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The role of information systems in the digital transformation of palm oil plantations: a systematic literature review

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ABSTRACT

This study examined the role of information systems in supporting digital transformation in oil palm plantations using a systematic literature review (SLR). Despite the increasing adoption of digital technologies, the strategic integration of information systems in plantation management remains limited. The review was conducted by searching three major scientific databases Scopus, Web of Science, and Google Scholar for articles published between 2020 and 2025. A total of 127 articles were initially identified, of which nine studies were selected based on predefined inclusion and exclusion criteria, including relevance to oil palm plantations, focus on information systems, and methodological rigor. The quality of the selected articles was assessed using a structured evaluation framework to ensure reliability. The results showed that 89% of the reviewed studies reported significant improvements in operational efficiency and data accuracy, while 78% highlighted enhanced decision-making supported by information systems. Web-based and integrated systems were the most commonly implemented technologies, appearing in 67% of the studies, particularly for data integration, monitoring, and reporting. However, 56% of the studies identified human resource limitations and 44% reported system integration issues and organizational resistance as major barriers. The study concluded that information systems serve not only as operational tools but also as strategic enablers of sustainable digital transformation in oil palm plantations, emphasizing the need for integrated systems and strong organizational support.



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Introduction

Digital transformation has become a strategic priority across industries due to its potential to enhance operational efficiency, data integration, and technology-based decision making (Verhoef et al., 2021; Vial, 2021). In the agribusiness sector, particularly in oil palm plantations, digital transformation is increasingly critical because of the complexity of land management, production systems, and supply chains, as well as growing demands for sustainability, traceability, and regulatory compliance (Rijswijk et al., 2021; Purnomo et al., 2020).

Information systems constitute the core infrastructure of digital transformation by enabling data acquisition, process automation, and analytical capabilities for managerial and strategic decision making (Chanias et al., 2021). In oil palm plantations, systems such as enterprise resource planning (ERP), geographic information systems (GIS), Internet of Things (IoT), and data analytics have been shown to improve productivity, optimize resource use, and strengthen supply chain transparency (Wolfert et al., 2022; Kurniawan et al., 2023). These

technologies collectively support the transition from traditional plantation management to data-driven and digitally integrated operations.

However, the digital transformation of oil palm plantations remains uneven and fragmented. Empirical studies consistently report persistent barriers, including limited digital infrastructure in remote plantation areas, insufficient human resource capabilities, weak system interoperability, and organizational resistance to technological change (Aguiar et al., 2021; Pratama et al., 2021). As a result, digital technologies are often adopted in isolated or pilot-scale implementations rather than as part of an integrated digital transformation strategy (Sott et al., 2021).

Although prior research has examined individual technologies or specific applications of information systems in plantation management, the literature remains conceptually fragmented. Most studies focus on technical performance, operational efficiency, or managerial adoption in isolation, without integrating these dimensions into a coherent digital transformation framework (Rijswijk et al., 2021; Nugraha & Setyanto, 2022). More importantly, there is no systematic synthesis that explains how technological factors (e.g., types of systems), organizational factors (e.g., human resources, management support), and environmental factors (e.g., infrastructure, regulation, market pressure) jointly shape the role of information systems in driving digital transformation in oil palm plantations, particularly in developing-country contexts such as Indonesia (Suroso et al., 2021).

To address this gap, this study adopts the Technology–Organization–Environment (TOE) framework as a conceptual lens to systematically analyze the literature on information systems and digital transformation in oil palm plantations. The TOE framework is widely used to explain digital and technological adoption by categorizing influencing factors into technological, organizational, and environmental dimensions, making it well suited for analyzing the multidimensional nature of digital transformation.

Accordingly, this study aims to systematically identify and classify (1) the types of information systems used in oil palm plantation digital transformation (technology dimension), (2) the organizational drivers and constraints influencing their implementation (organization dimension), and (3) the environmental factors shaping their adoption and impact (environment dimension).

Using a Systematic Literature Review (SLR) of studies published between 2020 and 2025, this research also quantifies the reported benefits (e.g., efficiency, data quality, decision support) and challenges across the three TOE dimensions

By providing a structured synthesis based on the TOE framework, this study contributes by clarifying how information systems function as both operational tools and strategic enablers of digital transformation in oil palm plantations. The findings are expected to support researchers and practitioners in designing more integrated, scalable, and sustainable digitalization strategies for the plantation sector (Verhoef et al., 2021; Wolfert et al., 2022).

Method

This study employed a Systematic Literature Review (SLR) to examine the role of information systems in supporting digital transformation in oil palm plantations. The review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure transparency, rigor, and replicability. A comprehensive literature search was conducted across four academic databases: Scopus, Web of Science, Google Scholar, and the Indonesian SINTA portal. The search used combinations of the following keywords in English and Indonesian: information system, digital transformation, oil palm plantation, agribusiness, and digitalization. Boolean operators (AND, OR) were applied to refine the search strings. The initial search produced 25 records after duplicate removal.

The review focused on studies published between 2020 and 2025 to capture the most recent developments in digital transformation, particularly those influenced by Industry 4.0 and post-pandemic digital acceleration. Earlier studies were excluded to ensure that the review reflected current technological and organizational conditions in plantation digitalization.

Articles were selected based on predefined inclusion and exclusion criteria. Studies were included if they (1) examined information systems or digital technologies in oil palm plantations or agribusiness, (2) addressed digital transformation, management, or operational performance, (3) were published in peer-reviewed international journals or SINTA-accredited national journals, and (4) provided empirical or systematic analytical results.

Table 1. Research Journal

Penulis (Tahun)	Judul Artikel	Metode Penelitian	Instrumen Penelitian	Intervention (Penerapan Teknologi)	Hasil
Rahmad et al. (2023)	Pengembangan Sistem Informasi Pertanian Terpadu	Research and Development	Observation, interviews, system testing	Web-based integrated information system	The system improves data integration and agricultural management efficiency.
Maulana et al. (2024)	Implementasi Sistem Informasi Manajemen Produksi Pertanian	Qualitative descriptive	Interviews, documentation	Management information system	Supporting decision-making and production control
Putri & Hakim (2023)	Digitalisasi Pengelolaan Data Pertanian Berbasis Aplikasi	Case study	Observation, questionnaire	Digital agriculture applications	Improving accuracy of recording and reporting
Risawandi et al. (2024)	Sistem Informasi Pengelolaan Perkebunan Kelapa Sawit Berbasis Web Pada Pt. Teboplasma Intilestari Nisam Antara	Rekayasa perangkat lunak	Questionnaire, system testing	Production information system	Work process efficiency and data management improved
Buluaro et al. (2024)	Implementasi Strategi Pengembangan Industri Kelapa Sawit dalam Menghadapi Revolusi 4.0	Deskriptif	Observation, documentation	Agricultural information system	Supporting data-driven agricultural management
Solihin et al. (2024)	Rencana Strategis Transformasi Teknologi Informasi Industri Perkebunan	Deskriptif kualitatif	Interviews, document analysis	IT strategic planning	Improving organizational readiness for digital transformation
Nurul Fikri (2023)	Pengembangan Sistem Informasi Terpadu untuk Agribisnis	Waterfall	System testing, documentation	Agribusiness information system	System integration improves operational effectiveness
Sott et al. (2021) (Internasional)	Digital Transformation in Agribusiness: A Systematic Review	Systematic Literature Review	SLR Protocol	IT-based digital transformation	SI plays a strategic role in the efficiency and sustainability of agribusiness
Rijswijk et al. (2021) (Internasional)	Digitalisation in the Agri-Food Sector	Systematic Literature Review	Literature analysis	Information system-based digitization	Digitalization drives the integration of data-driven processes and decisions

Studies were excluded if they were conceptual papers without empirical or analytical content, not focused on the plantation or agribusiness sector, or not available in full text.

The selection process followed the PRISMA workflow: identification, screening, eligibility, and inclusion. Titles and abstracts were first screened for relevance, followed by full-text assessment of eligible articles. Of the 25 records initially identified (15 from Google Scholar, 4 from Scopus, 3 from Web of Science, and 3 from SINTA), nine studies met all inclusion criteria and were included in the final synthesis.

To ensure the reliability of the evidence, the selected studies were evaluated using a structured quality appraisal checklist adapted from Kitchenham et al. (2020), which assessed: (1) clarity of research objectives, (2) appropriateness of methodology, (3) validity of data collection and analysis, and (4) transparency of results. Only studies meeting minimum quality thresholds were included in the final review.

Data were extracted into a structured table containing authors, year, research methods, types of information systems, key findings, and reported benefits and challenges. The analysis was guided by the Technology–Organization–Environment (TOE) framework, enabling the classification of findings into technological, organizational, and environmental dimensions. A narrative and quantitative synthesis was then conducted to identify dominant system types, reported benefits, and major implementation barriers across the selected studies.

Results and Discussions

This review synthesizes evidence from nine selected studies and organizes the findings using the Technology–Organization–Environment (TOE) framework to provide a structured interpretation of how information systems support digital transformation in oil palm plantations.

Across both national and international studies, information systems were predominantly implemented in the form of web-based management systems, digital monitoring applications, and integrated plantation information systems. Approximately two-thirds of the reviewed studies reported the use of web-based platforms to manage field data, production records, and reporting processes (Rahmad et al., 2023; Risawandi, 2024; Buluaro et al., 2024).

These technologies significantly reduced reliance on manual record-keeping and enabled faster and more structured data flows from plantations to management units. In practical plantation settings, this technological shift improved data accuracy, timeliness, and traceability, which are key prerequisites for digital transformation rather than merely digitization. International studies further emphasize that such systems enable cross-functional integration between production, logistics, and sustainability reporting (Sott et al., 2021; Rijswijk et al., 2021), indicating that information systems form the technological backbone of a digitally transformed plantation.

A clear contrast emerged between national and international studies. National studies were largely application-oriented, focusing on system development, pilot implementation, and usability testing through research-and-development (R&D), case studies, and software engineering methods (Rahmad et al., 2023; Maulana et al., 2024). This reflects the practical needs of Indonesian plantations, where basic digital infrastructure and operational efficiency remain primary challenges.

In contrast, international studies adopted a more strategic and organizational perspective, analyzing how information systems reshape decision-making, service innovation, and sustainability governance in agribusiness (Sott et al., 2021; Rijswijk et al., 2021). This difference can be explained by varying levels of digital maturity: developing countries tend to prioritize operational digitization, while more digitally advanced contexts focus on strategic digital transformation. This aligns with digital maturity theory, which suggests that organizations move from technology adoption to process integration and finally to strategic transformation.

Environmental factors were frequently identified as critical enablers or barriers. Limited digital infrastructure, regulatory complexity, and weak ecosystem support were cited in several national studies as constraints on system integration and scalability (Putri & Hakim, 2023; Solihin et al., 2024). Meanwhile, international studies emphasized external drivers such as sustainability certification, traceability requirements, and market transparency, which push plantations to adopt more integrated information systems (Rijswijk et al., 2021).

This indicates that digital transformation in oil palm plantations is not solely a technological issue but is strongly influenced by policy and market environments, especially increasing global pressure for sustainable palm oil production.

The synthesis shows that information systems consistently improve efficiency, data quality, and transparency, but their transformative impact depends on how well they are embedded within organizational structures and environmental conditions. Where systems are implemented only as technical tools, benefits

remain operational. However, when supported by organizational commitment and external sustainability demands, information systems become strategic enablers of digital transformation.

For policymakers and plantation managers, this implies that investments in technology must be accompanied by human resource development, system integration policies, and regulatory alignment. For researchers, the findings highlight the need for more studies that bridge technical implementation with organizational and environmental dynamics.

Conclusions

This study shows that information systems function not only as tools for operational digitization but as key enablers of digital transformation in oil palm plantations when aligned with organizational and environmental conditions. By synthesizing national and international studies through the TOE framework, this review reveals a structural gap: national research largely emphasizes practical system implementation and efficiency gains, while international studies focus on strategic integration, sustainability, and organizational transformation. This divergence indicates that digital initiatives in developing-country plantations, including Indonesia, are still dominated by early-stage digital maturity, where technology adoption has not yet been fully embedded into strategic and sustainability-driven transformation. However, these findings should be interpreted in light of several limitations, including publication bias, reliance on English- and Indonesian-language literature, and the geographic concentration of many studies in Indonesia. Future research should therefore prioritize longitudinal and comparative studies to examine how information systems influence productivity, sustainability, and governance over time, as well as conduct cross-country analyses among major palm oil-producing nations to assess the role of policy and infrastructure in shaping digital transformation. More quantitative evaluations of the economic and environmental impacts of integrated plantation information systems are also needed to support evidence-based decision making and policy formulation.

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