes factors influencing switching intentions among Indonesian users, capturing variations across different income levels, educational backgrounds, and usage intensities. Indonesia's unique context, with one of the world's largest populations of internet users and significant demographic diversity, may reveal distinct behavioral patterns that differ from other large-population countries where social media monetization dynamics are influenced by more homogeneous economic or infrastructural conditions (We Are Social Indonesia, 2024). Moreover, an in-depth understanding of the factors that influence switching intent to this premium service is becoming increasingly important as the social media subscription model trend develops across various global social media platforms.

This study chose the push-pull-mooring (PPM) theory because of its suitability in exploring the factors of user service transfer, as demonstrated in Bansal (2005). Compared to other frameworks, such as the

Technology Acceptance Model (TAM), which focuses on user acceptance of new technologies, or the Value Adoption Model (VAM), which examines value perceptions during adoption, PPM is more suitable for this study as it explicitly addresses migration and switching behaviors (Ye et al., 2022). PPM groups influencing factors into push, pull, and mooring components, allowing for a comprehensive analysis of the drivers, attractors, and inhibitors influencing users' decisions to switch services, which aligns well with the complexity of the transition from freemium to premium services on social media platforms (Ye et al., 2022). Using PPM theory, this study can comprehensively identify and analyze the factors that push, pull, and mooring social media users in Indonesia in the context of the transition to paid services, an area that has never been explored before in the literature.

Prior studies have focused mainly on developed countries, single-platform contexts, or general technology adoption, leaving a gap in understanding cross-platform user transitions to premium services within developing countries with high demographic diversity, such as Indonesia. Therefore, to address this gap, this study seeks to answer the research question: 'How do push, pull, and mooring factors affect Indonesian social media users' intentions to switch from freemium to premium services across multiple platforms? This study focuses on social media platforms widely used in Indonesia that employ a freemium model. These include, but are not limited to, Facebook, Instagram, TikTok, YouTube, and WhatsApp. By not limiting the analysis to specific platforms, this study captures a broader behavioral pattern among Indonesian social media users in the context of shifting from freemium to premium subscription services. Theoretically, this study contributes to the PPM framework and the concept of switching intention by extending them to the context of user transitions from freemium to premium social media platforms in Indonesia, a context that has not been previously explored. This research can also contribute to social media platforms in improving their paid services and increasing customer satisfaction.

Literature Review

Subscription Model

The subscription model has become a popular business model since the early 2000s, mainly due to the digitization process (Rese & Baier, 2025). This model can be seen in digital product service providers such as streaming service providers (Bischof & Rudolph, 2021), beauty product services (Woo & Ramkumar, 2018), and physical goods sales (Andonova et al., 2021). Users typically sign up for subscriptions to access additional services or specific services for an extended period (classic subscription) or within a specified timeframe (rental subscription) (Rese & Baier, 2025). The subscription model has been in existence since the 17th century and was created to allow the pre-ordering of specific books and articles at a discounted price in advance (Yang & Kwon, 2024). Along with the development of technology and the times, the concept of subscription has evolved into a payment model with a predetermined fee for either unlimited or limited use of a service or feature, typically outlined in contractual terms such as monthly or annual fees (Yang & Kwon, 2024).

One of the businesses that implements the subscription model is social media. Previously, social media platforms made money by displaying personalized ads based on user data (Li et al., 2024). Companies paid social media platforms to display ads to users who had been selected through data analysis (Kannen et al., 2024). In short, before the advent of social media subscriptions, social media platforms generated revenue by selling user data to advertisers (Geyer, 2024). This change in business model marks a shift in the monetization strategy implemented by social media (Lin et al., 2013). Social media platforms are increasingly adopting freemium and premium subscription models to diversify their revenue streams and cater to diverse user preferences (Sciglimpaglia & Raafat, 2022).

The term "freemium" is a combination of "free" and "premium" that describes a strategy where customers can access a basic version of a product or service at no cost and can upgrade to a premium version with additional features by making a payment (Gu et al., 2018). Freemium business models have two distinct phases: attracting as many users as possible to the free offer and then converting a portion of them to premium (Sciglimpaglia & Raafat, 2022). There are many alternatives, but four standard freemium models include offering multi-tiered products, a no-advertising upgrade, a service upgrade, and a full usage trial period (Sciglimpaglia & Raafat, 2022). In the free version of social media,

users can commonly sign up, create a profile, connect with friends, post content, or use messaging services without any charge (Frank, 2023).

Premium service is a paid upgrade within a freemium model that offers customers additional, enhanced, or unrestricted features compared to the free basic version (Gu et al., 2018). Majeed et al. (2022) showed that users value a more personalized and quality experience on social media. In a premium service, social media platforms can offer better features, reduce intrusive ads, and provide a safer experience for their users. For example, on LinkedIn, users can sign up, create a profile, apply for jobs, and connect with other users on the platform at no cost. However, LinkedIn Premium offers additional benefits, such as the ability to become a featured job applicant, view who has viewed your profile, and send more InMail messages (Frank, 2023). YouTube also offers a YouTube Premium service platform, allowing users to pay a fee to avoid advertisements (Geyer, 2024). Reddit also offers a similar service called Reddit Premium, where paying members acquire certain benefits, such as ad-free browsing, exclusive content, and access to specific features (Geyer, 2024).

Push-Pull-Mooring

Push-pull-mooring (PPM) is a framework often used to study the efforts, intentions, switching behaviors, and social phenomena of sellers of a product or service (Nimako & Ntim, 2013). The PPM theory is a migration theory used to explain the move from one service to another. This theory has been adapted to understand consumer behavior that varies across different contexts by categorizing the factors that influence those decisions into three main elements: push, pull, and mooring (Ye et al., 2022). The PPM theory diverges from the initial theory, the push-pull model developed by Lee (1966) and Bogue (1969), which was later expanded by Moon (1995) to include an additional factor: mooring (Nimako & Ntim, 2013). Lee (1966) explained that two factors influence human migration behavior: push and pull factors. Additionally, other factors that influence migration include distance, cost, and the difficulty of the journey (Lee, 1966). The Mooring factor provides a detailed explanation of the nature of displacement (Moon, 1995). The role of the mooring factor in PPM theory is as a comparative factor that functions as an inhibitor of the migration process (Moon, 1995).

Conceptual Model

This research model was compiled by referring to studies that include discussions of premium and freemium services, user switching, and the application of push-pull mooring theory (Fu et al., 2021; Liao et al., 2021; Lin et al., 2020; Mäntymäki et al., 2020; O'Brien, 2022; Tyrväinen & Karjaluoto, 2024; Xu et al., 2021; Ye et al., 2022; Zhou & Mi, 2024). Regarding the push factor, we identified dissatisfaction, functionality concerns, privacy concerns, and the intrusiveness of advertising. Regarding the pull factor, we adopted the concepts of perceived value, relative advantage, and price value. In addition, we adopted free mentality, switching cost, and social influence as the mooring factors. The proposed conceptual model is illustrated in Figure 1, which features ten variables and corresponding hypotheses.

The movement of an individual from one service to another is often triggered by dissatisfaction with the previous service. According to Fu et al. (2021), the feelings of discomfort and negative experiences by users encourage them to switch services, specifically to stop using Facebook. User satisfaction correlates positively with a user's desire to use a service (Ye et al., 2022). The higher the user satisfaction with a service, the stronger their desire to continue using it (Ye et al., 2022). Previous research has also demonstrated a positive relationship between user dissatisfaction and their desire to discontinue a service or switch to another (Fu et al., 2021; Sun et al., 2017). User dissatisfaction stems from unmet expectations from the moment users interact directly with the services or features provided by the service provider (Zhou & Mi, 2024). In the context of freemium social media, users may feel dissatisfied and dislike the experience of using freemium social media. It can manifest as anxiety over the limitations of the features provided, disappointment due to unmet usage expectations, numerous distractions such as advertisements that reduce satisfaction, and overall negative experiences that are perceived as detracting from the pleasure that should be obtained from using social media. Therefore, we propose the following hypothesis.

H1: Dissatisfaction (DS) influences social media switching intention from freemium to premium (SW).

Functionality is defined as a utility derived from the performance of a service ([Tyrväinen & Karjaluoto, 2024](#)). In a free service, there are usually restrictions or some of the service's functionality is limited ([Tyrväinen & Karjaluoto, 2024](#)). Users tend to leave a service if it has low quality due to the numerous restrictions on features or content that can be enjoyed ([Ye et al., 2022](#)). The shift in use is attributed to fatigue resulting from enduring limitations and low service quality ([Zhou & Wu, 2024](#)). Users switch to other services when they consider the value offered by these services to be greater than that of the services they currently use, due to their perceived benefits and superior features ([Chang & Chiu, 2023](#)). In the context of freemium social media, some of the functions provided in free versions are limited. Therefore, users must upgrade to premium services to gain full access to social media functionality. Then, we suggest the following hypothesis.

H2: Functionality (FN) influences SW.

Intrusiveness is a perception that arises due to disturbances in the audience's cognitive processes ([Li et al., 2002](#)). In the freemium business model, the presence of advertising provides benefits by covering the costs incurred in providing services to free users, as well as serving as a strategy to mitigate user dissatisfaction and discomfort ([Dörr et al., 2013](#)). [Tsai \(2023\)](#) also noted that users sometimes feel annoyed and unhappy when ads appear suddenly and block the content they are enjoying or interrupt their interaction with the service. In the context of freemium social media, users must tolerate content that is often mixed with advertisements, such as posts, short videos, or links inserted between the displayed content. These ads disrupt the user experience, reducing the level of enjoyment users derive from consuming content ([Mäntymäki et al., 2020](#)). Therefore, we proposed the following hypothesis.

H3: Intrusiveness of advertising (IA) influences SW.

Privacy concern is defined as the fear of a breach of the privacy of social services used, typically stemming from the user's inability to control the information posted by others about themselves, as well as the possibility that their identity information has been stolen ([Ye et al., 2022](#)). Excessive violations of user privacy can lead to user fatigue when using social networking services. In other words, users will most likely be encouraged to switch to safer social networking services or stop using social networks ([Ye et al., 2022](#)). In addition to feeling insecure and worried about data leaks, users also sometimes feel uncomfortable knowing that the social media services they use are monitoring their activities ([Dahabiyeh et al., 2024](#)). [Chen et al. \(2022\)](#) also stated that users have concerns about the services they use, as they have a premonition that the service collects personal information without their permission and uses it under the pretext of the applications or functionality. In the context of freemium social media, users often feel that their data security is compromised because these platforms collect and sell user data for personalized advertising, a strategy used by freemium social media to generate revenue ([Geyer, 2024](#)). Based on this, privacy concerns have a positive influence on the switching intention of freemium social media users to premium social media. Thus, we define the following hypothesis.

H4: Privacy concern (PC) influences SW.

[Yuen et al. \(2023\)](#) found that high service values can influence consumers' intention to try alternative services provided by their current service providers. In the context of social media, perceived value is defined as a user's evaluation of the benefits received from a service, including quality, experience, convenience, and user satisfaction, as well as the benefits obtained being commensurate with the features and capabilities offered by the freemium version. [Kang et al. \(2023\)](#) investigated consumer acceptance of robots in the hospital service industry and found that perceived value is a crucial factor influencing consumer purchasing decisions. In a study by [Mäntymäki et al. \(2020\)](#) that examined the value difference between free and paid users, it was found that perceived value is the primary factor motivating users to switch from free services to paid services. When users perceive added value or a sense of pleasure and comfort in using a service, they are more likely to switch to that service than to their previous one ([Zhou & Mi, 2024](#)). [Lin et al. \(2020\)](#) argue that a service will be able to attract users if users perceive that the benefits obtained are superior to those of the previous service. In the context

of freemium social media, users evaluate whether the premium version offers added value, such as advanced features, ad-free experiences, and enhanced convenience, compared to the limitations of the freemium version. When users perceive the premium service as offering significant additional value, they are more likely to switch to it. Then, we suggest the following hypothesis.

H5: Perceived value (PV) influences SW.

[Lin et al. \(2020\)](#) employed cost-benefit theory to assess the factors influencing the intention to use mobile payment services. In the context of social media, relative advantage is defined as the extent to which users believe that using premium features will offer greater advantages and benefits, such as convenience, efficiency, and effectiveness, compared to not using them. Users are interested in switching to new services because they perceive them as offering greater ease of use compared to previous services, thereby forming a sense of comfort and increasing their intention to switch ([Chen et al., 2022](#)). Services that were previously used by users, when they begin to cause discomfort and dissatisfaction, will lead users to develop a behavior of seeking alternative services ([Tsai, 2023](#)). When users feel comfortable with the alternatives they find, they will choose to switch; conversely, if they do not find a sense of comfort or mediocrity and the service is similar to the previous one, then the user will choose to settle for the previous service ([Tang & Chen, 2020](#)). In the context of freemium social media, users often seek to overcome discomfort by exploring alternative options. Premium social media offers a solution to these issues, making users more inclined to switch to premium services. Next, we propose the following hypothesis.

H6: Relative advantage (RA) influences SW.

[Mäntymäki et al. \(2020\)](#) noted that users tend to switch services after knowing the price offered by a service and comparing it with the benefits they obtain. The price factor is a decisive factor for potential users in deciding whether to use the service or not ([Mäntymäki et al., 2020](#)). Users are typically aware of the quality of freemium services and evaluate the prices offered by premium services before deciding to use them ([Tyrväinen & Karjaluoto, 2024](#)). Users tend to seek services that meet their needs, have a positive impact on the user experience, and offer the best value at the most optimal price, while also providing a sense of satisfaction ([Kushwah et al., 2024](#)). In line with this statement, [Venkatesh et al. \(2012\)](#) found that price value is defined as the consumer's cognitive consideration between the perceived benefits of the application and the financial cost of using it. Price value is said to have a positive impact if the benefits obtained from using a technology or service exceed the price that must be paid ([Venkatesh et al., 2012](#)). We contextualized the price value in our study by emphasizing that the premium social media services offered by social media platforms can serve as a pull factor, encouraging users to switch from freemium to premium services. Therefore, we identify the following hypothesis.

H7: Price value (PR) influences SW.

Previous studies have shown that switching costs play a significant role in influencing consumers' decisions to either switch or stay with a service or product. [Liao et al. \(2021\)](#) mentioned that switching cost is one of the important mooring factors that arise when a service provider makes changes, including cost, time, and effort. [Ye et al. \(2022\)](#) have identified that switching costs are not only financial but also involve aspects of time and adaptation efforts. The switching cost is defined as the financial and psychological costs incurred when switching from one option to another ([Sekarputri et al., 2023](#)). Users tend to be cautious when considering the psychological costs, such as time and effort, associated with subscribing to a service provider ([Chang & Chiu, 2023](#)). It includes the subscription costs that must be incurred, the time required to learn new features, and the effort needed to adapt to different interfaces. Within the context of this study, switching costs can encompass several key dimensions that influence consumer decision-making. These include the subscription fees that must be paid, the time required to learn new features, and the effort needed to adapt to different interfaces. The higher the switching cost, the lower the user's intention to switch to other services. Thus, we propose the following hypothesis.

H8: Switching cost (SC) influences SW.

Social influence is defined as the effect caused by the environment or people around the user that encourages them to form a particular behavior ([Chang & Chiu, 2023](#)). When a user learns that one of

their friends is using or adopting a new or recommended technology, such as generative AI, they tend to turn to it instead of traditional search engines (Zhou & Wu, 2024). In a study by Ye et al. (2022) on the switching intention of live-streaming e-commerce users, it was found that social influence refers to the impact exerted by social circles, such as friends, family, and peers, on an individual’s decision to switch to digital platforms. The study found that social influence can change individual and product perceptions, which in turn affect switching intention. Similar findings were explained by Lin et al. (2013) on the intention to pay for online music services, which confirms the important role of close social contact in shaping the adoption behavior of new technologies. In the context of transitioning from the free version to the premium version of social media, social influence has the potential to be a key factor in determining the perceived value of a service based on the experiences and opinions shared by users through their social networks. Social influence not only has a direct impact on switching intention but also plays a strategic role in shaping the perceived value of services (Lin et al., 2020). Thus, we propose the following hypothesis.

H9: Social influence (SI) influences SW.

The free mentality is a deep belief that digital content should be available for free (Lin et al., 2013). This belief is reinforced by the widespread availability of free services on the internet that influence consumer expectations and behavior towards digital platforms (Lin et al., 2013). A free mentality is also defined as the belief that all content available on the internet has the status of a public good, where no one is excluded from its use (O’Brien, 2022). The free mentality is the biggest obstacle in the process of subscribing users to online content, as it suggests that everything available online can be enjoyed for free (Liu et al., 2023). Users believe that a good service should provide more value and benefits even if they have no desire to pay, since the majority of online service providers offer it for free (Kim et al., 2018). In this context, we assumed that a free mentality would have an adverse effect on switching intention from the free version of social media services to the paid version, as users with a stronger free mentality are more likely to resist paying for online services. Then, we define the following hypothesis.

H10: Free mentality (FM) influences SW.

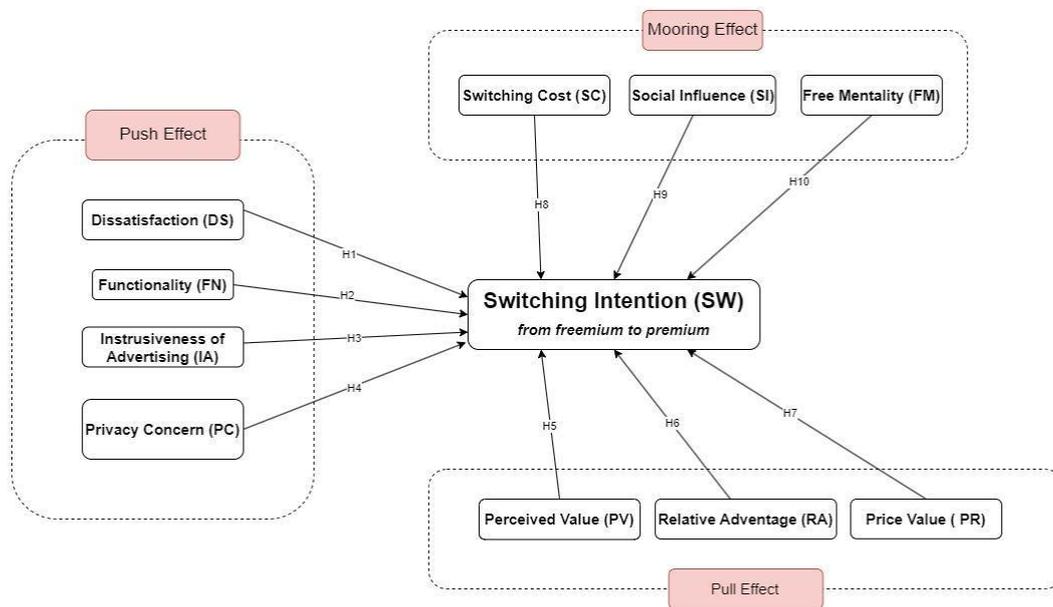


Figure 1. Proposed Conceptual Model

Methodology

Research Design

The mixed-methods approach applied in this study combines a quantitative approach, utilizing an online questionnaire, with a qualitative approach involving interviews. Specifically, the qualitative phase was

conducted to explore why specific hypotheses were supported while others were not and to capture respondents' perspectives that quantitative data could not fully explain. By integrating these two methods, this study generated richer insights into the concepts explored (Creswell, 2014). This study stage encompasses problem formulation, literature review, research model design, quantitative instrument development, readability testing, pilot study, quantitative data collection, quantitative data analysis, qualitative instrument design, qualitative data collection, qualitative data analysis, and conclusion.

The criteria for respondents in this study are Indonesian citizens aged 17 years or older who use premium social media and have a basic understanding of social media. Beyond the age and familiarity criteria, no additional exclusion criteria were applied; however, efforts were made to include respondents from diverse demographics, including educational backgrounds, genders, and ages, to enhance the representativeness of the data. To ensure diversity, we distributed the survey across multiple social media platforms (LINE, WhatsApp, Instagram, and Twitter) to reach respondents from various regions in Indonesia. We monitored incoming responses to ensure a balance in gender, age groups, and educational backgrounds. For the qualitative phase, participants were recruited from among the survey respondents who indicated willingness to participate in follow-up interviews.

Data Collection

Before distributing the questionnaire, a readability test was conducted to assess the extent to which prospective respondents could understand the content and ensure that the instrument was suitable for use. The readability test was conducted over five days, from September 16 to September 20, 2024, involving nine respondents. The results of the readability test consisted of suggestions from respondents regarding aspects that needed improvement in the questionnaire, such as sentence readability. Based on this feedback, we evaluated and revised the questionnaire before distributing it to the larger group of respondents.

A pilot study questionnaire was then conducted with 30 respondents. The purpose of this pilot study was to obtain the Cronbach's alpha (CA) value as a measure of the internal consistency of the questionnaire developed for this research. An ideal Cronbach's alpha value should be above 0.7 (Hair, 2014). The pilot study yielded a total CA value of 0.885, indicating good internal consistency; therefore, we proceeded to the primary data collection phase.

The questionnaire data collection process was conducted over 32 days, from October 11 to November 11, 2024, and resulted in the collection of 570 respondents. In quantitative research, a common rule of thumb for determining the minimum sample size is the "10-times rule". This rule suggests that the sample size should be at least 10 times the number of indicators used to measure a construct in a research model (Hair et al., 2011). This study employed 43 indicators, indicating a minimum required sample size of 430. Therefore, the sample size of 570 respondents exceeds this requirement, ensuring the adequacy of the sample for PLS-SEM analysis. Table 1 presents the demographic summary of respondents who completed the questionnaire.

Qualitative data collection is carried out to validate and support the hypotheses that have been tested. The process of collecting qualitative data involves conducting interviews. The interview was conducted both offline and online, involving a total of thirty respondents. Data saturation was used as the guiding principle in determining the adequacy of the sample size for the qualitative phase. We found that after approximately 25 interviews, no new significant themes or insights emerged, indicating that data saturation had been reached (Guest et al., 2006). An additional five interviews were conducted to confirm the consistency of the findings and ensure robustness, bringing the total to 30 interviews, which were deemed sufficient to capture the intended range of insights in this study. Data collection took place from November 18 to November 22, 2024, and all respondents provided written consent to participate in this study.

Table 1. Summary of Questionnaire Respondent Demographics

| Demographics | | Number of Respondents | Percentage |
|-------------------|---|-----------------------|------------|
| Gender | Man | 256 | 44.91% |
| | Woman | 262 | 45.96% |
| Age | 17-25 years old | 246 | 43.16% |
| | 26-35 years old | 212 | 37.19% |
| | 36-45 years old | 49 | 8.60% |
| | > 45 years old | 9 | 1.58% |
| Education Level | Elementary/junior high/high school/equivalent | 86 | 15.09% |
| | Diploma | 83 | 14.56% |
| | Bachelor | 326 | 57.19% |
| | Postgraduate | 24 | 4.21% |
| Domicile | Greater Jakarta | 218 | 38.25% |
| | Java (Non-Greater Jakarta) | 135 | 23.68% |
| | Bali | 42 | 7.37% |
| | Sumatra | 66 | 11.58% |
| | Kalimantan | 38 | 6.67% |
| | NTT/NTB | 14 | 2.46% |
| | Maluku | 3 | 0.53% |
| | Others | 3 | 0.53% |
| Work | Student | 150 | 26% |
| | Self-employed | 85 | 14.91% |
| | Private employees | 169 | 29.65% |
| | Civil servants | 46 | 8.07% |
| | Stated-owned employees | 49 | 8.60% |
| | Police | 11 | 1.93% |
| | Unemployment | 3 | 0.53% |
| | Others | 6 | 1.06% |
| Social media used | Instagram | 427 | 74.26% |
| | Whatsapp | 396 | 68.87% |
| | Line | 222 | 38.61% |
| | TikTok | 343 | 59.65% |
| | Twitter | 263 | 45.74% |
| | Others | 14 | 2.43% |

Data Analysis

We analyzed the questionnaire data using the partial least squares structural equation modeling (PLS-SEM) approach. The PLS-SEM was chosen because this study is exploratory, and PLS-SEM is capable of modeling complex cause-and-effect relationships between latent variables (Martinez et al., 2021). The tools used in data processing and analysis include SMART-PLS version 3 which is used to process data from outlier tests and common method bias tests using the PLS-SEM method, IBM SPSS Statistics

25 is also used to conduct outlier tests and common method bias tests, and Google Sheets which is used to accommodate data from the use of the SMART-PLS version 3 and IBM SPSS Statistics 25 applications.

Finally, the interview data were analyzed using the content analysis method, which consists of four systematic stages. The first stage, decontextualization, involved coding the data to identify meaning units from each transcript (Bengtsson, 2016). The second stage, recontextualization, involved reorganizing any remaining data that had not yet been assigned meaning units and determining whether these data could be formed into new meaning units or should be excluded (Burnard, 1995). In the third stage, categorization, the researchers grouped similar meaning units into the same categories to identify patterns within the data (Burnard, 1995). The final stage, compilation, involved documenting the established categories along with the number of meaning units within each category and its subcategories (Berg, 2001).

Research Instruments

The questionnaire is divided into three main sections: respondent validity, respondent demographic data, and questions related to the research topic. In the validity section, respondents will be asked several questions, including the length of time they use social media, the type of social media they use, whether they use premium social media, and the type of premium social media they use. In the respondent demographic section, information related to the respondent’s data will be collected. In the question section related to the research topic, there will be 43 questions addressing the push, pull, and mooring factors that influence respondents’ interest in switching to premium social media services based on predetermined variables. These items were adapted from prior literature (Cao et al., 2020; Fu et al., 2021; Lin et al., 2020; Lin et al., 2013; Mäntymäki et al., 2020; O’Brien, 2022; Tyrväinen & Karjaluoto, 2024; Xu et al., 2021; Ye et al., 2022; Zhou & Li, 2024; Zhou & Mi, 2024) and are listed in Appendix A. Respondents were asked to provide answers to each question using a five-point Likert scale, where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree (Joshi et al., 2015).

The interview questions were developed based on research variables, including hypotheses that were supported and that were not supported in the quantitative phase. Semi-structured interview items were prepared and administered to each participant. Using a semi-structured approach allowed for flexibility in probing further into participants’ responses while ensuring that all key constructs relevant to the study were systematically covered (Inglethorpe, 2024). The interview questions are presented in Appendix B.

Results

The average variance extracted (AVE) test is used to assess the extent to which a construct accounts for the majority of the variance in indicators (Hair et al., 2021). According to Hair et al. (2021), the minimum acceptable AVE value in a study is 0.5 or more. Cronbach’s Alpha (CA) measures reliability by assessing the intercorrelations among the observed indicator variables. Additionally, composite reliability (CR) testing is conducted to confirm construct reliability, with a minimum acceptable value of 0.7 (Hair et al., 2017). Table 2 describes the values of AVE, CR, and CA. The results in Table 2 indicate that all variables meet the requirements for reliability and convergent validity, with AVE values exceeding 0.5 and CR and CA values above the recommended threshold of 0.7.

Table 2. AVE, CR, and CA Values

| Variables | AVE | CR | CA |
|-----------|-------|-------|-------|
| DS | 0.697 | 0.902 | 0.855 |
| SHE | 0.717 | 0.910 | 0.869 |
| PV | 0.802 | 0.942 | 0.918 |
| PR | 0.701 | 0.903 | 0.857 |
| PC | 0.715 | 0.909 | 0.867 |

| Variables | AVE | CR | CA |
|-----------|-------|-------|-------|
| RA | 0.704 | 0.905 | 0.860 |
| SW | 0.776 | 0.912 | 0.856 |
| FM | 0.658 | 0.885 | 0.827 |
| FN | 0.810 | 0.945 | 0.922 |
| THE | 0.684 | 0.896 | 0.846 |
| SC | 0.811 | 0.945 | 0.922 |

Discriminant validity ensures that each construct is unique and capable of capturing phenomena that are not represented by other constructs in the model (Hair et al., 2017). We employed cross-loading and the Fornell-Larcker criterion to assess the discriminant validity of the model (Hair et al., 2017). The Fornell-Larcker criterion test involves comparing the square root of the AVE value with the correlation between constructs (Hair et al., 2017). The square root value of AVE for each construct must be greater than the correlation between that construct and the other construct (Hair et al., 2017). However, due to the limitations of both methods, this study also conducted an optional evaluation using the Heterotrait-Monotrait ratio value to obtain more reliable discriminant validity test results (Hair et al., 2017). The results of cross-loading are presented in Appendix C, and the Fornell-Larcker test results are included in Appendix D. HTMT is defined as the mean of hetero-trait-hetero-method correlation, and HTMT values below 0.85 or 0.90 are considered to meet the discriminant validity test (Henseler et al., 2015). Henseler et al. (2015) recommend a threshold of 0.85 when the constructs in the model are conceptually distinct and 0.90 when the constructs are highly conceptually similar. The results of the HTMT test are presented in Appendix E.

After testing the path coefficient, the study proceeded with a structural model test to assess the model's predictability using the R² determination coefficient, which was calculated through the PLS algorithm. R² is defined as a measure of the predictive strength of the research model, calculated as the square of the correlation between the actual value and the predicted value of a given endogenous construct (Hair et al., 2017). The interpretation of the R² value is as follows: values above 0.25, 0.50, and 0.75, respectively, indicate the ability of independent variables to explain the dependent variable in the research model, which are interpreted as weak, medium, and strong predictive abilities (Hair et al., 2017). The results of the coefficient of determination are presented in Table 3. The hypothesis test is based on the p-values and t-statistic values of the path coefficient test. A summary of the results of the hypothesis test is presented in Table 4.

Table 3. Result Coefficient of Determination (R²)

| Variable | R Square | R Square Adjusted | Description |
|----------|----------|-------------------|-------------|
| SW | 0.523 | 0.513 | Strong |

Table 4. Hypothesis Test Results

| Hypothesis | Original Sample (O) | Sample Mean (M) | Standard Deviation (STDEV) | T Statistics (O/STDEV) | P Values | Description |
|------------|---------------------|-----------------|----------------------------|--------------------------|----------|-------------|
| H1 | 0.083 | 0.082 | 0.049 | 1.704 | 0.089 | Rejected |
| H2 | 0.127 | 0.125 | 0.045 | 2.793 | 0.005 | Accepted |
| H3 | 0.100 | 0.103 | 0.051 | 1.973 | 0.049 | Accepted |
| H4 | 0.100 | 0.100 | 0.055 | 1.807 | 0.071 | Rejected |

| Hypothesis | Original Sample (O) | Sample Mean (M) | Standard Deviation (STDEV) | T Statistics (O/STDEV) | P Values | Description |
|------------|---------------------|-----------------|----------------------------|--------------------------|----------|-------------|
| H5 | 0.048 | 0.047 | 0.048 | 0.985 | 0.325 | Rejected |
| H6 | 0.145 | 0.143 | 0.046 | 3.154 | 0.002 | Accepted |
| H7 | 0.111 | 0.112 | 0.053 | 2.114 | 0.035 | Accepted |
| H8 | 0.127 | 0.124 | 0.053 | 2.402 | 0.017 | Accepted |
| H9 | 0.124 | 0.126 | 0.052 | 2.367 | 0.018 | Accepted |
| H10 | 0.052 | 0.054 | 0.053 | 0.991 | 0.322 | Rejected |

Discussions

This study found that H1 was rejected, indicating that the influence of dissatisfaction on social media switching intention was not significant. This result is not in line with [Xu et al. \(2021\)](#), who found that dissatisfaction affects the intention to switch platforms in the context of game streaming. Similarly, [Yoon and Lim \(2021\)](#) demonstrated that, in the context of e-banking, user dissatisfaction with existing services has a significant impact on their desire to switch to alternative bank services that may offer a better experience or lower fees. [Zhou and Mi \(2024\)](#) also argue that user dissatisfaction stems from unmet expectations from the moment users interact directly with the services or features provided by the service provider. Finally, [Tang and Chen \(2020\)](#) identified that dissatisfaction with the speed and quality of content can significantly affect users' intentions to seek out more responsive and innovative alternatives in the context of microblogging brands. The overall study highlights that dissatisfaction is a key factor that prompts users to reevaluate their choices and seek out services that better meet their needs and expectations. However, this study showed that many users found the free version of social media to be still reliable for daily use and satisfactory. Users have no problem using the free version of social media because it is sufficient for their daily needs, primarily when not used by Instagram celebrities or referred to as "selebgrams." Based on the results of the qualitative analysis, premium social media users found freemium social media to be satisfactory, aligning with the quantitative finding that dissatisfaction in freemium services does not influence switching intention. However, some of them were bothered by the ads ("*Freemium social media was still satisfactory, but I am a bit annoyed with ads, so I decided to switch to premium*" - [NW2]). In addition, access to all features is another reason for users to switch even though freemium social media is enough ("*I want to get the full experience from using the social media so, in the end, it is the one that encourages me to buy or use the premium*" - [NW9]).

This study also found that functionality has a significant influence on switching intention (H2). This finding aligns with [Mäntymäki et al. \(2020\)](#), who found that features that comprehensively meet users' needs not only retain customers on freemium services but also increase the perceived value of the price they receive. In this context, innovative and exclusive features can be a key determinant in consumers' decisions to stick with premium services. Users tend to leave a service if it has low quality due to the numerous restrictions on features or content that can be enjoyed ([Ye et al., 2022](#)). This concept is similar to the alternative attractiveness theory ([Sun et al., 2017](#)). Alternative attractiveness is a concept in consumer behavior theory that shows how users' perception of available alternatives can influence their decision to switch ([Sun et al., 2017](#)). In other words, when a product or service offers adequate features and meets user expectations, the likelihood of users switching to another product or service decreases. [Chang and Chiu \(2023\)](#) also argued that users tend to switch to other services when they perceive that these services offer better value, benefits, and features than the ones they are currently using. In the context of social media usage, if the free version has significant feature limitations, users are likely to switch to the premium version, which offers more features and capabilities. The results of this study make a consistent contribution to the understanding of how functionality limitations can be an important factor in shaping user intentions to switch services. This study highlights the importance for social

media platform providers to enhance the value of their premium features, ensuring that users perceive the additional cost as worthwhile. The qualitative findings provide nuance to these quantitative results, illustrating how the desire for enhanced functionality motivates users' decisions to switch to premium services. For instance, users reported that the ability to access premium features for content promotion was a key driver in their decision to upgrade (*"I really need the ads feature to boost the content I post so that people can see it, it drives me to move to premium social media"* - [NW1]). In addition, user needs and desires for a specific feature drive their intention to switch (*"Because there is a need and desire that drives me to use an ad-free feature, so it encourages me to switch to premium"* - [NW10]).

The intrusiveness of advertising also significantly affects social media switching intention (H3). If the advertisement makes it difficult for users to enjoy the service, then it can be considered intrusive (Li et al., 2002). Tsai (2023) noted that users sometimes feel annoyed when using social media services, as ads appear suddenly and block the content they are enjoying. In the context of freemium social media, users are required to tolerate content that is frequently interspersed with advertisements, including posts, short videos, or links embedded within the displayed content. These advertisements disrupt the user experience and diminish the enjoyment users derive from consuming content (Mäntymäki et al., 2020). The qualitative findings align with the quantitative results, reinforcing that the intrusiveness of advertising has a significant impact on social media switching intention. Respondents reported that the ads on freemium social media are very disruptive (*"Since I use a music platform primarily for entertainment, I find it intolerable when numerous advertisements appear, as they are disruptive and annoying. Sometimes, even horror-themed ads are shown, which can make listening at night feel tense and uncomfortable"* - [NW11]). In addition, the frequency of advertisements on freemium social media is perceived as quite high (*"After every 2–3 songs, 15–30 second ads appear that cannot be skipped. On YouTube, for a one-hour video, there can be 3–4 ad phases, and each phase can have two ads"* - [NW19]).

Additionally, privacy concerns do not significantly influence switching intentions (H4). This result contradicts Ye et al. (2022), who suggest that excessive violations of user privacy can lead to user fatigue when using social networking services, and users are more likely to switch to safer social networking services or stop using social networks. Supporting this statement, users not only feel insecure and worried about potential data leaks but also experience discomfort knowing that the social media services they use may be monitoring their activities (Dahabiyeh et al., 2024). Our findings suggest that users lack awareness of the confidentiality of their data, which has no impact on the perceived value of the benefits they seek when considering switching to premium social media services. Although personal data protection regulations have been established through Law Number 27 of 2022, this may be because, in some cases in Indonesia, users have not encountered issues related to data leaks from the social media platforms they use. Consequently, users perceive that the free version of social media is sufficient to protect the confidentiality of their data, which does not discourage them from remaining on the free version rather than switching to the premium version. The qualitative findings align with the quantitative results, showing that privacy concerns do not significantly influence switching intentions. For instance, users expressed limited concern about the security of their personal information, indicating that the type of data they share on these platforms is perceived as low-risk (*"Honestly, I am not too worried, maybe because this is a music platform, so the information I input is also not very important"* - [NW11]). In addition, users believe that social media platforms are capable of providing extra security for their data (*"I believe that big platforms like YouTube can prevent data leaks"* - [NW12]).

H5 in this study was rejected, indicating that perceived value did not have a significant effect on switching intention. This result is not in line with Yuen et al. (2023), who examined the influence of technology characteristics and relational engagement strategies on crowdsourced delivery (CD) platforms. They found that the perceived high value of a service can influence consumers' intention to use alternative services offered by their current service providers. Mäntymäki et al. (2020) assert that perceived value is a key factor motivating users to upgrade from free to paid services, as it reflects the evaluation of the benefits of accessing wider content at a cost-effective level. Similarly, Kang et al. (2023) found that perceived value is a crucial factor influencing consumer purchase decisions. In the context of premium social media, the premium version indeed offers additional value and benefits that

surpass those of freemium services, such as exclusive features and a more enjoyable user experience. However, the findings of this study indicate that perceived value did not have a significant effect on switching intention, suggesting that even though users may recognize the benefits of premium social media, this factor is insufficient to motivate them to transition from free to premium services. The qualitative findings add nuance to the rejected H5 by showing that perceived value alone may not directly drive switching intention because users still weigh the price when evaluating the worth of premium social media services. For example, some respondents perceived the price of premium social media as reasonable given the benefits they received, reflecting a positive perceived value (“*Yes, it is equivalent to the benefits obtained, so it influenced me to switch*” - [NW7]). However, other users viewed the price as too expensive and struggled to see sufficient value in the service to justify switching (“*In my personal opinion, for Twitter, it is quite expensive, and perhaps that is why not many people use Twitter Blue*” - [NW8]).

This study also found that relative advantage has a significant impact on social media switching intention (H6). This finding is consistent with [Lin et al. \(2020\)](#), who found that the relative advantage of a product or service, such as the availability of advanced features, can enhance users’ perceived value. Similarly, [Wang et al. \(2021\)](#) stated that users are likely to switch to a different service if it offers greater advantages, benefits, and value compared to the service they are currently using. [Cheng et al. \(2019\)](#) further explained that relative advantage has a positive effect on users’ switching intentions. In the context of premium social media, relative advantage, such as additional features, ease of use, as well as the efficiency and effectiveness of using features from premium social media, can influence their intention to switch from a freemium social media to the premium version. The qualitative findings align with the significant H6 result by illustrating that users perceive premium social media as more effective and efficient, reinforcing how relative advantage motivates their intention to switch (“*In my opinion, premium features are quite effective and efficient in supporting my activities, I get ease of access and better performance. It made me feel quite satisfied and interested in switching to premium.*” - [NW3]). Additionally, users expressed that the features available on premium social media were sufficient to encourage them to switch to premium services (“*On Spotify, navigating between songs is smooth, and on YouTube, there are no advertisements, so that is why I chose to switch*” - [NW21]).

This study found that price value has a significant effect on social media switching intention (H7). This result suggests that users tend to switch services after learning the price offered by a service and comparing it with the benefits they get. The price factor is a decisive factor for potential users in deciding whether to use the service or not ([Mäntymäki et al., 2020](#)). [Tyrväinen and Karjaluoto \(2024\)](#) explain that users are usually aware of the quality of freemium services or premium services and evaluate the prices offered by these services before deciding to use them. Users tend to seek services that meet their needs, provide a positive user experience, and offer an optimal price, ensuring they do not feel a sense of loss ([Kushwah et al., 2024](#)). In the context of premium social media, users often feel that the prices offered are worth the benefits obtained from the additional features. Thus, the price offered by social media, particularly when considering the cost of switching in relation to the benefits and advantages provided, can serve as a factor attracting users to subscribe to premium services. The qualitative findings align with the significant H7 result by showing that users view the price of premium social media as justified by the benefits received, reinforcing the price value’s role in switching intention (“*I think it is very beneficial, but for Twitter Blue, it is still fifty-fifty, I would say. Price was a significant consideration for me*” - [NW8]). Additionally, some users also feel that the cost of subscribing to premium services is not too expensive when considering the benefits they receive (“*When I feel that the price I pay aligns with the service and quality provided, price becomes an important consideration in my opinion, because if the price is too high, it makes the service not worth it*” - [NW1]).

This study also found that switching costs significantly influence social media switching intention (H8). This finding aligns with the notion that users tend to be cautious when considering the psychological costs, such as time and energy, associated with subscribing to a service provider ([Chang & Chiu, 2023](#)). Switching costs also influence the tendency of live streaming e-commerce (LSE) users not to switch to a new platform, as they must invest time and effort in learning how to use it ([Ye et al., 2022](#)). [Guo \(2022\)](#) also asserts that switching costs can significantly influence user decisions. They found that in addition to financial costs, the emotional and psychological aspects also influenced switching

intentions. In the context of this study, users are concerned about cost, time, or effort, as these factors are considerations in their decision to switch services. The qualitative findings provide nuance to H8 by demonstrating that switching costs have a significant impact on switching intention. The effort required to switch was perceived as minimal and outweighed by the ease of use and desire to access premium features (*“The process was not too complicated, I just entered my payment information, and it was automatically deducted every month. So, there was no extra effort”* - [NW1]). Furthermore, they also felt that the effort involved was far less than the benefits gained (*“In my opinion, the effort required was minimal and not burdensome, as subscribing and unsubscribing were easy and even easier than expected”* - [NW30]).

Then, H9 was accepted in this study, indicating that social influence has a significant effect on social media switching intention. This result aligns with [Ye et al. \(2022\)](#), who found that positive recommendations and reviews from friends or family can encourage users to try new platforms. This social influence suggests that people tend to be influenced by their environment in making decisions regarding the use of services. Similarly, a study by [Zhou and Li \(2024\)](#) showed that when a user discovers that one of their friends is using generative AI, they tend to switch to generative AI from traditional search engines. [Chang and Chiu \(2023\)](#) also demonstrate that family and friends often have a greater influence than the benefits and advantages offered by the service provider. In the context of this study, social media influencers frequently emphasize the benefits and superior features of subscribing to premium versions, which can significantly influence user perceptions and intentions. Given the strong influence that influencers have on their followers, their recommendations can serve as a valuable reference for users who are considering upgrading to premium services. The qualitative findings align with the significant H9 result, highlighting that recommendations from friends, family, and influencers effectively encourage switching to premium social media (*“Because many friends and family use the same feature, I was arguably influenced, and it felt odd not to use it myself”* - [NW5]; *“The recommendation actually from my aunt, who is not even the person I am closest to”* - [NW25]).

Finally, H10 was rejected in this study, indicating that the free mentality was not a significant predictor of social media switching intention. This finding is not in line with [Liu et al. \(2023\)](#), who stated that the free mentality is often considered the biggest obstacle to user subscription to online content, as it reflects the belief that everything online should be available without charge. Users may also believe that high-quality services should provide more value and benefits even if they are unwilling to pay, given that many online service providers offer services for free ([Kim et al., 2018](#)). Additionally, [O’Brien \(2022\)](#) demonstrated in a study on individual intentions to purchase digital journalism content that the free mentality can influence service switching. These prior studies indicate that users often believe music and digital news are types of content that should remain free. However, in the context of this study, users recognize that the features and services offered by premium social media are not always provided for free. Users understand that there are considerations, such as the need for company revenue, making it reasonable for them to pay when subscribing to premium social media services. The qualitative findings align with the rejected H10, indicating that users generally accept paying for premium features, which suggests that the free mentality does not influence switching intention. They believe that premium social media offers better benefits than freemium social media, so they are willing to pay for the premium service (*“I feel that premium social media offers more value, so I am encouraged to use it”* - [NW3]). Another respondent also justified that premium subscription fees serve as a source of income for the platform (*“Yes, no matter what the platform is, it definitely needs capital, so not everything can be free, and the company needs money to continue to grow”* - [NW17]).

Implications

Theoretical Implications

This study makes a theoretical contribution by extending the push-pull-mooring (PPM) framework to examine switching intention specifically in the context of freemium-to-premium transitions on social media platforms in Indonesia. This area has not been previously explored. By applying the PPM framework, this study identifies and analyzes the factors influencing users’ intentions to switch from freemium to premium social media services, thus advancing understanding of switching behavior in the

social media domain. Additionally, the findings of this study both confirm and contrast with prior research, offering nuanced insights that enrich the literature on platform-based switching behavior.

Regarding push factors, the findings demonstrate that, contrary to previous studies ([Cheng et al., 2009](#); [Xu et al., 2021](#); [Yoon & Lim, 2021](#)), dissatisfaction does not influence switching intention, suggesting that dissatisfaction may not universally drive switching across service contexts. Similarly, privacy concerns were found not to influence switching, which contrasts with the findings of [Ye et al. \(2020\)](#). Meanwhile, limited functionality and advertising intrusiveness align with [Mäntymäki et al. \(2020\)](#) and [Li et al. \(2002\)](#), respectively, confirming that these factors encourage switching when users face feature limitations and disruptive ads. For pull factors, the study reinforces the importance of relative advantage and price value in encouraging switching, consistent with prior literature, which emphasizes how perceived additional benefits and acceptable pricing drive user decisions during the transition to premium. In terms of mooring factors, this study aligns with [Ye et al. \(2022\)](#) in finding that social influence significantly drives switching intention. It extends prior models by conceptualizing switching costs beyond monetary price to include time and effort, offering a more comprehensive view of user considerations. Finally, the finding that the free mentality does not affect switching intentions contrasts with [O'Brien \(2022\)](#), suggesting that users may recognize the legitimacy of paid premium features on social media, refining the role of free mentality in digital service transitions.

Practical Implications

The results of this study offer practical implications for social media users, recommending that they make informed decisions before switching to premium services. Based on the results of the hypothesis test, dissatisfaction with freemium social media services is not the primary reason users switch to premium services. Social media users believe that social media platforms should offer paid features to provide more benefits. Therefore, they should carefully assess the specific benefits offered, the costs involved, and whether subscribing to premium services will effectively address the limitations they experience with freemium social media. To facilitate this, social media platforms can provide a “Premium Value Preview” feature, a clear, side-by-side comparison table showing freemium vs. premium benefits (e.g., ad frequency, access to exclusive tools like advanced analytics or scheduling, download capabilities, content quality improvements), estimated time saved by going ad-free, and clear subscription cancellation policies. This feature will help users evaluate whether upgrading will truly address the shortcomings they experience in freemium use.

Additionally, for social media platforms, this study recommends focusing on two key aspects: pricing and the development of premium features. Social media platforms should offer competitive subscription prices that align with the benefits provided. For premium feature development, social media platforms are encouraged to prioritize ad-free experiences, offline access, exclusive content, or advanced tools (e.g., analytics dashboards, content boosters), and responsive customer support. These features address common freemium limitations while providing added value, making premium subscriptions more attractive to users.

Conclusion

This study found that push, pull, and mooring affect users' intention to switch to premium social media. The push factor that has a strong influence on the user's intention to switch is the functionality of a premium social media service. Only dissatisfaction and privacy concerns were found as push factors that did not affect the user's desire to switch. The pull factors that have a high influence on the user's intention to switch are relative advantage and price value. Then, perceived value becomes a variable that does not influence the user's desire to switch to a premium social media service. The mooring factors that have a high influence on users' intention to switch are switching costs and social influence. This study concludes that costs, in terms of time and effort, are not one of the factors that negatively affect users' decisions to switch services. It also demonstrates that the influence of family, relatives, and colleagues can help users transition to premium social media services. Free mentality is a variable that does not affect the user's desire to switch services.

The limitations of this study include its dominance by respondents aged 17-25 years (43.16%) and residents of Greater Jakarta (23.68%). Future research can compare the results of this study with those of other developing countries to gain a deeper understanding of the cultural and user behavior differences between countries in their decision-making processes for switching to premium social media. Additionally, the study may be subject to self-selection bias, as respondents participating in the survey are likely to be those already aware of or interested in premium social media models, potentially influencing their responses. We also recognize that the majority of participants utilized premium features on social media, such as Instagram Exclusive Content (29.39%) and Instagram Verified (20.17%), followed by X Premium and Facebook Verified. This data suggests a possible overrepresentation of Instagram users with premium features in the sample, which may affect the applicability of the findings to other platforms and premium models. Lastly, this research did not account for the actual use of premium features, focusing instead on users' intentions to switch to premium services. From a theoretical viewpoint, future studies could employ models that connect intention with actual behavior, such as the Theory of Planned Behavior (TPB) or the Technology Acceptance Model (TAM). Furthermore, including actual usage statistics and subscription histories could enhance model validation and deliver a clearer understanding of user behavior regarding the adoption of premium social media services.

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Appendix

Appendix A. Measurement Items Questionnaire

| Code | Measurement Items | References |
|------|---|---|
| FN1 | I believe that a social media premium improves the platform's functionality by maximizing all available features, thereby enhancing the user experience. | Tyrväinen & Karjaluoto (2024) |
| FN2 | I feel that social media premium offers a range of features that are more adequate and make me feel comfortable, so that it is more than just a product that I buy. | |
| FN3 | I feel that if I do not subscribe to the social media premium, it will reduce the effectiveness of the service I get | |
| FN4 | I believe that the features of social media premium can assist me in various ways to find information. | |
| DS1 | I feel less satisfied with my overall experience using freemium social media. | Ye et al. (2022) |
| DS2 | I am not happy with my overall experience using freemium social media. | |
| DS3 | I was frustrated with my overall experience using freemium social media. | Fu et al. (2021) |
| DS4 | I feel uncomfortable with the overall experience of using freemium social media. | |
| PC1 | I was worried that the freemium social media was collecting my personal information without notice. | Ye et al. (2022) |
| PC2 | I am worried that the personal information I provide to the freemium social media is being misused. | |
| PC3 | I was worried that other irresponsible people would find my personal information on the freemium social media. | Lin et al. (2020) |
| PC4 | I was concerned that the social media freemium I was using did not offer sufficient protection for my personal information. | |
| IA1 | I felt that ads on social media freemium services distracted me from the main content I wanted to see and enjoy, making me consider switching to a paid service. | Mäntymäki et al. (2020) |

| Code | Measurement Items | References |
|------|--|---|
| IA2 | I found that ads on freemium social media platforms bothered me, making it difficult to enjoy the main content I wanted to see, and I considered switching to a different service. | and Tsai (2023) |
| IA3 | I felt that the ads displayed on freemium social media made me uncomfortable, so I decided to switch to a different service. | |
| IA4 | I feel like the feature on social media freemium made me consider leaving social media freemium. | |
| PV1 | I feel benefited by the value given when subscribing to the social media premium. | Lin et al. (2020) |
| PV2 | I feel that subscribing to social media premium is worth the benefits. | |
| PV3 | Overall, I am satisfied with the value of the service provided by Social Media Premium. | Zhou & Mi (2024) |
| PV4 | I believe that this social media premium has been beneficial in meeting my needs and desires from using social media. | |
| RA1 | Premium social media has more advantages than freemium. | Lin et al. (2020) |
| RA2 | The additional features that social media premium offers provide enough more value to make me want to switch services or give it a try. | Lin et al. (2020) |
| RA3 | Premium social media is more efficient than freemium. | Ye et al. (2022) |
| RA4 | Premium social media is more effective than freemium social media. | |
| PR1 | The prices offered by social media premium have good economic value. | Mäntymäki et al. (2020) |
| PR2 | I am satisfied with the subscription price offered by Social Media Premium. | |
| PR3 | I feel like the price of a social media premium subscription is too high, considering what it gives as an advantage. | Tyrväinen & Karjaluo (2024) |
| PR4 | I believe the price of the social media premium subscription is reasonable, considering the advantages provided. | Mäntymäki et al. (2020) |
| SI1 | The people around me do not like freemium social media, so it makes me want to switch to a premium social media service. | Lin et al. (2020) |
| SI2 | The people around me who use social media premium make me interested in subscribing. | Zhou & Li (2024) |
| SI3 | People around me recommended subscribing to social media premium, which made me interested in doing so. | |
| SI4 | People around me have positive opinions about the social media premium, which encourages me to consider switching to it. | Ye et al. (2022) |
| FM1 | I feel that all the features in the social media premium should be free. | O'brien. (2022) |
| FM2 | I believe that providing comprehensive features is what social media freemiums should do. | |
| FM3 | I believe that freemium social media platforms do not need to charge users for additional services. | Lin et al. (2013) |
| FM4 | I believe that social media freemium should offer the same benefits without requiring an upgrade to social media premium. | O'brien. (2022) |
| SC1 | I felt that the process of subscribing to social media premium was too complicated. | Cao et al. (2020) |
| SC2 | I feel like it takes a lot of time and effort to switch to a social media premium plan. | |
| SC3 | When I switched to social media premium, I found it challenging to learn the features and differences. | Lin et al. (2020) |

| Code | Measurement Items | References |
|------|---|---|
| SC4 | I feel that the effort required to understand and adjust to the social media premium is quite high. | Ye et al. (2022) |
| SW1 | I feel like moving to a premium social media service right away. | Xu et al. (2021) |
| SW2 | I have given considerable thought to switching to social media premium. | Tyrväinen & Karjaluoto (2024) |
| SW3 | I chose the social media premium to meet my needs. | Ye et al. (2022) |

Appendix B. Interview Questions

1. (H1) Do you find the freemium social media service unsatisfactory?
2. (H1) How did your dissatisfaction with using freemium social media affect your desire to switch to premium social media?
3. (H2) How does freemium social media limit the services you should get? Why do these restrictions affect your desire to switch to premium social media?
4. (H3) What is the condition of the frequency of ads appearing on freemium social media that makes you distracted and prompts you to switch to premium social media?
5. (H4) How does your belief in freemium social media’s ability to provide privacy protection affect your decision to stick with or switch to another service? Why is this important to you?
6. (H5) What do you think about the ability of premium social media to meet your needs and desires in social media? Why do you feel that premium social media is enough to meet these things that you chose to switch to premium social media?
7. (H6) What do you think about the additional features provided by premium social media? Why do you feel that this is enough to be an added value that you choose to switch?
8. (H7) How do you assess the benefits of subscribing to premium social media? Why does considering the price of premium services affect your desire to switch from freemium services?
9. (H8) How does the effort required to switch to premium social media affect your desire to switch from freemium social media?
10. (H9) How do recommendations by those around you (family, friends, and close relatives) affect your desire to switch to premium social media?
11. (H10) How do you feel about paying for social media? Why would you pay to enjoy social media?

Appendix C. Cross-loading

| | DS | SHE | PV | PR | PC | RA | SW | FM | FN | THE | SC |
|------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| DS1 | 0.798 | 0.413 | 0.386 | 0.423 | 0.512 | 0.377 | 0.473 | 0.262 | 0.336 | 0.477 | 0.345 |
| DS2 | 0.834 | 0.371 | 0.342 | 0.421 | 0.504 | 0.346 | 0.404 | 0.220 | 0.278 | 0.491 | 0.383 |
| DS3 | 0.849 | 0.371 | 0.367 | 0.418 | 0.487 | 0.345 | 0.417 | 0.254 | 0.297 | 0.461 | 0.397 |
| DS4 | 0.856 | 0.418 | 0.382 | 0.420 | 0.515 | 0.327 | 0.432 | 0.209 | 0.297 | 0.462 | 0.433 |
| FM1 | 0.274 | 0.349 | 0.336 | 0.297 | 0.259 | 0.251 | 0.331 | 0.809 | 0.356 | 0.403 | 0.362 |
| FM2 | 0.253 | 0.311 | 0.305 | 0.299 | 0.256 | 0.260 | 0.340 | 0.802 | 0.388 | 0.418 | 0.368 |
| FM3 | 0.166 | 0.260 | 0.292 | 0.275 | 0.197 | 0.254 | 0.356 | 0.807 | 0.307 | 0.307 | 0.416 |
| FM4 | 0.234 | 0.264 | 0.307 | 0.278 | 0.197 | 0.250 | 0.323 | 0.826 | 0.336 | 0.349 | 0.468 |

| | DS | SHE | PV | PR | PC | RA | SW | FM | FN | THE | SC |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| FN1 | 0.405 | 0.472 | 0.525 | 0.469 | 0.467 | 0.465 | 0.526 | 0.446 | 0.904 | 0.509 | 0.336 |
| FN2 | 0.289 | 0.478 | 0.529 | 0.413 | 0.382 | 0.492 | 0.451 | 0.344 | 0.898 | 0.435 | 0.155 |
| FN3 | 0.287 | 0.449 | 0.510 | 0.420 | 0.406 | 0.463 | 0.456 | 0.362 | 0.911 | 0.434 | 0.212 |
| FN4 | 0.316 | 0.432 | 0.482 | 0.392 | 0.392 | 0.489 | 0.464 | 0.375 | 0.888 | 0.432 | 0.247 |
| IA1 | 0.343 | 0.837 | 0.521 | 0.402 | 0.455 | 0.436 | 0.450 | 0.340 | 0.417 | 0.416 | 0.129 |
| IA2 | 0.398 | 0.846 | 0.515 | 0.424 | 0.513 | 0.479 | 0.451 | 0.272 | 0.436 | 0.444 | 0.131 |
| IA3 | 0.372 | 0.833 | 0.547 | 0.442 | 0.534 | 0.506 | 0.421 | 0.306 | 0.443 | 0.426 | 0.145 |
| IA4 | 0.480 | 0.871 | 0.522 | 0.497 | 0.513 | 0.454 | 0.500 | 0.317 | 0.429 | 0.473 | 0.257 |
| PC1 | 0.557 | 0.542 | 0.406 | 0.456 | 0.845 | 0.424 | 0.455 | 0.242 | 0.379 | 0.409 | 0.272 |
| PC2 | 0.488 | 0.480 | 0.374 | 0.390 | 0.834 | 0.370 | 0.398 | 0.259 | 0.400 | 0.337 | 0.270 |
| PC3 | 0.477 | 0.486 | 0.333 | 0.366 | 0.839 | 0.358 | 0.444 | 0.223 | 0.370 | 0.335 | 0.306 |
| PC4 | 0.524 | 0.499 | 0.386 | 0.416 | 0.864 | 0.403 | 0.456 | 0.226 | 0.407 | 0.364 | 0.273 |
| PR1 | 0.441 | 0.450 | 0.430 | 0.883 | 0.420 | 0.485 | 0.491 | 0.311 | 0.391 | 0.556 | 0.230 |
| PR2 | 0.422 | 0.451 | 0.471 | 0.863 | 0.435 | 0.515 | 0.488 | 0.286 | 0.438 | 0.553 | 0.248 |
| PR3 | 0.363 | 0.399 | 0.359 | 0.744 | 0.339 | 0.421 | 0.359 | 0.287 | 0.343 | 0.419 | 0.201 |
| PR4 | 0.456 | 0.449 | 0.511 | 0.852 | 0.411 | 0.512 | 0.503 | 0.305 | 0.403 | 0.574 | 0.253 |
| PV1 | 0.441 | 0.558 | 0.896 | 0.511 | 0.406 | 0.560 | 0.489 | 0.336 | 0.511 | 0.522 | 0.226 |
| PV2 | 0.395 | 0.545 | 0.884 | 0.479 | 0.410 | 0.553 | 0.488 | 0.305 | 0.493 | 0.502 | 0.149 |
| PV3 | 0.368 | 0.567 | 0.902 | 0.448 | 0.391 | 0.540 | 0.451 | 0.390 | 0.520 | 0.504 | 0.195 |
| PV4 | 0.382 | 0.551 | 0.899 | 0.471 | 0.380 | 0.530 | 0.459 | 0.339 | 0.512 | 0.505 | 0.187 |
| RA1 | 0.350 | 0.478 | 0.511 | 0.480 | 0.376 | 0.832 | 0.427 | 0.264 | 0.433 | 0.466 | 0.115 |
| RA2 | 0.333 | 0.456 | 0.507 | 0.492 | 0.389 | 0.838 | 0.422 | 0.236 | 0.450 | 0.407 | 0.093 |
| RA3 | 0.312 | 0.464 | 0.505 | 0.469 | 0.383 | 0.828 | 0.436 | 0.241 | 0.456 | 0.433 | 0.098 |
| RA4 | 0.403 | 0.457 | 0.523 | 0.502 | 0.396 | 0.857 | 0.521 | 0.302 | 0.440 | 0.472 | 0.169 |
| SC1 | 0.387 | 0.169 | 0.181 | 0.241 | 0.252 | 0.098 | 0.321 | 0.432 | 0.225 | 0.265 | 0.893 |
| SC2 | 0.389 | 0.168 | 0.169 | 0.250 | 0.287 | 0.106 | 0.322 | 0.479 | 0.241 | 0.286 | 0.895 |
| SC3 | 0.464 | 0.186 | 0.183 | 0.245 | 0.326 | 0.159 | 0.365 | 0.448 | 0.226 | 0.329 | 0.902 |
| SC4 | 0.432 | 0.191 | 0.224 | 0.270 | 0.324 | 0.151 | 0.365 | 0.434 | 0.273 | 0.331 | 0.911 |
| SI1 | 0.549 | 0.367 | 0.406 | 0.520 | 0.313 | 0.405 | 0.415 | 0.283 | 0.382 | 0.796 | 0.342 |
| SI2 | 0.442 | 0.432 | 0.442 | 0.515 | 0.345 | 0.408 | 0.495 | 0.446 | 0.421 | 0.817 | 0.286 |
| SI3 | 0.473 | 0.432 | 0.504 | 0.511 | 0.363 | 0.440 | 0.494 | 0.451 | 0.457 | 0.858 | 0.295 |
| SI4 | 0.426 | 0.484 | 0.521 | 0.551 | 0.392 | 0.503 | 0.477 | 0.307 | 0.406 | 0.836 | 0.203 |
| SW1 | 0.490 | 0.493 | 0.461 | 0.505 | 0.504 | 0.486 | 0.882 | 0.352 | 0.487 | 0.546 | 0.339 |

| | DS | SHE | PV | PR | PC | RA | SW | FM | FN | THE | SC |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| SW2 | 0.384 | 0.441 | 0.453 | 0.462 | 0.390 | 0.469 | 0.862 | 0.354 | 0.438 | 0.482 | 0.294 |
| SW3 | 0.492 | 0.490 | 0.481 | 0.498 | 0.473 | 0.478 | 0.898 | 0.395 | 0.470 | 0.479 | 0.375 |

Appendix D. Fornell-Lacker

| | DS | SHE | PV | PR | PC | RA | SW | FM | FN | THE | SC |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| DS | 0.835 | | | | | | | | | | |
| SHE | 0.473 | 0.847 | | | | | | | | | |
| PV | 0.444 | 0.620 | 0.895 | | | | | | | | |
| PR | 0.505 | 0.523 | 0.534 | 0.837 | | | | | | | |
| PC | 0.606 | 0.594 | 0.443 | 0.482 | 0.845 | | | | | | |
| RA | 0.419 | 0.552 | 0.610 | 0.580 | 0.460 | 0.839 | | | | | |
| SW | 0.520 | 0.540 | 0.528 | 0.555 | 0.519 | 0.542 | 0.881 | | | | |
| FM | 0.284 | 0.365 | 0.382 | 0.354 | 0.280 | 0.313 | 0.417 | 0.811 | | | |
| FN | 0.364 | 0.509 | 0.569 | 0.472 | 0.460 | 0.530 | 0.529 | 0.427 | 0.900 | | |
| THE | 0.567 | 0.520 | 0.568 | 0.633 | 0.428 | 0.531 | 0.571 | 0.454 | 0.505 | 0.827 | |
| SC | 0.466 | 0.199 | 0.211 | 0.280 | 0.332 | 0.144 | 0.383 | 0.497 | 0.268 | 0.338 | 0.900 |

Appendix E. Heterotrait-Monotrait Ratio Values

| | DS | SHE | PV | PR | PC | RA | SW | FM | FN | THE |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| SHE | 0.544 | | | | | | | | | |
| PV | 0.498 | 0.696 | | | | | | | | |
| PR | 0.586 | 0.604 | 0.596 | | | | | | | |
| PC | 0.701 | 0.685 | 0.496 | 0.556 | | | | | | |
| RA | 0.484 | 0.641 | 0.685 | 0.672 | 0.532 | | | | | |
| SW | 0.601 | 0.623 | 0.595 | 0.641 | 0.599 | 0.627 | | | | |
| FM | 0.338 | 0.431 | 0.440 | 0.423 | 0.332 | 0.368 | 0.495 | | | |
| FN | 0.404 | 0.569 | 0.618 | 0.528 | 0.512 | 0.596 | 0.592 | 0.486 | | |
| THE | 0.671 | 0.603 | 0.642 | 0.738 | 0.497 | 0.620 | 0.667 | 0.538 | 0.568 | |
| SC | 0.524 | 0.218 | 0.228 | 0.313 | 0.369 | 0.156 | 0.428 | 0.571 | 0.286 | 0.383 |

How to cite:

Harahap, N. C., Alnazhary, L., Reksahamanoto, S. M. S., Djibat, Z. B., & Handayani, P. W. (2025). Users' Switching Intention from Social Media Freemium to Premium. *Jurnal Sistem Informasi (Journal of Information System)*, 21(2), 62–85.

ISSN: 2088-7043

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JOURNAL OF INFORMATION SYSTEMS

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