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Development of a Supply Chain Information System Framework for Sustainable Manufacturing Operations

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Abstract: The increasing complexity of manufacturing activities requires efficient, integrated, and technology-driven solutions to manage supply chain processes effectively. Supply chain management (SCM) has become a critical component in ensuring competitiveness, agility, and sustainability within manufacturing industries. However, many organizations still face challenges in aligning operational activities with real-time information flow, which often leads to inefficiencies such as delays, excess inventory, and increased operational costs. This study aims to develop a conceptual framework for a Supply Chain Information System (SCIS) that supports manufacturing operations by integrating key supply chain functions into a unified digital platform.The proposed framework is designed to enhance decision-making processes by providing accurate and timely information across procurement, production, inventory, and distribution activities. The development approach combines system design principles with best practices from SCM, emphasizing data integration, process standardization, and digital connectivity. The framework also incorporates performance monitoring mechanisms that allow manufacturers to evaluate operational efficiency and identify areas for continuous improvement.The findings highlight that implementing an SCIS framework can improve collaboration among stakeholders, reduce lead times, optimize resource allocation, and strengthen supply chain visibility. Furthermore, the framework supports manufacturing firms in adapting to dynamic market demands and mitigating risks associated with supply chain disruptions. By leveraging digital technologies, the system ensures real-time data exchange and facilitates predictive analytics for proactive decision-making.In conclusion, this research contributes to both academic and practical perspectives by presenting a structured framework for developing a supply chain information system tailored to manufacturing operations. The study underscores the potential of information system design as a strategic enabler for operational excellence and sustainable manufacturing practices. Future research is recommended to validate the framework through case studies and empirical testing within diverse industrial contexts.

Keywords: Supply Chain Information System, Manufacturing Operations, System Framework, Operational Efficiency, Digital Integration.

Introduction

In today's globalized world and during a time of constant digital change, supply chain management (SCM) has become key to improving business efficiency and competitiveness. SCM includes essential processes like supply planning, material procurement, production, storage, and delivering final products to customers [1]. When structured SCM is put into practice, it can boost transparency, speed up distribution, and enhance the accuracy of operational data and reports [2]. For small and medium-sized enterprises, especially MSMEs, effective SCM can cut operational costs, enhance customer service, and provide broader market access [3] [4]. However, not all Sustainable manufacturing has emerged as a strategic imperative in modern industrial ecosystems, driven by the need to balance economic performance, environmental stewardship, and social responsibility. Global supply chains are increasingly pressured to adopt sustainable practices that not only reduce waste and energy consumption but also enhance transparency and resilience. However, achieving sustainability goals requires more than operational improvements it demands the integration of real-time data, advanced analytics, and collaborative decision-

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making across the supply chain network. Consequently, the development of an integrated information system framework is essential to enable visibility, traceability, and continuous performance monitoring in sustainable manufacturing operations.

Despite the growing body of research on sustainable supply chain management (SSCM), many organizations still face significant challenges in aligning digital transformation initiatives with sustainability objectives. Current systems often operate in silos, resulting in fragmented data flows and limited coordination between supply chain stakeholders [5]. Moreover, the lack of a standardized framework for integrating sustainability indicators into information systems hinders effective performance assessment and decision-making. Addressing these limitations requires a systematic approach that incorporates technological, organizational, and environmental dimensions into a cohesive supply chain information system framework.

The digital transformation of manufacturing and logistics operations provides an opportunity to address these challenges through the use of advanced technologies such as the Internet of Things (IoT) [6], artificial intelligence (AI) [7], big data analytics [8] [9], and cloud computing [6]. These technologies enable real-time data collection, predictive analytics, and automated decision-making that can significantly enhance sustainability performance across the supply chain. However, the successful adoption of such technologies depends on the existence of a well-designed information system framework that ensures data interoperability, scalability, and alignment with sustainability objectives [10]. The framework must not only integrate diverse data sources but also embed sustainability indicators such as carbon footprint, energy efficiency, and social compliance into decision-support processes. This integration allows for more transparent, accountable, and adaptive supply chain operations. Several studies have explored frameworks for sustainable supply chain management, yet most existing models focus on conceptual or managerial perspectives rather than information system implementation. There remains a significant research gap in linking information system design with sustainability-driven operational goals. Developing an integrated framework for supply chain information systems in sustainable manufacturing contexts can provide both theoretical and practical contributions. From a theoretical standpoint, it extends the understanding of how digital systems can support sustainability performance through data integration and analytics. From a practical perspective, it offers a roadmap for industries seeking to operationalize sustainability principles using digital tools and system-based approaches.

This study aims to develop a conceptual and technological framework for a supply chain information system that supports sustainable manufacturing operations. The proposed framework integrates sustainability metrics, data management mechanisms, and intelligent analytics to facilitate strategic and operational decision-making. By adopting a holistic systems approach, this research contributes to the advancement of sustainable digital transformation in manufacturing. The outcomes are expected to provide a practical foundation for industries seeking to implement data-driven sustainability practices, as well as a reference model for researchers exploring the intersection of information systems and sustainable supply chain management.

Materials And Methods

The development of the Supply Chain Information System (SCIS) framework in this study adopts the Waterfall model, a traditional and structured software development methodology that emphasizes a sequential and systematic approach. As illustrated in Figure 1, the Waterfall model consists of five main stages: Requirements, Design, Implementation, Verification, and Maintenance [11][12]. Each phase must be completed before proceeding to the next, ensuring a disciplined flow of development activities and well-documented progress at every stage.

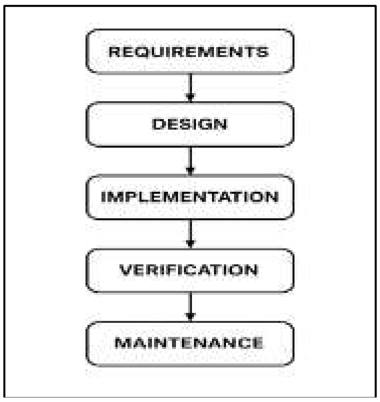

Figure 1. Waterfall Model.

1. Requirements

The first stage involves gathering and analyzing user requirements related to sustainable supply chain operations. This process includes identifying key functionalities, sustainability indicators, and data integration needs through literature review, field observation, and stakeholder interviews. The outputs of this phase are detailed functional and non-functional requirement specifications that serve as the foundation for system design.

2. Design

In the design stage, the system architecture, database schema, and user interface layout are defined based on the previously gathered requirements. The design process focuses on building a modular structure that supports interoperability between supply chain entities, data transparency, and sustainability performance monitoring [13]. Unified Modeling Language (UML) diagrams and Business Process Model and Notation (BPMN) are used to visualize workflows and data interactions within the system [14] [15].

3. Implementation

The implementation stage translates the system design into a functional prototype. The SCIS framework is developed using Python for back-end logic and PostgreSQL for database management, ensuring scalability and high data integrity. This phase integrates modules for data collection, sustainability performance tracking, and reporting across supply chain partners.

4. Verification

Verification involves rigorous system testing to ensure that each module meets the functional and sustainability requirements defined earlier. The process includes both black-box and white-box testing techniques to validate data accuracy, performance efficiency, and interface usability. The system is also evaluated by domain experts to ensure alignment with sustainable manufacturing objectives.

5. Maintenance

The final stage focuses on continuous improvement and maintenance of the system. Feedback from users and stakeholders is analyzed to enhance system performance and add new sustainability features as needed. Regular updates and performance audits are conducted to ensure that the information system remains adaptive to technological changes and evolving sustainability standards. In summary, the Waterfall method provides a structured and traceable framework for the systematic development of the Supply Chain Information System. Its sequential nature ensures that each stage is thoroughly documented and validated, minimizing development risks and ensuring that the resulting framework aligns with sustainability-driven manufacturing goals.

Results And Discussion

The Supply Chain Management (SCM) information system was developed to support PD. Sidamakmur's operational activities encompass the management of the supply chain in its entirety, including the formulation of supply plans, the procurement of fish from suppliers, and the distribution process up to and including the delivery of the goods to consumers. The system is web-based and can be accessed by two main types of users: namely administrators and business owners. The primary features that have been implemented include the management of fish data, supplier data, purchase and sales transactions, stock management, and the printing of real-time operational reports. The system has been designed to be user-friendly for non-technical users, such as business owners, as recommended by the user interface design study in the SCM system.

It is essential to emphasize that the development of the Supply Chain Information System (SCIS) framework was conducted through a structured and systematic approach following the Waterfall development methodology. Each phase from the identification of system requirements, architectural design, and implementation, to verification and maintenance was carefully executed to ensure the system's alignment with the research objectives, particularly in supporting sustainable manufacturing operations. The validation process integrated both qualitative and quantitative assessments to evaluate the framework's functionality, performance, and contribution to sustainability goals. The subsequent section elaborates on the outcomes of the framework development and presents a detailed discussion of the findings in relation to existing literature and industrial practices.

1. System Framework Overview

The result of this study is the development of a Supply Chain Information System (SCIS) framework that integrates sustainability indicators into manufacturing operations. The framework was designed and implemented following the Waterfall development model, ensuring that each stage from requirements analysis to maintenance was systematically executed. The resulting system architecture consists of three core layers: (1) the Data Layer, which manages sustainability data from suppliers, production units, and logistics partners; (2) the Process Layer, which handles workflow automation and data synchronization; and (3) the Decision Support Layer, which provides performance analytics and sustainability evaluation dashboards [16] [17]. The Supply Chain Management (SCM) information system was developed to support the operational activities of PD. Sidamakmur in managing the supply chain from supply planning, fish procurement from suppliers, to the distribution process to consumers. This system is web-based and can be accessed by two main types of users, namely administrators and business owners. The main features implemented include fish data management, supplier data, purchase and sales transactions, stock management, and real-time operational report printing. The system is designed to be user-friendly for non-technical users such as business owners, as recommended by the user interface design study in the SCM system. Translated with DeepL.com (free version)

2. Design

The system was designed using the Unified Modeling Language (UML) approach. The diagrams employed in this study encompass use case diagrams, activity diagrams, class diagrams, and sequence diagrams [18]. The system is characterised by the presence of two distinct user groups. Admin and Business Owner. The administrator's remit includes the recording of supplier data, fish stock, purchase and sales transactions, and report generation. The Business Owner's interaction is confined to the report and monitoring dashboard sections. The system was developed using the Laravel framework, which supports the Model-View-Controller (MVC) architecture to ensure modularity and development efficiency [19]. The user interface was designed to be responsive and straightforward for typical users. In the present study, the functional representation between actors and the system was illustrated by means of a Use Case Diagram. The Use Case Diagram for the Admin actor is shown in Figure 2 below. The diagram illustrates the administrator's function in the management of supplier data, purchases, fish stock, sales transactions, and report generation.

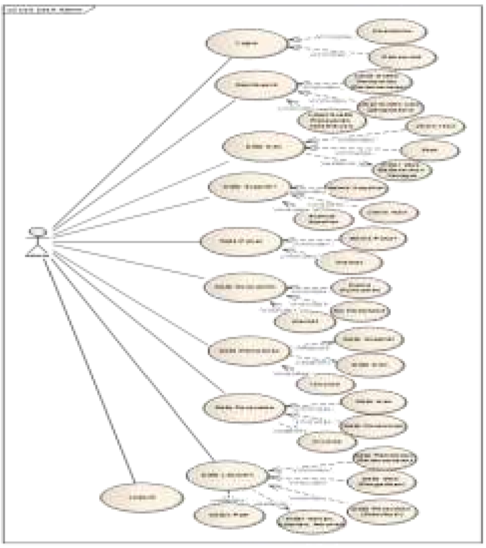

Figure 2. Use Case Diagram for the Admin actor.

3. Implementation

The system was constructed utilising a user-centric approach, ensuring that every component of the interface is meticulously tailored to the requirements of field users who possess limited technological expertise. For instance, the navigation features are uncomplicated and intuitive, with large buttons, and the data input process is designed with automatic validation to avoid entry errors. This aspect is of particular significance given that one of the most substantial impediments to technology adoption in MSMEs is the level of digital literacy among users.

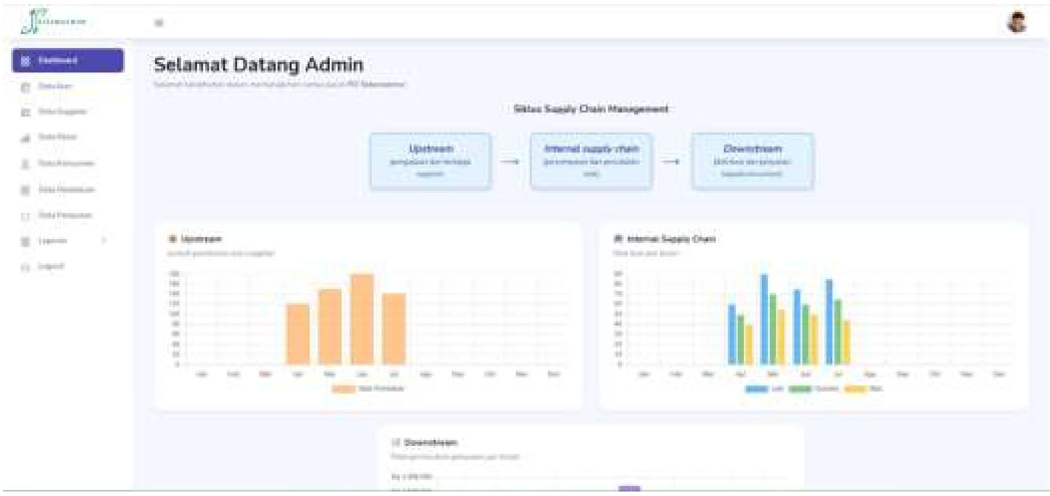

Figure 3. SCM Information System Admin Dashboard Display.

The system provides a range of functions, which are divided into three primary phases of SCM.

a. Planning: Administrators are able to monitor stock availability and estimate supply requirements based on historical transaction reports. The utilisation of real-time data has been demonstrated to facilitate enhanced accuracy in demand forecasting by business owners [19].

b. Sourcing: The purchasing module facilitates the documentation of purchase transactions from suppliers, incorporating a payment proof upload functionality and automatic stock recording, contingent upon the fulfillment of the minimum requirement (≥20 kg). This process accelerates the recording process while ensuring the accuracy of inventory records.

c. Distribution (Deliver): The sales module facilitates the management of transactions with consumers. The system is designed to verify the availability of stock and subsequently generate invoices, which are then transmitted via WhatsApp.

This process is initiated upon the attainment of a minimum sales quantity of 5 kilograms. The efficacy of automatic reminder features, including notifications via WhatsApp Gateway, has been demonstrated in previous studies [20]. It is evident that the business owner has the capability to supervise all undertakings executed by the administrative personnel in an instantaneous manner. In addition, the owner has the capacity to access print reports on a daily, weekly, or monthly basis, thereby facilitating operational decision-making[21]. The delineation of roles and the establishment of access protocols between the administrative personnel and the proprietor serve to mitigate the risk of errors and enhance the efficacy of reporting processes. The clarity that this division of functions engenders also facilitates the system's capacity to support the principle of good governance in the realm of small business management.

4. Verification

The system was subjected to testing that employed the black-box testing method. The purpose of this testing was to ensure that all features functioned according to the functional requirements. The present method is based on the testing of the system in relation to both input and output, without reference to the internal code structure. This renders the method suitable for the testing of the functionality of web-based applications [22] [23]. The results of testing the five main modules of the system are summarized in Table 1 below

Table 1. Black-box Testing Results on Modules.

No	Module	Test Status	Result
1	Supplier Data Input	Passed	As Expected
2	Fish Procurement	Passed	As Expected
3	Stock and Distribution	Passed	As Expected
4	Sales Transaction	Passed	As Expected
5	Report Generation	Passed	As Expected

Following the successful completion of the testing phase, the system was subsequently implemented directly in PD. The following report details the daily operations carried out by Sidamakmur over a period of two weeks. Prior to this, training was conducted for administrators on how to use the system. The evaluation was based on the system's effectiveness in accelerating reporting, enhancing data entry efficiency, and optimising user experience. The findings indicated a substantial enhancement in data accessibility, operational transparency, and the efficiency of reporting. These findings are consistent with the research conducted by Aryadutha and Budhisantosa, which concluded that digital systems can enhance the efficiency and accuracy of operational recording in MSMEs [24] [25]. This research method has been demonstrated to facilitate the design and testing of an SCM information system that is adaptive to the needs of small businesses. Furthermore, it has been shown to be implementable in the fisheries sector with limited technology. The utilisation of flowcharts and systematic stages furnishes a lucid framework for the development of web-based digital solutions, with the objective of enhancing the efficiency and precision of business processes at PD. Sidamakmur.

5. Maintenance

The maintenance phase represents the final and continuous stage in the development of the Supply Chain Information System (SCIS) framework, ensuring that the system remains functional, efficient, and adaptable to evolving organizational and technological needs. After the system implementation and verification phases, several maintenance activities were conducted to enhance system stability, correct potential errors, and improve usability based on user feedback. This stage aims to guarantee the long-term reliability of the SCIS framework in supporting sustainable manufacturing operations. Furthermore, user training remains constrained in its scope and does not quantify learning outcomes. The present study employs a qualitative approach, drawing upon interviews and observations. However, a more systematic approach is required in future research to measure the effectiveness of system adoption by users. Nevertheless, the findings of this study demonstrate that web-based information systems have the capacity to enhance operational efficiency, particularly within the context of the traditional fisheries sector. In the future, development can be directed towards data integration between MSMEs, expansion of Internet of Things (IoT)-based features for automatic distribution tracking, and development of analytical modules that support visual data-driven decision making based on historical data.

Conclusions

This study successfully developed a Supply Chain Information System (SCIS) framework designed to support sustainable manufacturing operations through a structured and data-driven approach. By applying the Waterfall development methodology, each stage from requirements analysis, system design, and implementation, to verification and maintenance was systematically executed to ensure both technical robustness and alignment with sustainability goals. The resulting framework integrates economic, environmental, and social performance indicators into a unified system, enabling real-time monitoring, transparency, and informed decision-making across the supply chain network. The system was designed using a modular approach and a user-friendly interface to facilitate adaptation on an SME scale that did not previously have a digital system. It was demonstrated through the utilisation of the black-box method that all of the system's core features functioned optimally and exerted a substantial influence on the efficiency of business processes. The system's advantages are twofold: firstly, its functionality is impressive; secondly, and perhaps more importantly, it is well-suited to the field conditions and technological infrastructure limitations that are characteristic of MSMEs. The findings of this study serve to expand the existing scope of research on SCM digitalisation, particularly in the fisheries sector. It is demonstrated that a technological approach which is simple yet adaptive can serve as an effective solution in improving the transparency, accuracy, and speed of supply chain processes.

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Conflict of Interest: The authors declare that there are no conflicts of interest concerning the publication of this article.

References

[1] A. M. Yusuf and D. Soediantono, "Supply Chain Management and Recommendations for Implementation in the Defense Industry : A Literature Review Supply Chain Management dan Rekomendasi Penerapannya Pada Industri Pertahanan : A Literature Review," vol. 3, no. 3, pp. 63–77, 2022.

[2] A. C. Perdana, A. Syamil, M. Munizu, and M. A. Fahmi, *Manajemen rantai pasok*, no. June. 2023.

[3] G. P. S. Nofri Yudi Arifin, Rohmat Indra Borman, Imam Ahmad, Sari Setyaning Tyas, heni Sulistiani, Alim Hardiansyah, "Analisa Perancangan Sistem Informasi".

[4] D. A. Siti Monalisa, "RANCANG BANGUN SISTEM INFORMASI SUPPLY CHAIN MANAGEMENT DISTRIBUSI BARANG DAN JASA BERBASIS WEB," vol. 7, no. 2, pp. 139–144, 2021.

[5] Y. Lin, A. Chen, Y. Yin, Q. Li, Q. Zhu, and J. Luo, "International Journal of Production Economics A framework for sustainable management of the platform service supply chain : An empirical study of the logistics sector in China," *Int. J. Prod. Econ.*, vol. 235, no. March, p. 108112, 2021, doi: 10.1016/j.ijpe.2021.108112.

[6] K. M. Sallam, "Internet of Things (IoT) in Supply Chain Management : Challenges , Opportunities , and Best Practices," vol. 2, pp. 1–32, 2023.

[7] P. D. MD Rokibul Hasan, Md Zahidul Islam, Md Fakhrul Islam Sumon, Md Osiujjaman and L. Pant, "Integrating Artificial Intelligence and Predictive Analytics in Supply Chain Management to Minimize Carbon Footprint and Enhance Business Growth in the USA," pp. 195–212, 2024, doi: 10.32996/jbms.

[8] J. Mageto, "Big Data Analytics in Sustainable Supply Chain Management : A Focus on Manufacturing Supply Chains," 2021.

[9] A. Jahin, S. H. Shovon, J. Shin, and L. G. Sep, "Big Data – Supply Chain Management Framework for Forecasting : Data Preprocessing and Machine Learning Techniques," pp. 1–47.

[10] M. H. Dilla Fitria Nasution, Fauriatun Helmiah, "Penerapan Supply Chain Management Berbasis Web di Gudang Rejeki Tanjungbalai," vol. 1, no. 1, pp. 1–5, 2023.

[11] M. G. Ramadhan, L. Nurpulaela, and U. Latifa, "Perancangan Sistem Informasi POS (Point Of Sales) Berbasis Web dengan Menggunakan Framework Codeigniter pada Pasar Swalayan," vol. 14, no. 3.

[12] T. Cahyono, S. Setianingsih, and D. Iskandar, "WEBSITE-BASED BOOK LENDING SYSTEM IMPLEMENTASI METODE WATERFALL PADA PERANCANGAN SISTEM," vol. 3, no. 3, 2022.

[13] H. Pardede, A. B. L. Mailangkay, T. St, and M. Msi, "SNAP _ 2021 _ FULL PAPER _ 16 PERANCANGAN USER INTERFACE BERBASIS WEB PENDISTRIBUSIAN BARANG (Supply Chain Management) MENGGUNAKAN METODE DESIGN THINKING," pp. 38–41.

[14] S. Kasus and A. Bank, "DIAGRAM UML DALAM MEMBUAT".

[15] A. S. Vingerhoets, S. Heng, and Y. Wautelet, "Using i * and UML for Blockchain Oriented Software Engineering : Strengths , Weaknesses , Lacks and Complementarity," no. 26, pp. 26–45, 2021.

[16] S. B. Kharisma, "PENGUKURAN KINERJA SUPPLY CHAIN MANAGEMENT (SCM) DENGAN MENGGUNAKAN SCOR MODEL DAN METODE ANALITYCAL HIERARCHY PROCESS (AHP) DI PT . LOKA," vol. 02, no. 05, pp. 121–132, 2021.

[17] N. Cahyani, "DAN SUPPLY CHAIN MANAGEMENT PADA BANK BUMN DI," vol. 14, no. September, pp. 3038–3051, 2025, doi: 10.34127/jrlab.v14i3.1669.

[18] S. Narulita, A. Nugroho, and M. Z. Abdillah, "Diagram Unified Modelling Language (UML) untuk Perancangan Sistem Informasi Manajemen Penelitian dan Pengabdian Masyarakat (SIMLITABMAS) Universitas Nasional Karangturi Semarang , Indonesia (deskripsi) dan perancangan sistem , khususnya pada pemrograman berorientasi objek (Nistrina," no. 3, pp. 244–256, 2024.

[19] J. Abdillah *et al.*, "Ekasakti Jurnal Penelitian Dan Pengabdian Analisis Dan Perancangan Supply Chain Management (SCM) Pada Toko," vol. 5, no. 2, pp. 306–321, 2025.

[20] R. R. B. Adi Muhamad Muhsidi, Asep Mahpudin, "DENGAN PENDEKATAN SUPPLY CHAIN MANAGEMENT," vol. 2, no. 2, pp. 69–87, 2024.

[21] I. P. W. Loso Judijanto, Kushariyadi, Khamaludin, Tri Mulyono, Adhi Purnomo, "PENGETAHUAN DASAR SUPPLY".

[22] N. Made, D. Febriyanti, A. A. K. Oka, and I. N. Piarsa, "Implementasi Black Box Testing pada Sistem Informasi Manajemen Dosen," vol. 2, no. 3, 2021.

[23] D. Widhyaestoeti *et al.*, "BLACK BOX TESTING EQUIVALENCE PARTITIONS UNTUK PENGUJIAN FRONT-END PADA SISTEM AKADEMIK SITODA," vol. 7, no. 3, 2021.

[24] S. Sadariyah, "Analisis Efektivitas Manajemen Rantai Pasok dalam UMKM Kerupuk Singkong," vol. 8, no. 1, pp. 146–154, 2024.

[25] V. Febriana, N. Ahmadi, B. Rahmani, and P. R. Silalahi, "Digital Supply Chain Integration in Tofu MSMEs of Rambung Merah Village : Integrasi Rantai Pasokan Digital di UMKM Tahu Desa Rambung Merah," vol. 26, no. 3, pp. 1–12, 2025.