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Application of Smart Technology for Market Modernization: A Case Study of SIPETIR in Traditional Markets

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ABSTRACT

Digital transformation in traditional markets faces significant challenges, particularly limited digital literacy, fragmented business processes, and low system integration. This study proposes Integrated Market Information System (SIPETIR), an integrated information system designed to support traditional market operations by managing transactions, inventory, and reporting within a single, unified platform. To ensure the system is accessible and usable effectively by merchants with diverse digital backgrounds, SIPETIR was developed using a mobile-based client–server architecture that supports centralized processing and efficient data synchronization. This study employed a paired, before–and–after empirical evaluation approach involving 20 identical merchants, each representing a single traditional market. The evaluation results showed that the implementation of SIPETIR reduced average transaction time by 34% and reduced inventory recording errors by 41%. Furthermore, usability testing using the System Usability Scale (SUS) yielded an average score of 74.73, indicating a good level of system usability. These findings indicate that the modular integration approach implemented in SIPETIR is effective in improving the operational efficiency of traditional markets with limited digital literacy.

1. INTRODUCTION

Traditional markets in Batam, one of the major cities and main trading centers in the Riau Islands, play a vital role in meeting the basic needs of the community and supporting the local micro, small, and medium enterprises (MSMEs) economy. Traditional markets in Batam have long been important centers for providing affordable goods to local residents, providing a livelihood for small traders, and contributing significantly to local economic stability [1, 2]. On the other hand, modern markets and e-commerce platforms that rely on digital technology are growing rapidly and attracting the attention of many consumers, especially the younger generation, who are more connected to technology. With more organized systems, faster payments, and easier shopping, traditional markets are increasingly lagging behind in terms of convenience and consumer appeal [3, 4].

According to a report from the Indonesian E-Commerce Association (2019), the e-commerce sector in Indonesia is growing rapidly, with transaction values predicted to reach more than IDR 250 trillion by 2023, with the largest contribution coming from the millennial generation who prefer digital shopping platforms to traditional markets.

In the citiesIn large cities like Jakarta, Surabaya, and Yogyakarta, many traditional markets are turning to technology-based systems to improve inventory management, transactions, and customer interactions. For example, in Surabaya, Wonokromo Market has implemented a digital system for transactions and stock monitoring that allows traders to manage stock in real time and speed up the transaction process, reducing queue times by up to 30% (Source: Surabaya Trade Office, 2021). This demonstrates that digitizing traditional markets is not only possible but can also improve operational convenience and efficiency. However, in recent years, traditional markets in Batam have experienced a significant decline in customer visits [3, 5].

This decline is caused by various challenges, such as outdated management systems, a lack of transparency in market operations, and intense competition from more structured and technology-based modern markets and e-commerce platforms [6-8]. Modern markets and e-commerce have emerged as attractive alternatives due to their well-organized operations, convenience, and technology-driven business models, which appeal especially to younger consumers and those more familiar with digital technology [9].

One of the main challenges facing traditional markets in Batam is the low level of digitalization in their operational management [10]. The majority of traditional markets still rely on manual processes for recording transactions, managing inventory, and collecting fees. This reliance on traditional

methods not only reduces operational efficiency but also exacerbates the lack of transparency in market management [11-13]. Meanwhile, modern markets and e-commerce platforms are increasingly utilizing information technology to streamline transactions, facilitate purchases, and reduce operational costs. In this context, traditional markets in Batam, like many other major cities in Indonesia, are lagging behind in adopting technologies that could help them remain competitive [14].

In the Industry 4.0 era, digital transformation has become a key factor in the evolution of various sectors, including retail trade. Technologies such as the Internet of Things (IoT), Big Data, Cloud Computing, and Artificial Intelligence (AI) have revolutionized the way industry and the retail sector operate, enabling faster processes, automation, and data-driven decision-making [15, 16]. Digitalization has enabled businesses to improve operational efficiency, enhance customer experience, and optimize decision-making with accurate, data-driven insights. However, although digitalization has proven beneficial for many sectors, its implementation in traditional markets in Batam is still limited [17].

One of the reasons for the low adoption of technology in traditional markets is the limited infrastructure that supports digital technology. Many traditional markets lack reliable internet access and the necessary hardware and software to support digital systems. Furthermore, digital literacy among market traders is a significant obstacle. Many traders are unfamiliar with advanced technological systems and face challenges adapting to new technologies. Furthermore, the lack of an integrated and easily accessible information system exacerbates the problem, making market management inefficient and difficult for market managers and local governments to monitor [18, 19].

A 2023 survey conducted by the Batam City Department of Industry and Trade revealed that more than 60% of traditional market traders in Batam had not yet adopted digital systems for transaction recording, inventory management, or retribution payments. This results in operational inefficiencies and challenges in oversight by market managers and local governments. The inability to integrate data across market units further hampers data-driven decision-making and reduces the overall competitiveness of traditional markets [18, 20].

To address these challenges, technological innovation is needed that is not only cutting-edge but also adaptive to the conditions and characteristics of traditional markets. The solution lies in a digital platform that integrates various aspects of market management, while being easily accessible and usable by traders with varying levels of digital literacy. An innovative solution to this problem is the development of Integrated Market Information System (SIPETIR), a smart application designed to support efficient, transparent, and integrated traditional market management [21, 22].

SIPETIR was developed to integrate various aspects of market management, including procurement processes, vendor data management, kiosk organization, and real-time transaction recording and reporting. By leveraging intelligent systems and data analytics, SIPETIR aims to improve market operational efficiency and provide actionable data insights to support strategic decision-making by market managers and local authorities. This approach enables real-time market monitoring, increases transparency in transaction and management processes, and provides better accessibility for vendors who previously struggled with digital systems [23-25].

The development of SIPETIR also aims to increase the competitiveness of traditional markets by improving service quality, transparency, and digital participation of traders. This aligns with the vision of digitalization in the public sector, where local governments can use technology to improve traditional market management and support regional economic growth. In this context, SIPETIR is expected to be an example of the application of inclusive smart technology, thereby having a significant impact on strengthening regional economies in the digital era. With increasing technology adoption by traditional market traders, SIPETIR can help strengthen the position of traditional markets in the increasingly competitive digital economy [26, 27]. Although various digital applications have been developed for traditional markets, the majority of these systems only focus on single functions such as payments or inventory recording, without providing comprehensive functional integration and adaptability to real-world market conditions. Furthermore, most previous studies were exploratory and conducted on a limited scale, without involving direct implementation tests in actual market operational contexts [28-30].

The novelty of this research lies in the application of a research and development-based Design Science Research approach to design, implement, and evaluate SIPETIR as an integrated market information system tailored to the operational characteristics of traditional markets. This research focuses not only on application development but also on formulating system design decisions that directly address traders' limited digital literacy, unequal technological infrastructure, and the fragmented managerial processes commonly found in traditional markets.

Within this framework, SIPETIR was developed in a modular and adaptive manner as a DSR artifact, where modularity is positioned as a design mechanism to support gradual adoption, ease of use, and implementation flexibility in heterogeneous market environments. This design principle enables the integration of transaction processes, inventory management, reporting, and digital payments within a single, unified workflow, without burdening users with excessive system complexity. This approach contributes relevant design knowledge to the development of information systems in the informal economy.

The methodological and empirical contributions of this study are strengthened by the application of a paired before–and–after evaluation design, where data before and after SIPETIR implementation were collected from the same 20 vendors, each representing a traditional market in Batam City. The use of identical units of observation in both measurement conditions allows for a more controlled analysis of performance changes, allowing observed differences to be more directly attributed to system implementation rather than to variations between markets or different respondent characteristics.

The evaluation focused on system usability, operational efficiency, management transparency, and user acceptance. By combining contextual design principles and paired evaluation design, this study provides initial empirical evidence on how an SIPETIR can improve operational performance and support the sustainable digital transformation of traditional markets.

Thus, the contribution of this research lies not only in the SIPETIR technological artifact, but also in providing design

understanding and contextual empirical evidence that can be replicated in other traditional markets with similar characteristics, while enriching the Information Systems literature related to the application of Design Science Research in the context of digital transformation of the informal economic sector.

2. LITERATURE REVIEW

Traditional markets still play a vital role in the local economy in many developing countries, particularly as distribution centers for basic necessities and sources of livelihood for micro and small businesses [31-33]. However, various studies indicate that traditional markets are facing increasing pressure due to the expansion of modern retail and digital trading platforms. Key issues frequently identified include fragmented operational processes, error-prone manual record-keeping, low data transparency, and limited access to integrated information systems [34-36].

Digital transformation is seen as a key strategy for improving operational efficiency, transparency, and competitiveness in the trade sector [37, 38]. Several previous studies have reported that the implementation of digital technology, such as cashless payment systems, sales recording applications, and digital-based inventory management, can accelerate transaction processes and reduce administrative errors. However, the implementation of digital technology in traditional market environments is still partial and uneven, mainly due to limited infrastructure, differences in traders' digital literacy levels, and the low readiness of market management organizations [39-41].

Further analysis of the literature shows that most previous studies have adopted a separate functional approach [42-44]. Some studies focus on the adoption of digital payments and its impact on transaction speed and consumer convenience, while others examine stand-alone sales recording or inventory management applications. While these findings make important contributions at the operational level, this fragmented approach fails to depict traditional markets as integrated socio-technical systems. Consequently, the potential strategic benefits of digitalization, such as cross-process data integration, data-driven decision-making, and holistic market management, have not been adequately explored [3, 45, 46].

Several studies have proposed the use of integrated information systems to overcome the limitations of this partial approach. Integrated systems allow the integration of various operational functions, such as trader data collection, inventory management, transactions, and reporting, into a single, unified platform. Conceptually, this approach is believed to improve data consistency and managerial efficiency [47-49]. However, empirical evidence regarding the implementation and evaluation of integrated systems in the context of traditional markets remains limited. Most studies are conceptual, conducted in a single location, or do not seriously consider the characteristics of traditional market users who have varying levels of digital literacy [50-52]. Furthermore, aspects of system design, especially modularity and usability, have received relatively little attention in previous research. Many digital solutions are developed with the assumption that users have a sufficient level of technological familiarity, making them less suited to the real-world conditions of traditional market traders. This mismatch between system design and user characteristics is often a major factor in the low adoption and sustainability of digital systems in traditional market environments [53, 54].

Based on these limitations, this study proposes SIPETIR as a mobile-based digital platform designed modularly to support the digital transformation of traditional markets. SIPETIR integrates several key operational modules, namely merchant registration and authentication, inventory management, digital procurement, QRIS-based cashless transactions, and data reporting and analytics, into a single integrated system. The modular approach allows each function to operate independently yet remain interconnected, allowing data generated from one process to be directly utilized by other processes. This cross-module integration differentiates SIPETIR from previous digital solutions, which tended to be stand-alone and disconnected.

3. METHODOLOGY

This section describes the SIPETIR intelligent application development methodology, including system flowcharts, software architecture, and easy-to-understand user interface designs. A complete description of each component will be discussed in detail in the following sections.

3.1 System flowchart

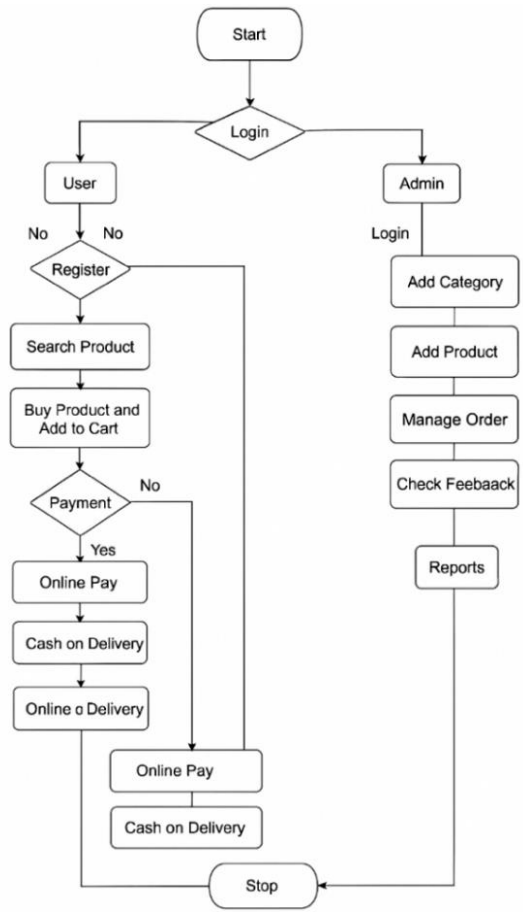

Figure 1. Integrated Market Information System (SIPETIR) flow diagram

The SIPETIR system flowchart illustrates the main application process, from merchant registration to transaction execution and reporting (Figure 1). The process begins with merchant registration through the app, after which merchants

can manage stock and digitally submit procurement requests. The system processes payments with digital payment integration, facilitating fast and secure digital transactions. All transaction activity and user interactions are automatically recorded for analysis to support decision-making and improve market operational efficiency. Thus, the flowchart ensures that each stage of the process is integrated and systematic, supporting the smooth operation of traditional markets.

The development of the SIPETIR application involves several integrated main menus to meet the needs of users and market managers. The registration and authentication menu ensures a secure and controlled user registration and login process. The inventory management menu provides the ability to monitor stock in real time and manage procurement needs. Furthermore, an integrated procurement module allows merchants to digitally request goods, connecting directly with suppliers. The digital payment menu utilizes QRIS services to process transactions efficiently and securely. The system is also equipped with an analysis and reporting module that processes transaction data and user behavior to generate reports useful for strategic decision-making. The notification and communication module serves to provide users with important information and reminders regarding transaction status and other market activity. This modular approach allows for flexible development and easier future maintenance.

3.2 Software architecture

The SIPETIR software architecture is designed to address the key limitations of traditional markets, particularly unstable network connectivity, low bandwidth, and the need for an easy-to-use and sustainable system. The system adopts a modular client–server architecture with a mobile-first approach, as shown in Figure 2.

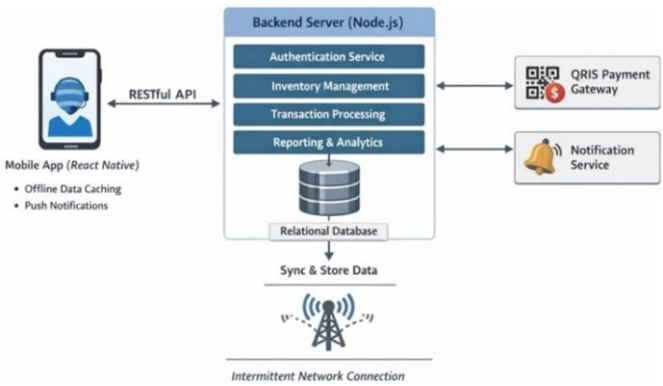

Figure 2. Integrated Market Information System (SIPETIR) architecture software

The mobile application was developed using react native to ensure interface consistency and cross-platform usability. On the client side, the system features an offline data caching mechanism that allows merchants to continue recording transactions and inventory when an internet connection is unavailable. Locally stored data is automatically synchronized to a central server via a RESTful API when the network connection is stable again, ensuring operational continuity even in intermittent network conditions.

On the backend, SIPETIR uses Node.js with a modular service architecture that separates authentication, inventory management, transaction processing, and reporting and analytics functions. This approach supports scalability, long-term system maintenance, and the integration of additional features without disrupting core services. Integration with the QRIS payment gateway and notification services is designed to improve transaction efficiency and system responsiveness to user activity.

3.3 User interface design

The SIPETIR user interface was designed using a usability-centered design approach to accommodate the characteristics of traditional market traders, who have varying levels of digital literacy and operate in environments with limited technological infrastructure. Therefore, the primary focus of the interface design was not on feature complexity, but rather on simplicity of interaction, visual consistency, and efficient user flow.

The user interface design guidelines presented in Table 1 represent the design principles applied during the system development phase. These guidelines do not represent empirical testing results, but rather serve as a conceptual basis for developing the SIPETIR interface to ensure it is easy to learn, easy to use, and minimizes user error. Applying these principles can reduce cognitive load and enhance user interaction, particularly for merchants unfamiliar with digital applications.

Evaluation of the effectiveness of the implementation of the UI design guidelines is carried out indirectly through system usability testing using the System Usability Scale (SUS) method, as explained in Section 3.5. Thus, SUS testing reflects the overall user experience as a cumulative result of the application of established interface design principles, rather than as a test of each design element separately.

Table 1. User interface design guidelines on Integrated Market Information System (SIPETIR)

UI Design Aspects	Applied Design Principles	Design Objectives in the Context of Traditional Markets
Interface Simplicity	Minimalist look with limited visual elements	Reducing user cognitive load with diverse digital literacy
Navigation	Linear and consistent menu structure across all pages	Makes it easier to understand the usage flow without intensive training
Layout Consistency	Uniform placement of buttons and icons	Increase learnability and reduce interaction errors
Use of Color and Icons	Contrasting colors and familiar icons	Improve readability and function recognition
Number of Interaction Steps	The transaction and recording process is made as short as possible	Increase efficiency and reduce input errors
System Feedback	Simple visual notifications for every action	Providing certainty over user actions
Network Condition Adaptation	Local data storage (offline data caching)	Ensures continuity of use when the connection is unstable

3.4 Data collection

Data collection was conducted during the SIPETIR field trial phase to obtain empirical data related to the system's use in a traditional market context. The study subjects consisted of 20 market traders, each representing a different traditional

market in Batam City. Respondents were selected purposively, taking into account the traders' direct involvement in SIPETIR use during the initial implementation period. Data were collected after the system was used in daily operational activities, such as transaction recording, inventory management, and utilization of digital payment features. The data collection process was conducted under real-world conditions in traditional markets to ensure that the data obtained reflected the actual experience of using the system. Data collected in this study included user responses to system use as well as supporting notes from limited observations during the trial process.

3.5 Integrated Market Information System usability testing

SIPETIR usability testing was conducted to assess user perceptions of the system's ease and convenience after implementation in a traditional market context. This evaluation aimed to ensure that the system, designed with a usability-oriented approach, was acceptable to users with varying levels of digital literacy.

Usability evaluation was conducted using the SUS as a standardized instrument. The SUS questionnaire consists of 10 items used to measure overall system usability, as presented in Table 2. Testing was conducted after respondents used SIPETIR in their daily operational activities during the trial period.

Table 2. System Usability Scale (SUS) questionnaire items for usability evaluation

No.	Question
1	I think I would use this application frequently.
2	I found the application unnecessarily complex.
3	I thought the application was easy to use.
4	I think I would need technical support to be able to use this application.
5	I found the various functions in this application were well integrated.
6	I thought there was too much inconsistency in this application.
7	I imagine that most people would learn to use this application very quickly.
8	I found the application very easy to use.
9	I feel very confident using the application.
10	I needed to learn a lot of things before I could get going with this application.

4. RESULTS AND DISCUSSION

The SIPETIR mobile app's user interface (UI) is designed with simplicity, ease of use, and accessibility in mind, aiming to support traditional market traders, many of whom may have limited experience with digital technology. The design adopts a user-centered approach, focusing on minimizing cognitive load and ensuring smooth navigation between modules.

4.1 Use case diagram

Figure 3 presents the context diagram of a traditional market information system involving three primary actors: Merchants, Buyers, and Market Officers. The system is designed to digitize transaction processes, services, and overall market management. Merchants interact with the system through features such as registration, transaction recording, stock checking, and turnover reporting, which support operational efficiency and business transparency. Buyers can place orders, check prices, and make payments digitally, enhancing the shopping experience to be faster and more convenient. Market Officers perform administrative and analytical functions including data verification, cleanliness monitoring, and market trend analysis. This role enables more accurate and data driven decision making in real time. Overall, the system represents a digital transformation of traditional markets toward a more integrated, efficient, and user responsive ecosystem.

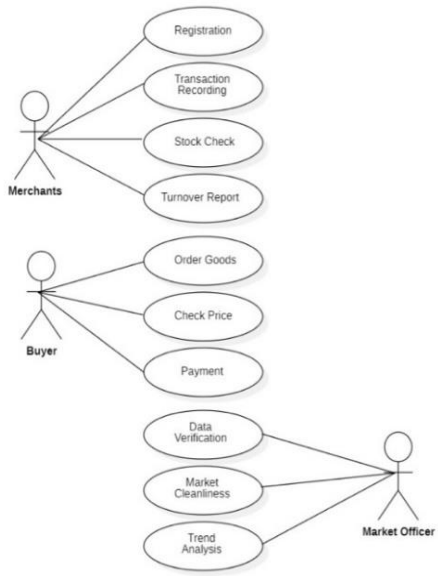

Figure 3. Use case diagram

4.2 Login main screen

The registration and login features are fundamental elements in the development of the SIPETIR application, serving as the initial gateway for users to access the system securely and according to their respective access rights (Figure 4). These features are designed with usability and security principles in mind, and are tailored to the characteristics of users, most of whom are traditional market players with varying levels of digital literacy.

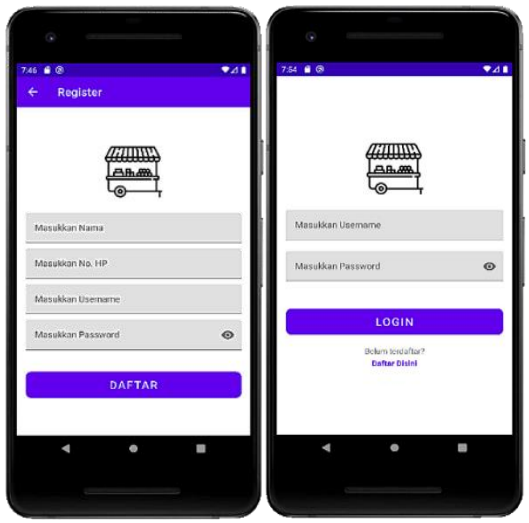

Figure 4. Registration and login

4.3 Home screen

The Home feature is the main page (homepage) that serves as the navigation center and initial information point for SIPETIR application users (Figure 5). This feature is designed to provide an efficient and informative user experience, displaying content appropriate to the user's role (trader, consumer, or market manager).

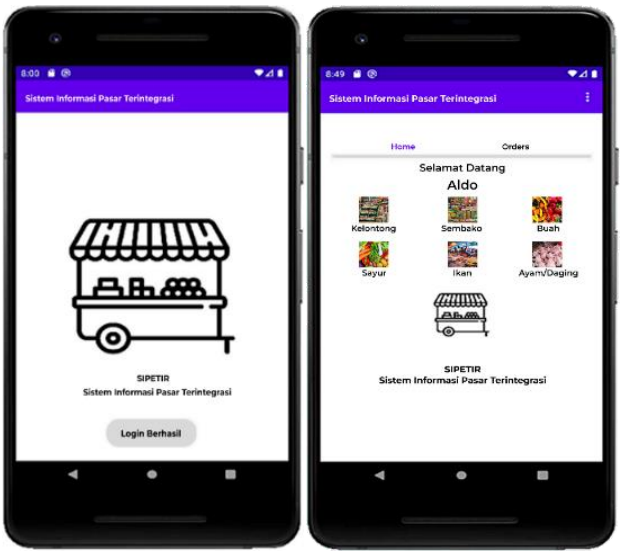

Figure 5. Successful login and home screen

4.4 Inventory management

The Inventory Management feature is a core component of the SIPETIR application, designed to make it easier for traditional market traders to digitally manage product data (Figure 6). This feature allows users to add, edit, and delete data on sold items, thus supporting the effectiveness of daily stock and transaction recording.

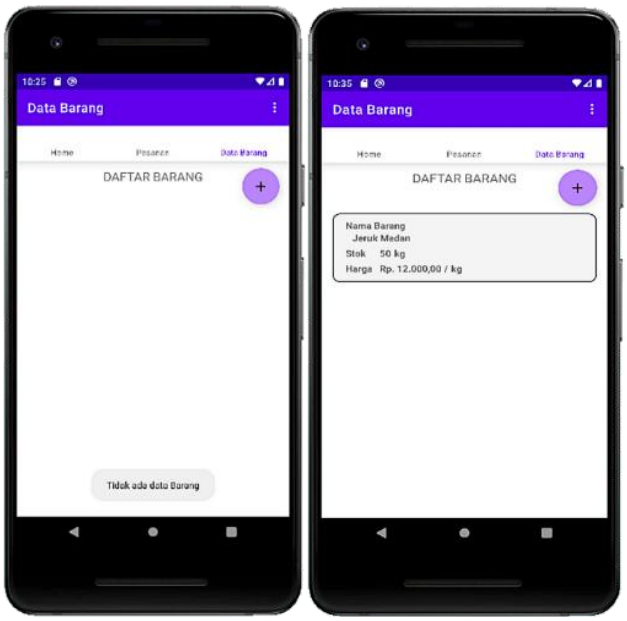

Figure 6. Inventory management

4.5 Product purchasing and order delivery

The purchase and order delivery feature is a key element of the SIPETIR application, serving as a direct link between consumers and traders in traditional markets (Figure 7). This feature was developed to address distribution challenges and time constraints for people shopping directly at markets, while also supporting digital transformation in the traditional trade sector.

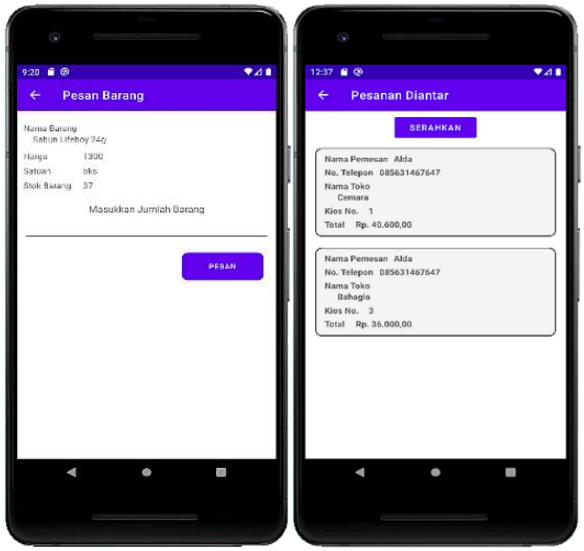

Figure 7. Product purchasing and delivery

4.6 Payment

The Payment feature in the SIPETIR application plays a crucial role in efficiently, securely, and integratedly completing transactions between consumers and traditional market vendors (Figure 8). This system is designed to support the digitalization of payment methods, thereby reducing cash transactions and increasing user trust in digital market services.

Figure 8. Payment

4.7 Usability analysis of the Integrated Market Information System application using the System Usability Scale

The results of the SIPETIR usability testing using the SUS

are presented in detail in Table 3. The table displays the individual SUS scores of all respondents, thus providing an overview of the variation in user perceptions of the system's usability. Based on the calculation results, SIPETIR obtained an average SUS score of 74.73, which indicates a good level of system usability. Referring to the classification proposed by Permatasari et al. [12], a SUS score above 70 is included in the acceptable category, so that in general SIPETIR can be accepted by users in the context of traditional market operations.

Although the average scores indicate positive results, Table 3 also shows variation in scores across respondents. Some users gave relatively low scores, such as respondent R9 with a score of 35.0. This variation reflects the heterogeneity of traditional market users, particularly differences in digital literacy levels and technology experience. These findings suggest that even though the system has been designed with a usability-oriented approach, usability support and interaction simplification are still needed to improve the consistency of the user experience.

Based on Figure 9, the SUS score graph shows that the SIPETIR application has a good level of usability, with an average score of 74.73 from 20 respondents. This score indicates that users find the application useful, easy to learn, and enjoyable. The red line on the graph represents the average score, which classifies the application as good in terms of ease of use.

Table 3. System Usability Scale (SUS) score results per respondent

Respondents	SUS Score
R1	75.0
R2	60.0
R3	92.5
R4	37.5
R5	75.0
R6	62.5
R7	100.0
R8	67.5
R9	35.0
R10	80.0
R11	62.5
R12	100.0
R13	100.0
R14	70.0
R15	75.0
R16	40.0
R17	100.0
R18	62.5
R19	87.5
R20	75.0
Average	74.73

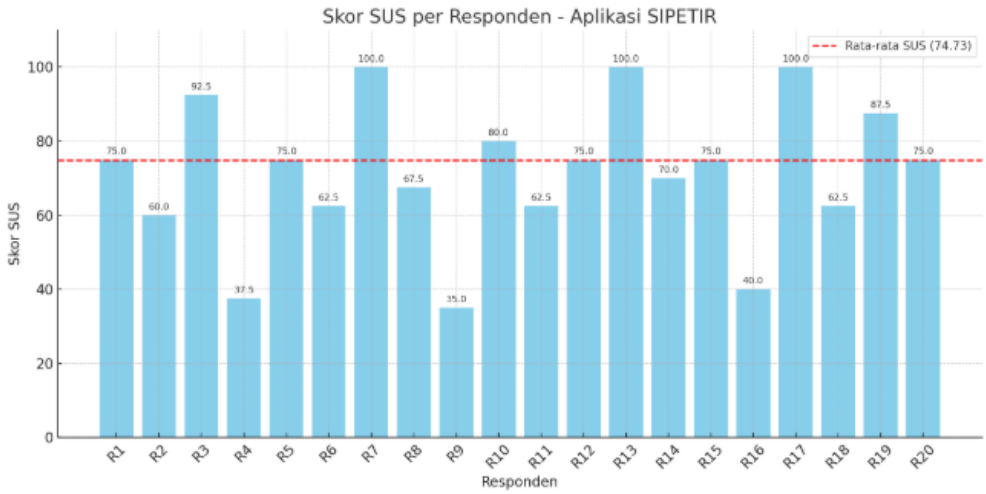

Figure 9. System Usability Scale (SUS) score chart

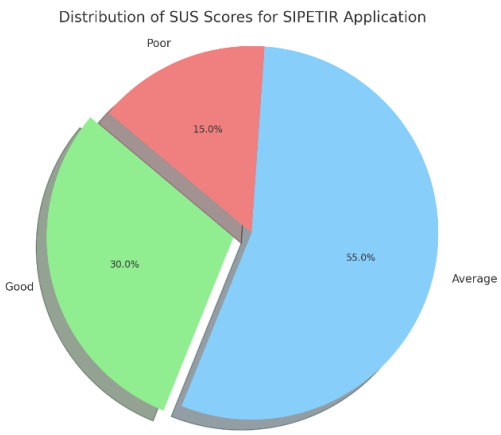

Figure 10. System Usability Scale (SUS) score distribution for the SIPETIR application

Figure 10 illustrates the distribution of SUS scores from 20 respondents who tested the SIPETIR application. Based on the graph, the scores were divided into three main categories: Good, Moderate, and Poor. The majority of respondents scored in the good category, indicating that the SIPETIR application was well-received by users. This reflects that the application is easy to use, effective, and meets user expectations in digitizing traditional market management. However, some respondents scored in the Moderate and Poor categories, indicating that several areas need improvement, such as optimizing features or refining the user interface for smoother interactions, especially for traders with low digital literacy.

Figure 11 presents the evaluation results of specific SUS aspects used to assess the SIPETIR app. Each statement in the SUS is measured on a scale of 1 to 5, reflecting users' perceptions of various aspects of the app. The results indicate

that most respondents found the app easy to use, well-integrated, and quick to learn. Aspects such as ease of use and confidence in using the app scored high, indicating that the app successfully delivered a positive user experience. Although some respondents found the app somewhat complicated at first, overall, the results indicate that SIPETIR has a high level of usability and is well-received by traditional market users.

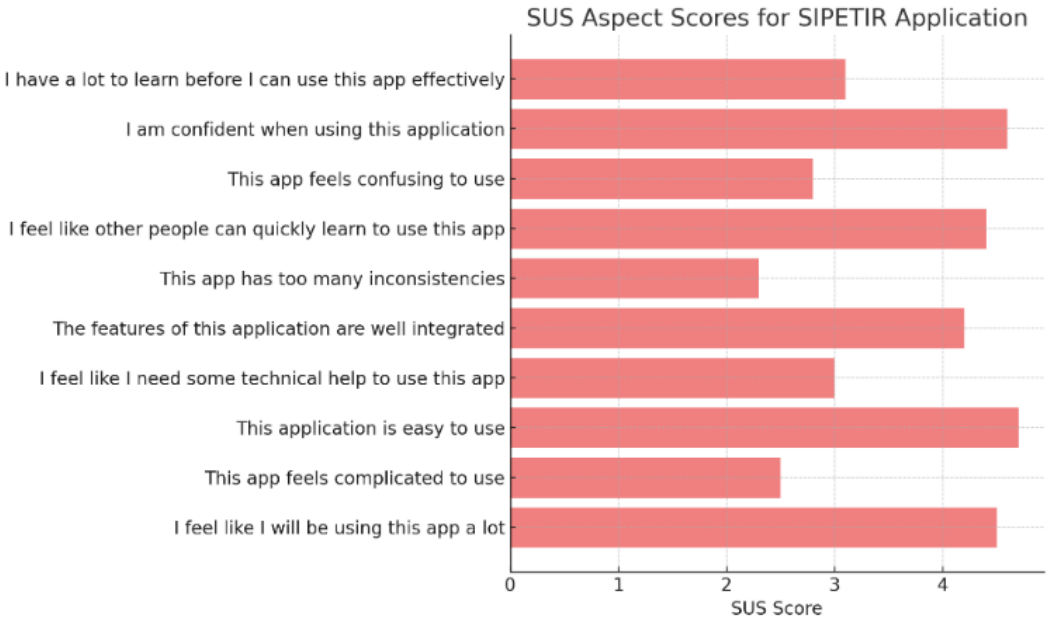

Figure 11. System Usability Scale (SUS) aspect scores for the Integrated Market Information System (SIPETIR) application

4.8 Impact of Integrated Market Information System implementation on operational efficiency

The evaluation of SIPETIR's operational efficiency was conducted using a paired before-and-after comparison design. Pre- and post-implementation data were obtained from the same 20 vendors, each representing a single traditional market. Thus, each post-implementation measurement was directly compared to the baseline conditions in an identical observation unit, ensuring that observed differences were not influenced by inter-market or inter-individual variations.

Operational efficiency was measured using two main indicators: average transaction time and the number of inventory recording errors. Data collection was conducted through two weeks of field observations, one week before and one week after the implementation of SIPETIR at each merchant.

Measurement results showed that the average transaction time decreased from 88.2 seconds before implementation to 58.3 seconds after implementation, representing a 34% decrease. Meanwhile, the average number of weekly inventory recording errors decreased from 11.8 to 7.0, a 41% decrease. These findings indicate that the use of SIPETIR contributes to the acceleration of the transaction process while improving the accuracy of inventory recording.

To assess the significance of changes before and after implementation, a paired sample t-test was conducted on both indicators. The results showed that the reduction in transaction time and inventory recording error rate was statistically significant ($p < 0.05$). This indicates that the observed differences were not solely due to random variation.

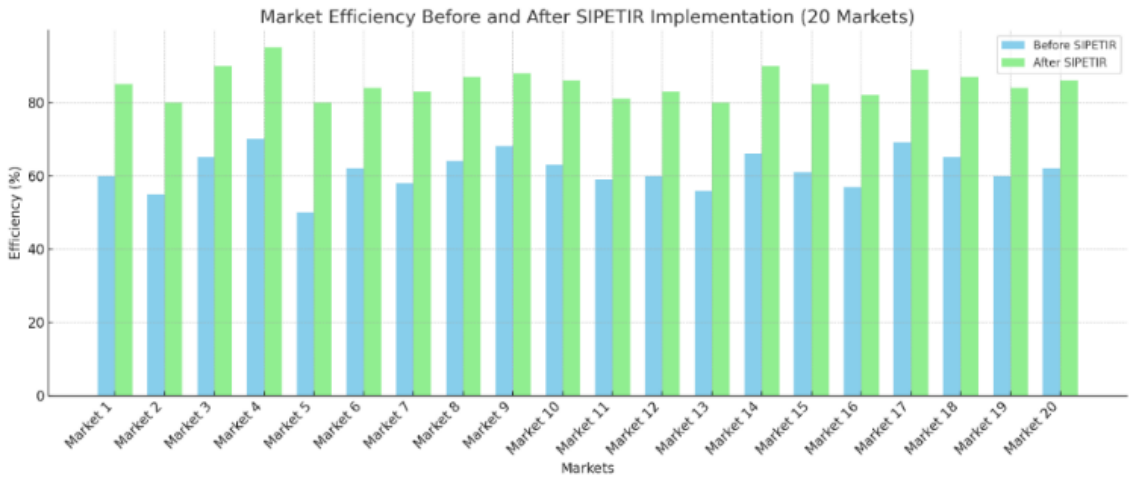

Figure 12. Market efficiency before and after Integrated Market Information System (SIPETIR) implementation in 20 traditional markets

Figure 12 presents a comparison of average values before and after SIPETIR implementation across all observed traders. This visualization demonstrates a relatively consistent pattern of efficiency increases, thus supporting the results of the quantitative analysis.

However, this study acknowledges that external factors, such as seasonal variations in trading activity and changes in market management policies, can potentially impact operational performance. However, the use of a paired comparison design on the same traders helps minimize the influence of such variability and strengthens the internal validity of the findings.

4.8 Research limitations

This study has several limitations that should be considered when interpreting the results. First, the sample size was relatively limited, involving 20 traditional markets. Therefore, generalizing the findings to a broader context of traditional markets or regions with different social and economic characteristics requires caution. Second, the system testing period was short-term and focused on the initial implementation phase, so it does not fully reflect the adoption patterns, sustainability of use, and long-term impacts of the SIPETIR system.

Third, the evaluation in this study primarily reflects the perspective of direct users, namely market traders. While the perspectives of other stakeholders, such as market managers and local governments, have not been explicitly analyzed. These stakeholders play a crucial role in policymaking, infrastructure management, and the sustainability of the digital transformation of traditional markets. Fourth, advanced technical aspects such as system security, data privacy, and scalability have not been thoroughly evaluated, given that the research's scope focused on usability and operational efficiency in the early stages of implementation.

Based on these limitations, further research is recommended to involve a wider number and variety of market locations and employ a longitudinal study design to evaluate the system's adoption and long-term impact. Furthermore, future research could integrate multi-stakeholder perspectives, including market managers and local governments, to gain a more comprehensive understanding of the success factors for digital transformation in traditional markets. From a technical perspective, further evaluation of the system's security, data privacy, and scalability is also needed to ensure its readiness to support broader and more sustainable implementation.

5. CONCLUSION

This research demonstrates that an integrated, modularly designed digital platform can effectively support the digital transformation of traditional markets when adapted to the operational characteristics and digital literacy limitations of its users. Through the development and implementation of SIPETIR, this research provides empirical evidence that an integrated mobile-based information system can improve operational efficiency and data accuracy in traditional market environments.

A paired before-after evaluation involving 20 traditional market traders showed that the implementation of SIPETIR reduced average transaction time by 34% and reduced inventory recording errors by 41%, with both changes being statistically significant. These findings confirm that the integration of transaction processing, inventory management, digital procurement, and cashless payments within a single system architecture can address the issues of fragmentation and reliance on manual processes that have been major obstacles to traditional market management. Furthermore, a SUS score of 74.73 indicates that the system has an acceptable level of usability for users with varying levels of digital literacy, thus emphasizing the importance of a usability-oriented and modular design approach.

From a theoretical perspective, this research contributes to the literature on information systems and digital transformation through the application of Design Science Research (DSR) to the context of traditional markets, which have received relatively little attention compared to the formal retail sector. The modular design approach applied to SIPETIR produces design knowledge that demonstrates how flexibility, ease of gradual adoption, and simplicity of interaction can be integrated into a system architecture to support environments with limited infrastructure and heterogeneous user capabilities. This contribution is relevant for the development of information systems in the informal and semi-formal economic sectors.

Practically, the results of this study demonstrate that SIPETIR has the potential to become a digital infrastructure that market managers and local governments can utilize to improve transparency, operational efficiency, and data-driven decision-making. By providing real-time data integration and reducing reliance on manual record-keeping, this system supports more accountable and sustainable traditional market governance.

However, this study has limitations, particularly related to the relatively limited sample size and short-term evaluation period, which means it does not fully capture the dynamics of adoption and the long-term impact of the system. Future research is recommended to employ a longitudinal design, involve a broader range of stakeholders, such as market managers and policymakers, and evaluate advanced technical aspects such as data security, privacy, and system scalability. This approach is expected to strengthen the generalizability of the findings and support the implementation of integrated digital systems in traditional markets on a broader scale.

REFERENCES

[1] Chowdhury, S., Das, T.K., Chisty, N.N., Biswas, S.K., Rahman, M.Z., Ling, J., Lindahl, J.F. (2025). Regulations, biosecurity measures, and impact of COVID-19: A comprehensive mixed method study in traditional wet and live animal markets in Bangladesh. One Health, 20: 101014. https://doi.org/10.1016/j.onehlt.2025.101014

[2] Widiyani, W., Ciadi, Y.M., Putra, B.A. (2025). Understanding shoppers' decision-making process in traditional markets in Indonesia. Journal of Regional and City Planning, 36(1): 59-67. https://doi.org/10.5614/jpwk.2025.36.1.4

[3] Song, Y., Escobar, O., Arzubiaga, U., De Massis, A. (2022). The digital transformation of a traditional market into an entrepreneurial ecosystem. Review of Managerial Science, 16(1): 65-88. https://doi.org/10.1007/s11846-020-00438-5

[4] Rosário, A., Raimundo, R. (2021). Consumer marketing

strategy and E-commerce in the last decade: A literature review. Journal of Theoretical and Applied Electronic Commerce Research, 16(7): 3003-3024. https://doi.org/10.3390/jtaer16070164

[5] Kurniasari, F., Lestari, E.D., Tannady, H. (2023). Pursuing long-term business performance: Investigating the effects of financial and technological factors on digital adoption to leverage SME performance and business sustainability-evidence from Indonesian SMEs in the traditional market. Sustainability, 15(16): 12668. https://doi.org/10.3390/su151612668

[6] Lawi, A., Dermawan, A.A., Kurniawan, D.E., Reza, I. M., Gulo, F.E., Hasibuan, Z.A. (2025). Exploring the landscape of deep learning techniques for IoT data: A systematic literature review. International Journal on Advanced Science, Engineering & Information Technology, 15(2): 578-588.

[7] Dermawan, A.A., Lawi, A., Putera, D.A., Kurniawan, D.E., Ummatin, K.K., Steve, J. (2024). Optimizing inventory management: Data-driven insights from K-means clustering analysis of prescription patterns. Scientific Journal of Informatics, 11(3): 811-820. https://doi.org/10.15294/sji.v11i3.8690

[8] Lawi, A., Dernawan, A.A., Aranski, A.W., Mursalim, M.K.N., Lesmana, N.I., Hasibuan, Z.A. (2025). Development of a smart waste management system for marine plastic pollution: Integrating IoT and machine learning for renewable energy conversion in Batam. Journal Européen des Systèmes Automatisés, 58(10): 2177-2185. https://doi.org/10.18280/jesa.581017

[9] Ma, Z., Chen, X., Sun, T., Wang, X., Wu, Y.C., Zhou, M. (2024). Blockchain-based zero-trust supply chain security integrated with deep reinforcement learning for inventory optimization. Future Internet, 16(5): 163. https://doi.org/10.3390/fi16050163

[10] Ziółkowska, M.J. (2021). Digital transformation and marketing activities in small and medium-sized enterprises. Sustainability, 13(5): 2512. https://doi.org/10.3390/su13052512

[11] Permatasari, R.D., Bora, M.A., Hernando, L., Handayani, V.A., Rahman, T., Larisang, M.R., Fitrianti, A. (2025). Optimizing da'wah through the MASJIDA application: A cognitive ergonomics approach to enhance user experience. International Journal of Computational Methods and Experimental Measurements, 13(4): 802-814. https://doi.org/10.56578/ijcmem130405

[12] Permatasari, R.D., Bora, M.A., Hernando, L., Saputra, T., Fauzan, H., Shilah, N., Salsabila, T.A. (2025). Evaluating usability and clustering of SILCARE system for MSME shipping: A data-driven approach using SUS and user behavior analysis. Journal of Applied Data Sciences, 6(2): 981-996. https://doi.org/10.47738/jads.v6i2.590

[13] Permatasari, R.D., Bora, M.A., Hernando, L., Sari, A.P., Kurniawan, A., Siagian, T.E., Fauzan, H. (2025). Developing a Smart Religious Tourism App (ReligiGO) to enhance visitor engagement: A case study in Batam, Indonesia. Ingenierie des Systemes d'Information, 30(10): 2747-2761. https://doi.org/10.18280/isi.301020

[14] Omar, I.A., Jayaraman, R., Salah, K., Debe, M., Omar, M. (2020). Enhancing vendor managed inventory supply chain operations using blockchain smart contracts. IEEE Access, 8: 182704-182719. https://doi.org/10.1109/access.2020.3028031

[15] Liu, L., Song, W., Liu, Y. (2023). Leveraging digital capabilities toward a circular economy: Reinforcing sustainable supply chain management with Industry 4.0 technologies. Computers & Industrial Engineering, 178: 109113. https://doi.org/10.1016/j.cie.2023.109113

[16] Melesse, T.Y., Orrù, P.F. (2025). The digital revolution in the bakery sector: Innovations, challenges, and opportunities from Industry 4.0. Foods, 14(3): 526. https://doi.org/10.3390/foods14030526

[17] Choruma, D.J., Dirwai, T.L., Mutenje, M.J., Mustafa, M., Chimonyo, V.G.P., Jacobs-Mata, I., Mabhaudhi, T. (2024). Digitalisation in agriculture: A scoping review of technologies in practice, challenges, and opportunities for smallholder farmers in sub-saharan Africa. Journal of Agriculture and Food Research, 18: 101286. https://doi.org/10.1016/j.jafr.2024.101286

[18] Dibbern, T., Romani, L., Massruhá, S. (2025). Drivers and barriers to digital agriculture adoption: A mixed-methods analysis of challenges and opportunities in latin American. Sustainability, 17(8): 3676. https://doi.org/10.3390/su17083676

[19] Adjei-Bamfo, P., Maloreh-Nyamekye, T., Ahenkan, A. (2019). The role of e-government in sustainable public procurement in developing countries: A systematic literature review. Resources, Conservation and Recycling, 142: 189-203. https://doi.org/10.1016/j.resconrec.2018.12.001

[20] Kallmuenzer, A., Mikhaylov, A., Chelaru, M., Czakon, W. (2025). Adoption and performance outcome of digitalization in small and medium-sized enterprises. Review of Managerial Science, 19(7): 2011-2038. https://doi.org/10.1007/s11846-024-00744-2

[21] Ilham, I. (2026). Modeling the economic impacts of Indonesia's Zero Over-Dimension Over-Load policy: A logistics system governance perspective. Journal of Engineering Management and Systems Engineering, 5(1): 33-41. https://doi.org/10.56578/jemse050103

[22] Li, Z., Wang, L. (2025). Research on financial management and control innovation in the integration of industry finance and taxation empowered by digital intelligence technology: --New scenarios and grouping paths for dynamic capability theory. In Proceedings of the 2025 International Conference on Digital Economy and Information Systems, pp. 39-47. https://doi.org/10.1145/3745133.3745142

[23] Faruq, M.O. (2024). Vendor risk management in cloud-centric architectures: A systematic review of soc 2, Fedramp, and ISO 27001 practices. International Journal of Business and Economics Insights, 4(1): 1-32. https://doi.org/10.63125/j64vb122

[24] Zhou, Y. (2025). A blockchain-enabled collaborative management framework for optimizing green power market transactions. Energy Informatics, 8(1): 89. https://doi.org/10.1186/s42162-025-00549-x

[25] Olayinka, O.H. (2021). Big data integration and real-time analytics for enhancing operational efficiency and market responsiveness. International Journal of Science and Research Archive, 4(1): 280-296. https://doi.org/10.30574/ijsra.2021.4.1.0179

[26] Nurlaila, Nurbaiti, Nasution, M.L.I., Albahi, M., Fauzan, M., Harahap, R.S.P., Sitorus, A.P. (2025). The impact of financial technology on the income of traditional market traders in Indonesia. International Journal of Accounting

and Economics Studies, 12(7): 543-550. https://doi.org/10.14419/b9yb6f92
[27] Marselinus, R.Z., Wijaya, K.A.S., Lukman, J.P. (2025). Inovasi pelayanan administrasi kependudukan SIPINTER online di desa tegal harum kota denpasar. Jurnal Hukum Dan Sosial Politik, 3(2): 166-180. https://doi.org/10.59581/jhsp-widyakarya.v3i2.5157
[28] Bora, M.A., Permatasari, R.D., Hernando, L., Abdullah, H.M.W., Siagian, T.E., Kurniawan, V.F., Fauzan, H. (2025). Optimization of public cemetery management through a cognitive ergonomics approach based on a Smart Cemetery System (SCS). Journal Européen des Systèmes Automatisés, 58(11): 2337-2349. https://doi.org/10.18280/jesa.581112
[29] Dermawan, A.A. (2025). Artificial intelligence-based intelligent navigation system for alleviating traffic congestion: A case study in Batam City, Indonesia. International Journal of Computational Methods and Experimental Measurements, 13(2): 309-321. https://doi.org/10.18280/ijcmem.130208
[30] Candra, J.E., Dermawan, A.A., Bora, M.A., Lawi, A., Permatasari, R.D., Leman, A.M. (2025). Assessing physical fitness of elementary school students: A case study of SD Negeri 002 Lubuk Baja, Batam City. Mathematical Modelling of Engineering Problems, 12(6): 1939-1950. https://doi.org/10.18280/mmep.120610
[31] Guo, F.F., Wang, S., Chen, S.Y. (2024). Competitive supply chain strategy optimization based on game model and NSGA-II algorithm. Journal of Industrial Intelligence, 2(2): 118. https://doi.org/10.56578/jii020204
[32] Blankson, C., Renner, P. (2021). Understanding rural micro and small business marketing practices in Ghana. In Business in Africa in the Era of Digital Technology: Essays in Honour of Professor William Darley, pp. 141-156. https://doi.org/10.1007/978-3-030-70538-1_9
[33] Cahya, S.B., Waspodo, T.S., Norida, C.S. (2024). The role of traditional markets in improving the economy of the community in Indonesia. International Journal, 2(1): 386-396. https://doi.org/10.62951/ijecm.v2i1.432
[34] Loo, P. (2025). Transfromation of traditional marketing strategy to digital; challenges and opportunities for retailers. Oikonomia: Journal of Management Economics and Accounting, 2(2): 32-44. https://doi.org/10.61942/oikonomia.v2i2.301
[35] Partogi, C., Chakim, M.H.R., Mulyati, M. (2024). Smart strategies in the digital age: Conventional retail facing the revolution e-commerce. International Journal of Multidisciplinary Research and Analysis, 7(11): 5303-5309. https://doi.org/10.47191/ijmra/v7-i11-42
[36] Bajaj, A. (2024). Navigating the digital shift: Challenges and opportunities for traditional retailers in India's evolving marketplace. IOSR Journal of Business and Management, 26(10): 32-35. https://doi.org/10.9790/487x-2610113235
[37] Popov, O., Makarov, O. (2025). Modern Features of digitalization implementation in small business in the trade sector. The Problems of Economy, 2(64): 67-76 https://doi.org/10.32983/2222-0712-2025-2-67-76
[38] Havran, V.Y., Hrybyk, I., Komar, Y. (2025). Research into new business models and business styles of leading enterprises in the trade sector (domestic and foreign practices). Series Manag. Issues, 9(1): 179-489. https://doi.org/10.23939/semi2025.01.179
[39] Savellano, J. (2025). Technology-driven business management: The impact of digitalization on operational strategies, International Journal of Advanced and Applied Sciences, 12(8): 53-62. https://doi.org/10.21833/ijaas.2025.08.005
[40] Oktaviani, R.F. (2024). Unpacking the resistance of traditional market to digital payment: A qualitative approach. Riset: Jurnal Aplikasi Ekonomi Akuntansi dan Bisnis, 6(2): 070-086. https://doi.org/10.37641/riset.v6i2.2119
[41] Rehman, F.A., uz Zaman, S., Asif, A., Shafi, K. (2025). Technological impact of digital payment systems on consumer behavior and optimization of the cash flow conversion cycle in Pakistan. The Asian Bulletin of Big Data Management, 5(1): 130-144. https://doi.org/10.62019/zpq9m565
[42] Parlatini, V., Radua, J., Dell'Acqua, F., Leslie, A., Simmons, A., Murphy, D.G., de Schotten, M.T. (2017). Functional segregation and integration within fronto-parietal networks. Neuroimage, 146: 367-375. https://doi.org/10.1016/j.neuroimage.2016.08.031
[43] Derby, K.M., Wacker, D.P., Peck, S., SAsso, G.A.R.Y., DeRaad, A., Berg, W., Ulrich, S. (1994). Functional analysis of separate topographies of aberrant behavior. Journal of Applied Behavior Analysis, 27(2): 267-278. https://doi.org/10.1901/jaba.1994.27-267
[44] Hanley, G.P., Iwata, B.A., McCord, B.E. (2003). Functional analysis of problem behavior: A review. Journal of Applied Behavior Analysis, 36(2): 147-185. https://doi.org/10.1901/jaba.2003.36-147
[45] Rudiyanto, A.R., Fattah, A., Mustagfirin, M. (2025). KASIRKU application design with mobile on management transaction, stock and sales report. Jurnal Ilmiah Sistem Informasi, 4(2): 99-109. https://doi.org/10.51903/dsd2w714
[46] Kalsum, U., Wakil, A. (2025). The influence of payment system digitalization on consumer transaction efficiency in Urban Areas. Nomico, 2(5): 81-91. https://doi.org/10.62872/2phk8t06
[47] Ganbold, O., Matsui, Y., Rotaru, K. (2021). Effect of information technology-enabled supply chain integration on firm's operational performance. Journal of Enterprise Information Management, 34(3): 948-989. https://doi.org/10.1108/jeim-10-2019-0332
[48] Hangga, M.H., Pati, G.K., Sabawaly, D.R. (2025). Implementation of a building materials sales system using the rad method at toko merah delima. Neptunus: Jurnal Ilmu Komputer Dan Teknologi Informasi, 3(4): 10-22. https://doi.org/10.61132/neptunus.v3i4.1097
[49] Hamdat, A., Ceskakusumadewi, B., Samalam, A.G., Rizal, M., Lawalata, I.L. (2024). The impact of management information systems on decision-making efficiency. Vifada Management and Digital Business, 1(2): 56-74. https://doi.org/10.70184/qpw1rq78
[50] Dhany, U.R., Rahmansyah, A.I., Musriati, T. (2025). Pengaruh QRIS terhadap Informasi Akuntansi dan Keputusan Keuangan dengan Moderasi Literasi Digital pada Pedagang Tradisional. AKUA: Jurnal Akuntansi dan Keuangan, 4(3): 546-555. https://doi.org/10.54259/akua.v4i3.5375
[51] Nafis, M., Pujianto, W.E., Qurratu'aini, N.I., Sholikhah, A. (2025). QRIS impactfull: How to develop traditional market financial? Dinasti International Journal of

Economics, Finance & Accounting, 6(3): 2088-2097. https://doi.org/10.38035/dijefa.v6i2.4624

[52] Anggoro, Y., Dwiastanti, A. (2025). Revitalizing traditional markets through digital marketing: PKM intervention model in the e-commerce era. Socious Journal, 2(2). https://doi.org/10.62872/rv55hh55

[53] Zakaria, U., Juhana, T. (2024). Frontend subsystem development in traditional market digitalization E-commerce applications. In 2024 18th International Conference on Telecommunication Systems, Services, and Applications (TSSA), Bali, Indonesia, pp. 1-5. https://doi.org/10.1109/tssa63730.2024.10864078

[54] Timbayo, O.O., Wijaya, D.I., Ikhsan, R.B., Putri, S.A. (2025). Behavioural analysis of traditional clothing traders toward E-commerce adoption: A pathway to business sustainability. IOP Conference Series: Earth and Environmental Science, 1488(1): 012030. https://doi.org/10.1088/1755-1315/1488/1/012030