ISSN 2087-3336 (Print) | 2721-4729 (Online)
TEKNOSAINS: Jurnal Sains, Teknologi dan Informatika
Vol. 14, No. 1, 2027, page. 20-31
http://jurnal.sttmcileungsi.ac.id/index.php/tekno
DOI: 10.37373

Smart tracking technology implementation to reduce inventory loss: A systematic literature review

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Submitted: 04/02/2026 Revised: 15/06/2026 Accepted: 28/06/2026

Abstract

Inventory loss is a common issue in inventory management across sectors such as manufacturing, education, and construction. This problem is often caused by limitations of manual recording systems that cannot provide adequate data visibility or real-time asset monitoring. Digital technologies such as *Radio Frequency Identification* (RFID) and the *Internet of Things* (IoT) offer solutions to improve inventory management efficiency and reduce the risk of asset loss. This study aims to analyze the implementation of digital technologies in inventory management systems and evaluate their impact on operational efficiency and asset control. The research uses a *systematic literature review* method by examining relevant national and international journal articles published between 2017 and 2025. The analysis focuses on identifying key findings from previous studies regarding the application of RFID and IoT in inventory tracking systems. The results show that technology-based tracking systems can improve recording accuracy, enable real-time inventory monitoring, and reduce the risk of asset loss. However, several challenges remain, including high initial implementation costs and the readiness of information technology infrastructure.

Keywords: RFID; Internet of Things; inventory management; real-time tracking; systematic literature review.

1. Introduction

Inventory management is a crucial aspect in supporting operational efficiency and the sustainability of an institution. Inventory not only serves as a supporting asset for organizational activities but also plays a role in ensuring the smooth flow of work processes and resource distribution. Inefficiencies in inventory management can lead to various problems such as lost goods, delayed distribution, and increased operational costs, all of which impact overall organizational performance [1].

Despite this, many institutions still rely on manual record-keeping systems such as paper documents or simple spreadsheets. These methods have several limitations, including susceptibility to recording errors, difficulty tracking borrowing history, and the inability to provide real-time inventory information. This leads to low asset visibility and complicates inventory management control and decision-making [2].

The development of digital technology provides an opportunity to address these issues through the implementation of automated tracking systems. One widely used technology is Radio Frequency Identification (RFID), an identification technology that allows for automatic object tracking using radio waves without the need for direct physical or visual contact. By assigning a unique identity to each item, RFID can improve recording accuracy and expedite inventory monitoring [3].

For a tracking system to function optimally, integration with Internet of Things (IoT) technology is required. IoT enables various devices to be connected via an internet network, allowing data from

sensors or identification devices to be collected, processed, and displayed in real time within a digital management system. The integration of RFID and IoT enables automated recording, continuous asset monitoring, and more structured data storage.

Based on these issues, this study aims to analyze the application of digital technology in the development of an RFID- and IoT-based inventory lending system. This study also evaluates how the integration of these technologies can improve operational efficiency and strengthen asset control through a more accurate and real-time inventory tracking system.

2. Method

This study uses a Systematic Literature Review (SLR) approach to systematically examine the application of technology in digital inventory management systems, specifically Radio Frequency Identification (RFID) and Internet of Things (IoT) technologies. The SLR method was chosen because it allows researchers to identify, evaluate, and synthesize findings from various previous studies in a structured manner, resulting in a comprehensive understanding of research developments on a particular topic [4]. The literature collection process was conducted through major scientific databases, namely ScienceDirect and IEEE Xplore, which provide reputable international journal articles in the fields of information technology, logistics systems, and inventory management. The selection of these sources aims to ensure the quality and relevance of the analyzed literature.

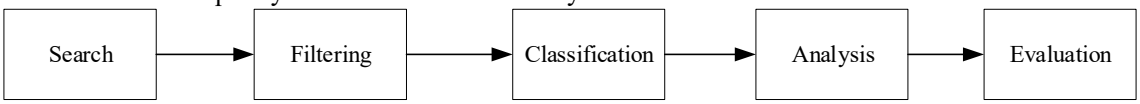

Figure 1. Method framework

The framework of this research method is shown in Figure 1, which depicts the systematic stages in the SLR process from searching for articles to synthesizing research findings.

Article Search

A literature search was conducted using several key keywords related to the research topic, such as RFID in inventory management, IoT-based asset tracking, and digital inventory systems. The selected articles were limited to publications from 2017–2025 to ensure that the analyzed literature reflects the latest technological developments in digital inventory tracking systems.

Literature screening

At this stage, a selection process was carried out based on inclusion and exclusion criteria. Selected articles must discuss the application of RFID technology, IoT, or digital tracking systems in the context of inventory management. Articles that were irrelevant to the research topic, did not discuss inventory tracking technology, or were simply non-scientific reports were eliminated from the analysis process.

Literature classification

Articles that pass the selection stage are then classified based on several aspects, namely the application sector (such as manufacturing, education, and logistics), the type of technology used, and the purpose of implementing the digital inventory system.

Thematic analysis

Each piece of literature was analyzed using a thematic analysis approach to identify patterns in research findings. Aspects analyzed included the effectiveness of technology in reducing inventory loss, improving data accuracy, real-time tracking capabilities, and its impact on organizational operational efficiency.

Synthesis of findings

The final stage is to synthesize the various research findings analyzed. This process aims to identify research trends, key benefits of implementing RFID and IoT technologies in inventory management, and implementation challenges such as initial investment costs, information technology infrastructure

readiness, and organizational factors in the technology adoption process. Through this SLR approach, the research not only describes the existing literature but also synthesizes scientific findings regarding the effectiveness of integrating RFID and IoT technologies into digital inventory systems and their implications for improving operational efficiency and asset control.

3. Results and Discussion

Based on a synthesis of 35 journal articles analyzed using a systematic literature review, most studies highlighted the limitations of manual inventory management systems. Paper-based or spreadsheet-based systems often lead to problems such as data entry errors, limited inventory visibility, and difficulty monitoring inventory borrowing history. This increases the risk of inventory loss and reduces an organization's operational efficiency.

A number of studies show that the application of Radio Frequency Identification (RFID) and Internet of Things (IoT) technology can be a solution to this problem. The integration of these two technologies allows automatic identification of goods via RFID tags connected to the IoT network system. With this mechanism, the inventory recording process can be carried out automatically and allows real-time monitoring of assets, thereby increasing data accuracy and transparency of inventory management. In addition, several studies also report that digital tracking systems can speed up the process of borrowing and returning goods and reduce the potential for inventory loss.

Identifying technology problems and solutions

Literature analysis shows that the main problem faced by institutions in inventory management is related to the low level of automation in the recording system. In this context, RFID and IoT technologies act as solutions, enabling each inventory item to have a digital identity that can be automatically tracked. Several studies emphasize that the success of tracking system implementation depends not only on the technology used but also on a system design that supports ease of use for end users.

Grouping of research studies

The literature analyzed in this study comes from publications between 2017 and 2025 and can be grouped based on several key aspects: the technology application sector, the type of technology used, and the benefits of system implementation. In terms of application sector, most research was conducted in the manufacturing, logistics, and education sectors, which have a high demand for efficient inventory management. From a technological perspective, most studies utilize a combination of RFID and IoT as inventory tracking systems. The integration of these two technologies enables item identification, automated recording, and storage of inventory data in a digital system that can be accessed in real time.

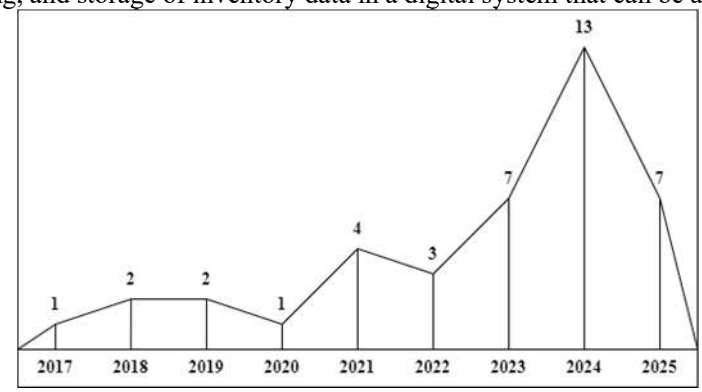

Figure 2. Publications by year

Based on the results of the literature grouping by year of publication in Figure 2, there is a visible trend of increasing number of studies discussing the application of technology in digital inventory management systems throughout the period 2017 to 2025. In the initial period, namely 2017 to 2020, the number of publications was still relatively limited with an average of only one to two articles per year. This condition indicates that research related to the integration of technologies such as RFID and

the Internet of Things (IoT) in inventory management is still in the early stages of development and has not attracted much attention from researchers.

Year 2021 to 2023, the number of publications has gradually increased. This increase is thought to be related to the acceleration of digital transformation in various industrial sectors following the COVID-19 pandemic, the increasing adoption of Industry 4.0 concepts, and the increasing affordability of RFID and IoT devices. These factors have driven researchers' growing interest in utilizing digital technology to improve inventory management efficiency and real-time asset tracking. The peak of publications was seen in 2024, with 13 peer-reviewed articles. This concentration of publications indicates that the topic of tracking technology-based digital inventory systems is experiencing significant growth, making it relevant and timely for further study in line with current industry needs.

Meanwhile, the number of publications in 2025, recorded at 7 articles, should be interpreted with caution. This decrease should not be interpreted as a decline in research interest, but rather due to the data collection process, which began in July 2025, meaning that publications published in that year were not yet fully indexed and included in the analysis. Overall, this increasing trend in publications demonstrates the urgency of conducting literature synthesis to map developments and future research directions in the field of digital inventory management.

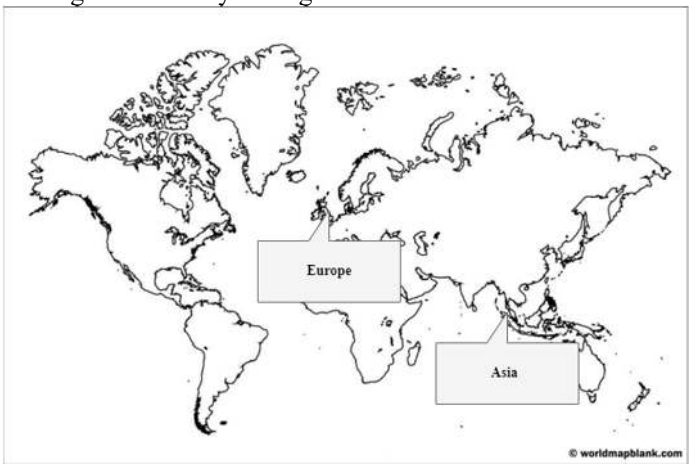

Figure 3. Publications by continent

Based on the results of the literature grouping by geographic region in Figure 3, research on the application of technology in digital inventory management systems is spread across several continents, with publications predominantly originating from Asia and Europe. This study included 35 scientific journals from various countries, with 20 articles originating from Asia and 15 from Europe. Countries such as Indonesia, China, India, and Germany are strong representatives in the development and implementation of technology-based asset tracking systems across various industrial sectors.

The dominance of publications from Asia is likely related to the rapid growth of the manufacturing and logistics sectors in countries such as China, India, and Indonesia, which have a high demand for efficient inventory management systems. Furthermore, substantial investment in the implementation of Industry 4.0 concepts and Asia's position as a hub of the global supply chain have also driven the growth of research in this field. Meanwhile, contributions from Europe, particularly Germany, reflect the maturity of technological research and strong industrial standardization, making the region a pioneer in the development of RFID and IoT technology.

On the other hand, the limited number of publications from other regions, such as the Americas and Africa, indicates a research gap and needs to be addressed as a limitation, considering that uneven geographic distribution can affect the generalizability of study results. Overall, this distribution of literature serves as the basis for compiling a literature review to examine the effectiveness of technology in reducing inventory loss and improving operational visibility, while also opening up opportunities for further research in regions with minimal representation. The results of data extraction from all articles that met the inclusion criteria are presented in Table 1. The table contains the paper identifiers in the

form of author names and year of publication, along with a summary of the main findings from each study, which serve as the basis for identifying patterns of technology application in digital inventory management systems.

Table 1. Data extraction results from 35 selected articles

No	Paper Identity	Results
1	(Cindy Fikriliani et al., 2025) [5]	This study designed the UI/UX of the District Attorney's Office inventory system using Design Thinking and tested it using the SEQ method. The results demonstrated ease of use. However, there were limited respondents and features such as QR codes were not yet available. Further development is recommended to improve efficiency and user experience.
2	(Gerardine Immaculate Marya et al., 2025) [6]	A UWB-based tracking system with Arduino is capable of accurately detecting assets indoors. Combined with a simple UI, this system is effective for asset tracking and loss reduction.
3	(Yi-Shan Lee et al., 2025) [7]	Literature study, task experiment, semi-structured interview, validation using SUS (System Usability Scale), NPS, and User Subjective Perception Scale; 2x2 design experiment between groups.
4	(Yihua Wang et al., 2025) [8]	The proposed method can reduce costs by up to 19.2% compared to the company's current policy. Products with high and stable demand should be stored in local DCs, while products with low and unstable demand are better centralized. Virtual pooling provides better results when demand is stable.
5	(Shan Jin et al., 2025) [9]	This research integrates IoT, RFID, and blockchain for intelligent inventory management in the insurance supply chain. The multi-objective model minimizes distribution costs and time through real-time tracking. This integration improves visibility, data accuracy, and operational efficiency, supporting the digital transformation of inventory management.
6	(Yves R. Sagaert et al., 2025) [10]	This research proposes an inventory management method utilizing macroeconomic indicators and hierarchical forecasting. This model improves the accuracy of SKU demand predictions, supports stocking decisions, and is adaptive to supply chain disruptions. Integration of external data predictions strengthens the digitalization of global inventory management.
7	(Adelio Shatara Nugraha et al., 2025) [11]	RFID technology can improve security, identification accuracy, and real-time visibility of high-risk goods. RFID implementation supports supply chain digitization, minimizes manual errors, and accelerates logistics processes and regulatory compliance.
8	(Longfei Qin et al., 2024) [12]	The use of IoT in Botswana's agricultural sector supports the digitalization of stock management, animal tracking, environmental monitoring, and real-time livestock health. IoT systems help farmers optimize decisions, reduce asset loss, and improve operational efficiency through sensors, the cloud, and automated notifications.
9	(Suryodiningrat, 2024) [13]	IMS was developed with design thinking principles for users with low digital literacy. The system was successfully tested through User Acceptance Testing (UAT), demonstrating effective functionality and ease of use. The intuitive design, including color, typography, and layout, improves user efficiency, engagement, and understanding, while minimizing human error, lost items, and increasing productivity
10	(Linett Velasquez Jimenez et al., 2024) [14]	- 85% of respondents rated the interface design as very intuitive - 88% rated ease of use as excellent - Loading and e-commerce improvements needed

No	Paper Identity	Results
11	(Marisha Pertiwi et al., 2024) [15]	The UI/UX design of the OBE assessment system was accepted by users and was deemed effective, efficient, memorable, and satisfying based on usability principles.
12	(Ahmad Ali Atieh Ali et al., 2024) [16]	Digital adaptability and flexibility positively impact information visibility and inventory management effectiveness. However, digital agility has no significant impact. Information visibility has also been shown to foster more efficient inventory management
13	(Md. Kausar Alam et al., 2024) [17]	In developing an inventory management system for SMEs, integrating RFID and IoT technologies can improve supply chain visibility and the efficiency of raw material and product tracking. Meanwhile, implementing UI/UX principles in the system interface will make it easier for SMEs with low digital literacy to use technology effectively.
14	(Albert Budiyanto et al., 2024) [18]	RFID improves real-time visibility, accuracy, and efficiency of inventory management across multiple sectors. Integration with IoT, AI, and blockchain extends benefits such as predictive analytics and tracking. However, technical challenges, costs, and organizational resistance still hinder widespread adoption, requiring supportive policies and further research.
15	Petri Helo et al., 2024) [19]	IoT-based Logistics 4.0 tracking technology increases supply chain transparency and efficiency. This system can reduce inventory loss and improve the user experience through greater digital visibility and control
16	(Akbar Iskandar et al., 2024) [20]	-The system works well, is easy to use, and is secure. -37.5% of respondents were very satisfied and 62.5% were satisfied. -The system helps streamline the registration process, reduces data errors, and improves communication between the school and prospective students/parents.
17	(Orven E. Llantos et al., 2024) [21]	A lightweight tracking device with a customized user interface delivers accurate results in tracking small objects. This system supports asset loss prevention with a user-friendly UI/UX approach.
18	(Yang, 2023) [22]	A lightweight tracking device with a customized user interface delivers accurate results in tracking small objects. This system supports asset loss prevention with a user-friendly UI/UX approach.
19	(Baenil Huda et al., 2023) [23]	Using the Design Thinking method, CV. Smart Motecare Mandiri's inventory information system was successfully designed to meet user needs. SUS testing results demonstrated good user experience (UX), ease of use, integration, and increased user trust. This system supports inventory management and the efficiency of the company's business processes.
20	(Miguel Ramos Miller et al., 2023) [24]	The implementation of a web-based system has significantly improved inventory management: - Inventory search efficiency: 85.51% - Inventory recording: 90.31% - Annual report generation: 83.11% - Overall inventory process improvement: 86.31% This system strengthens staff collaboration, ensures data accuracy, simplifies reporting in accordance with government guidelines, and reduces processing time and information duplication.
21	(Ti-Jun Fan et al., 2023) [25]	RFID use in retail effectively reduces shrinkage and increases profits if tag costs are below a certain threshold. The benefits of RFID increase when RFID read rates are high or shrinkage is significant. However, the

No	Paper Identity	Results
		investment is only profitable if the tag costs are commensurate with the benefits.
22	(Wouter van Groesen et al., 2022) [26]	The integration of QR codes and blockchain in construction asset tracking enables automation and reliable record-keeping. The system's UI supports compliance and transparency, reducing manual recording errors.
23	(Pratik Maheshwari et al., 2022) [27]	Using SCDT helps companies make better decisions regarding inventory levels. This technology can also improve customer satisfaction and lower overall supply chain operating costs.
24	(Erlangga Bayu Setyawan et al., 2022) [28]	Monitoring helps companies monitor inventory availability and movement, both directly and indirectly. With an RFID-based monitoring system, the recording process is faster, more accurate, and more controlled in real time, supporting decision-making and improving logistics service performance through technological innovation.
25	(Jinsong Zuo et al., 2022) [29]	RFID, along with sensors and embedded systems, supports the development of IoT in the food logistics sector by improving efficiency, security, and quality. While RFID is superior to barcodes, challenges such as cost, reading range, and privacy remain. Chipless RFID is expected to be a more affordable future solution.
26	(Sheshadri Chatterjee et al., 2021) [30]	The adoption of AI in manufacturing is driving operational efficiency and control. Studies suggest developing AI-based user interfaces to improve decision-making and prevent asset loss due to human error.
27	(Jan Chocholac et al., 2021) [31]	This study demonstrates that RFID and drones can efficiently track vehicles in consolidation areas. This system reduces lost goods with a clear and easy-to-understand tracking display.
28	(Salah Elaskari et al., 2021) [32]	The use of barcodes for attendance and asset tracking on campus has proven to be efficient. The system is user-friendly, reduces input errors, and facilitates digital and systematic inventory tracking.
29	(Xiaowei Zhu et al., 2021) [33]	RFID enables accurate inventory tracking, lowers labor costs, and simplifies business processes. Its implementation increases supply chain efficiency and provides a competitive advantage. Despite technical and privacy challenges, technological developments and collaboration between companies will drive adoption and future research potential.
30	(Vincenzo Varriale et al., 2021) [34]	The combined use of RFID, IoT, and blockchain improves visibility, transaction security, and supply chain traceability, resulting in time efficiencies and environmental benefits. Simulations demonstrate the potential for tangible benefits, although implementation costs and environmental impacts require further investigation, particularly for international and multi-actor scenarios.
31	(Kousay Samir et al., 2019) [35]	Real-time tracking in manufacturing is used to develop a Digital Twin. Implementing a real-time UI supports asset monitoring and facilitates data-driven decision-making, reducing the potential for loss.
32	(Mouna Amrou M'hand et al., 2019) [36]	This research proposes a real-time tracking architecture for RoRo terminals using auto-IDs such as barcodes, QR codes, and magnetic cards. This system supports logistics digitalization by improving vehicle monitoring accuracy, reducing queue times, and supporting decision-making through automated data mining.
33	(Y Yannuar et al., 2018) [37]	A web-based internship information system has been developed with features for students, mentors, coordinators, and industry. Blackbox testing demonstrated 100% system functionality, streamlining internship monitoring and reporting, and supporting data management and communication between parties.

No	Paper Identity	Results
34	(Kelly Bronson et al., 2018) [38]	This article examines three key innovations in digital agriculture: Big Data, Precision Agriculture, and Automation. Key findings include the potential of digital technologies to improve agricultural efficiency and adaptation to climate change, as well as social risks such as unequal access, corporate data silos, and impacts on farmers' cultural identities. The authors emphasize the need for an inclusive and ethical approach to agricultural digitalization.
35	(Martin Kirch et al., 2017) [39]	RFID has proven effective in mass reading of vehicle components and pallet tracking. Smart Logistics Zones improve logistics visibility, efficiency, and security.

Based on the data extraction results in Table 1, an analysis of 35 research articles relevant to the topic of digital inventory systems shows that most studies focus on the implementation of automated tracking technologies such as Radio Frequency Identification (RFID), the Internet of Things (IoT), and user interface (UI/UX) development. The analyzed literature dates from 2017–2025 and covers various sectors, including manufacturing, logistics, education, agriculture, and construction. In general, the study results reveal three main findings. First, most studies highlight the limitations of manual inventory systems still widely used by organizations. Manual or spreadsheet-based systems carry the risk of data input errors, delays in information updates, and poor visibility of inventory movements. These conditions increase the potential for lost items and reduce operational efficiency.

Second, numerous studies demonstrate that the implementation of RFID and IoT technologies can improve inventory recording accuracy and support real-time asset tracking. RFID enables each inventory item to have a unique identifier that can be automatically read by the system, while IoT serves as the infrastructure that connects reader devices to digital inventory management systems. The integration of these two technologies enables automatic recording, monitoring of item movements, and more structured inventory data management.

Third, several studies emphasize the importance of user interface (UI/UX) design in the successful implementation of digital inventory systems. Systems designed with a user-centered approach, such as the Design Thinking method, have been shown to improve ease of use, speed up work processes, and reduce human error in inventory management. These findings demonstrate that the success of digital systems is determined not only by tracking technology, but also by the quality of the system design that users experience. In addition, several studies have also identified challenges in implementing digital inventory technology, including relatively high initial investment costs, the need for information technology infrastructure, and organizational resistance to changing from manual to digital systems.

Discussion

The Role of RFID and IoT-Based Digital Systems in Inventory Management

The results of a literature synthesis indicate that the implementation of RFID- and IoT-based digital systems significantly improves inventory management effectiveness. RFID technology enables automatic item identification without requiring physical contact, thereby accelerating the recording process and reducing data input errors. Meanwhile, integration with IoT enables inventory data to be transmitted and processed in real time over a digital network.

Several studies have shown that the implementation of digital tracking technology can improve supply chain visibility, accelerate the distribution process, and reduce the risk of inventory loss. This system also supports data-driven decision-making because information related to the availability and movement of goods can be directly accessed by system managers. Furthermore, developments in digital technology have encouraged integration with other technologies such as blockchain, artificial intelligence (AI), and digital twins. This technological integration expands the function of inventory

systems from mere recording to analytical systems capable of supporting demand prediction, optimizing distribution, and more efficient supply chain management.

The Role of UI/UX in Implementing a Digital Inventory System

In addition to the tracking technology aspect, several studies also highlight the importance of UI/UX design in supporting the successful implementation of digital inventory systems. Systems with intuitive and easy-to-use interfaces have been shown to increase user acceptance and reduce operational errors. User-centered design approaches such as Design Thinking are widely used in the development of modern inventory systems. This method enables system developers to understand user needs more deeply, resulting in simpler, clearer, and more understandable interface designs. Several studies have shown that systems with good UI/UX design can improve user efficiency, speed up the borrowing and return process, and enhance inventory recording accuracy. Thus, UI/UX plays a role not only as a system's visual element but also as a critical factor in the successful implementation of digital systems in organizations.

4. Conclusion

Based on the results of a Systematic Literature Review (SLR) of 35 research articles discussing the application of technology in inventory management, it can be concluded that the use of digital inventory systems based on tracking technology has a positive impact on asset management efficiency. Most studies indicate that the limitations of manual systems remain the main cause of recording errors, low inventory visibility, and an increased risk of lost goods. The results of the literature synthesis indicate that the application of Radio Frequency Identification (RFID) and Internet of Things (IoT) technology can improve data recording accuracy, accelerate inventory monitoring processes, and enable real-time asset tracking. The integration of these two technologies allows for the automation of inventory management processes, from item identification and movement monitoring to recording loan and return transactions in an integrated digital system. In addition to technological aspects, several studies also emphasize the importance of user interface (UI/UX) design in supporting the successful implementation of digital inventory systems. Systems designed with a user-centered approach have been shown to improve ease of use, accelerate work processes, and minimize operational errors. This indicates that the success of a digital inventory system depends not only on tracking technology but also on the quality of the system design used by users.

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