

Digitization of Subsidized Fertilizer Distribution and Operational Challenges in Serving Aging Farmers: A Systematic Literature Review

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ABSTRACT

Digitalization plays a role as a thing that moves in modern service management. Digitalization is not only used for administrative work needs, but also for the process of restructuring operations, optimizing information circulation, improving data accuracy, and strengthening accountability mechanisms. The purpose of this study is to see how digitalization in agriculture is able to serve elderly farmers in the subsidized fertilizer scenario. This research method uses the systematic literature review method with PRISMA logic. Data was obtained from articles published from 2021-2026 with a total of 17 articles. The results of this study are that the use of technology or digitalization in the agricultural sector has obstacles in its skills for elderly farmers such as low digital literacy and difficulties in accessing technology. This research proposes to build inclusive technology in four dimensions, including system readiness to ensure easy access to digitalization for elderly farmers.

ABSTRAK

Digitalisasi berperan sebagai suatu hal yang terus bergerak dalam manajemen pelayanan modern. Digitalisasi tidak hanya digunakan untuk kebutuhan pekerjaan administratif, tetapi juga untuk proses restrukturisasi operasional, optimalisasi sirkulasi informasi, peningkatan akurasi data, serta penguatan mekanisme akuntabilitas. Tujuan penelitian ini adalah untuk melihat bagaimana digitalisasi di bidang pertanian mampu melayani petani lanjut usia dalam skenario pupuk bersubsidi. Metode penelitian ini menggunakan metode systematic literature review dengan logika PRISMA. Data diperoleh dari artikel-artikel yang diterbitkan pada tahun 2021-2026 dengan total 17 artikel. Hasil penelitian ini menunjukkan bahwa penggunaan teknologi atau digitalisasi di sektor pertanian mengalami kendala dalam hal keterampilan bagi petani lanjut usia, seperti rendahnya literasi digital dan kesulitan dalam mengakses teknologi. Penelitian ini mengusulkan untuk membangun teknologi yang inklusif dalam empat dimensi, termasuk kesiapan sistem guna memastikan kemudahan akses digitalisasi bagi petani lanjut usia.

INTRODUCTION

Digitalization has now developed to be at the core of modern service management. Digital technology is no longer just a tool in supporting administrative work, but has developed into the core of the mechanism for optimizing work processes. Digital technology is also used to accelerate the reception and delivery of information, strengthen data accuracy, and increase accountability. Digitalization is now growing with a wide range of services and public delivery. The success of these services depends on the availability of technology and the organization's ability to integrate resources, coordinate work, and manage how users use the technology (Zaman et al., 2025).

Digitalization at this time is increasingly relevant to daily activities, including in the agricultural sector, where digitalization is used to ensure how the effectiveness of distribution runs smoothly in terms of timeliness, availability of inputs, quality of information, and effectiveness (Lestari & Magfiroh, 2025). In order for agricultural activities to run smoothly and remain productive, farmers need unlimited access to seeds, fertilizers, market information, and other supporting services (Mishra et al., 2024). Management issues as the digitalization of agricultural services are carried out are now not limited to internal efficiency but also include user readiness, implementation capacity in the field, and inclusivity of service access.

Fertilizer is a form of agricultural services that has strategic value in the distribution of production inputs (Penuelas et al., 2023). One of the programs provided by the government is subsidized fertilizer which is defined as fertilizer whose procurement and distribution receive subsidies from the government to meet the needs of farmers (Yuwono & Munajad, 2024). The process of distributing subsidized fertilizers has now become increasingly complicated because of the involvement in determining recipients, setting quotas, validating data, exchanging at kiosks, and supervising so that the journey of subsidized fertilizers can be in accordance with the target. Digitalization in subsidized fertilizer distribution not only moves manual procedures into applications, but also changes the way service organizations identify recipients, verify transactions, coordinate distribution actors, and ensure the availability of fertilizers at a time that suits the needs of the growing season (Hermawan et al., 2025).

The object of the study of subsidized fertilizer distribution was chosen because the system is at the intersection of public services, operational management, digital technology, and user behavior. Unlike commercial digital services that allow users to choose alternative services, the distribution of subsidized fertilizers is more binding for beneficiary farmers. Farmers who need a subsidy price must follow a predetermined service mechanism, including digital procedures used in data collection and redemption processes (Lazuardi et al., 2024). As a result, service failures not only impact low user satisfaction, but can also create barriers to access for the neediest groups of farmers. This condition makes the distribution of subsidized fertilizers an important object in applied management studies, especially related to service effectiveness, process design, inter-sector coordination, and the ability of digital systems to serve diverse users.

A number of previous studies have discussed the adoption of agricultural technology, the benefits of digital agriculture, the adoption of technology by farmers, and the barriers that

smallholders face in leveraging digital services. The literature on subsidized fertilizers in Indonesia also highlights the implementation of farmer cards, target accuracy, farmer satisfaction, and distribution effectiveness (Hatta et al., 2022; Hendrita et al., 2024; Marhaeni & Ratih, 2024). This study shows that digitalization can improve the efficiency of medication distribution and increase transparency, accuracy, and efficiency. Websites such as i-Pubers, farmer cards, tracking systems, and GIS provide valuable tools for data analysis and decision-making. Those involved in the agricultural sector, especially older farmers, may fail due to limited education, labour market constraints, and others. The findings show that a network should have a mission readiness, organizational flexibility, capacity building of partners and partner organizations, and strategic planning. These four components are crucial. The efforts of policymakers and agricultural service providers must be coordinated to ensure the distribution of subsidized fertilizer fosters efficient, equitable, and sustainable development.

This paper proposes a new approach that offers a methodical, thorough analysis of the digitalization of subsidized fertilizer distribution offering and operational perspective of comprehensive digital services. The uniqueness of this research is the effort to bring the digitalization of distribution, operational issues and service accessibility issue for aged farmers under one application management frame. Based on the above background, the objective of this research is to identify the distribution pattern of subsidized fertilizers, explain the operational difficulties, analyze the impact on the older farming community, and provide measures to improve service management in agricultural technology in Indonesia.

Digitalization of Distribution

The digitalization of distribution from a managerial viewpoint can serve two purposes, one being the use of devices and the other being the transformation of services which connects the actors as well as the data, procedure and operation decision (Aghahadi et al., 2024). Digital transformation is not merely an electronic transfer of manual tasks that is effective change that aims to impact how organizations create value, manage processes, and make informed decision. Favoretto et al. (2022) show that digital transformation in business and management research is developing as a strategic issue related to changes in processes, organizations, and service models, while Nazara et al. (2024) affirm that digital technology in operations management is changing decision-making patterns and configuration of operational processes.

Subsidized Fertilizer Distribution

Subsidized fertilizer distribution is a complex service operating system because it involves the government, producers, distributors, official kiosks, extension workers, farmer groups, transaction providers, and farmers as end users. The effectiveness of subsidized fertilizer distribution is generally assessed through the principle of six precise, namely right price, right quantity, right time, right place, right quality, and right type. Marhaeni & Ratih (2024) explained that the distribution of subsidized fertilizers must meet these six principles, both in distribution using farmer cards and without farmer cards, while Isyanto (2024) also emphasized that the subsidized fertilizer distribution policy is directed so that distribution can achieve the principles

of right quantity, right type, right price, right place, time, and right quality. This principle shows that subsidized fertilizers are not only agricultural commodities, but also production input distribution services that require process reliability, data synchronization, stock availability, clarity of redemption procedures, as well as quick response when there is a disruption at the point of service.

Inclusive Digital Service Operations

Inclusive digital service operations can be understood as a digital services management framework that emphasizes that the success of digital transformation is not only determined by technological readiness, but also by the ability of service processes to accommodate the diversity of users, especially groups at risk of digital exclusion. Several factors can affect how farmers adopt digital technology, such as age, education, experience in using technology, access to infrastructure, and social support. Akudugu et al. (2023) shows that the factors that influence the adoption of technology in farmers are education, experience in farming and access to resources, while Bontsa et al. (2023) stating that the age of farmers is an important factor in the adoption of technology because farmers with older age tend to take longer to master digital skills.

Research Framework



Figure 1. Research Framework

RESEARCH METHODS

This study uses the Systematic Literature Review (SLR) method with reference to the logic of PRISMA (Optional Reporting Item Protocol for Systematic Review). This method was chosen in accordance with the research objectives, which are to map, assess, and synthesize knowledge about digitalization in the distribution of subsidized fertilizers and its operational challenges for farmers with the elderly. Article eligibility criteria are determined based on the following PICOTS framework.

Table 1. PICOTS Framework

Framework	Description
Population	Regional farmers are especially elderly farmers and other actors involved in the distribution of subsidized fertilizers
Intervention	Digitalization in the distribution of subsidized fertilizers (e-RDKK, farmer cards, farmer databases, and others)

Comparator	Studies that compare manual and digital distribution systems, the use of different platforms, or the delivery of different services
Outcomes	Operational outcomes include distribution effectiveness, timeliness, transaction reliability, accessibility, and digital literacy barriers
Timing	Studies published between 2021-2026
Study Design	Qualitative, quantitative, mixed, empirical, case study, bibliometric, and other studies relevant to the research theme

The inclusion criteria in this study are articles written in Indonesian or English, can be downloaded in full text, relevant to the research theme, and published in the 2021-2026 period. Articles used as literature reviews are not limited to specific methods. However, articles from other countries can still be used when discussing the digitalization of agricultural services, agricultural supply chains, technology adoption, digital divides, or services to elderly farmers that can enrich conceptual synthesis.

Articles that do not meet the inclusion criteria are excluded from the analysis process. The selection criteria for exclusion included papers for which the full text was not available, and papers which were not directly concerned with fertilizer distribution, agricultural input subsidy, digitalization of agricultural services and technology adoption by farmers. Research articles on agriculture, seed breeding, fertilizer production and laboratory testing that were not about distribution and management activities were also excluded. Supplementary materials in the analysis may comprise of legal or organizational documents. However, the document must not be the reference document.

The information covered in this reviewed was extracted from databases and research sites such as Google Scholar, CrossRef, OpenAlex, and Semantic Scholar. A search strategy literature was made by using Indonesian and English keywords. Through the use of Indonesian keywords, the literature on subsidized fertilizers in Indonesia was successfully obtained, while through the use of English keywords, papers on various topics were successfully obtained including digitalization, distribution management, agricultural supply chains, technology adoption, and others. Boolean operators like AND and OR were utilized to further enhance search results and filter the paper material most relevant to the main topics.

The selection of papers was done in three stages Documents in each database were organized and filtered according to the keywords. The second stage was an initial screening phase, where titles and abstracts were reviewed to determine relevance to the research topics. The first database did not include papers that did not touch upon the areas of digitalization, fertilizer distribution, agricultural production, introduction of new technology and operational challenges in agriculture. In the third step, these 40 papers were assessed in full text to determine their substantial contribution to the research questions.

The researcher used forms constructed in Microsoft Excel for data extraction. Information collected entailed the authors' name, year of publication, title of the article, journal source,

country/region of study, objectives of research, methods used in the article, types of marketing mentioned, value chain stakeholders, operational challenges, farm yields, and taxpayers. Furthermore, the papers were categorized into major topics: allocation efficiency of resources, efficiency of distribution of subsidized pesticides, the technology used for farming, digital technology, efficiency of supply chain, quality of data, and risk of marginalization of aging farmers. It helped in validating the data and to discuss the themes.

Analysis of the data was done using thematic and content analysis method. This method was used to analyze the patterns, relationships, and research findings present in the selected papers. The main themes that emerged from the extraction results were categorized into four categories that digitalization of care delivery, service barriers, provider characteristics, user barriers, and relevant service design. Meta-analysis was not performed because the methods, subjects, and outcomes of the research papers were heterogeneous.

RESULTS AND DISCUSSION

Article Search & Selection

Based on the initial search before the process of filtering titles, abstracts, duplicates, and full text, 47 articles were obtained from Google Scholar, CrossRef, OpenAlex, and Semantic Scholar. All of these articles were then selected based on the inclusion and exclusion criteria that had been set.

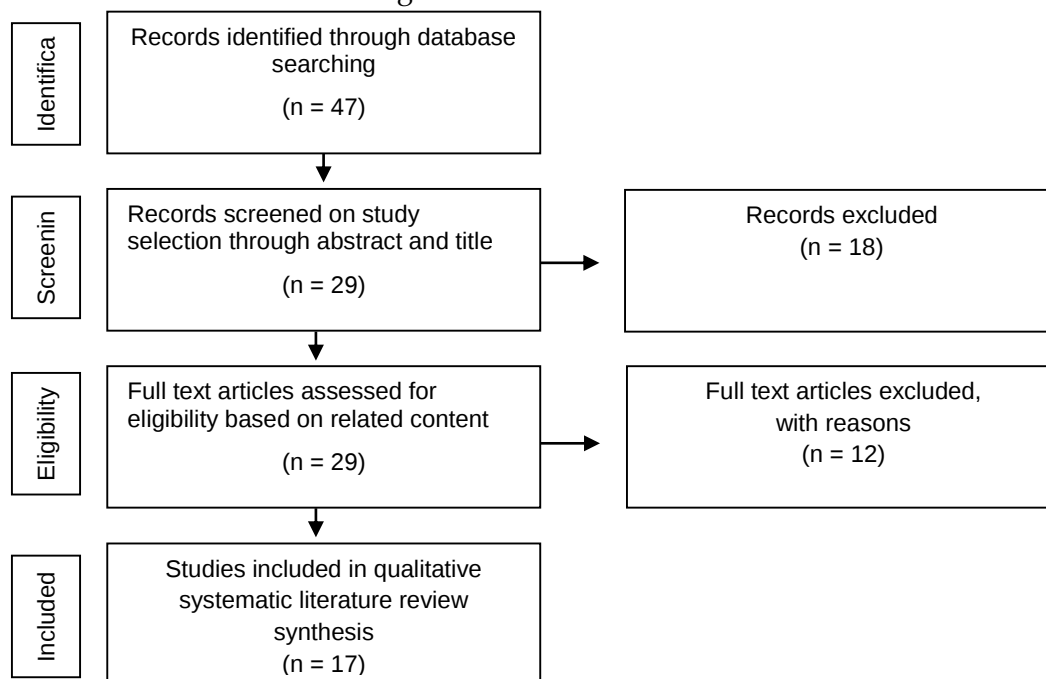
Table 2. Article Search Query

Article Source	Query	Articles Obtained
Google Scholar	"pupuk bersubsidi" AND "digitalisasi" AND "distribusi"	12
CrossRef	"subsidized fertilizer distribution" AND "digitalization"	22
OpenAlex	"subsidized fertilizer distribution" AND "digitalization"	6
Semantic Scholar	"subsidized fertilizer distribution" AND "digitalization"	1
Google Scholar	"subsidized fertilizer distribution" AND "digitalization"	6
Articles Total		47

Source: Processed Data (2026)

Furthermore, the article was selected based on the suitability of the title and abstract with the focus of the research, namely the digitization of subsidized fertilizer distribution, operational challenges, the adoption of agricultural technology, digital literacy of farmers, and access to services for elderly farmers.

Figure 2. Article Selection



Based on the initial screening process, a total of 18 articles were issued because they were not directly relevant to the focus of the study, discussed technical aspects of agronomy that were not related to distribution or digital services, or were not in accordance with the context of service management and distribution operations. Thus, as many as 29 articles were continued to the full text feasibility assessment stage. At the eligibility stage, as many as 29 full-text articles were assessed in more depth based on the suitability of the content, the clarity of the method, the relevance of the findings, and their contribution to the discussion of the digitalization of subsidized fertilizer distribution and inclusive digital service operations. From this stage, 12 articles were issued because they did not meet the eligibility criteria, such as discussions that were too general, did not adequately explain digitalization or operational aspects, did not provide clear methodological information, or only discussed fertilizer policies without any connection with distribution services and farmers' experiences. After the entire selection process was carried out, a total of 17 articles were determined as final articles to be used in the synthesis of systematic literature review. The articles were then analyzed qualitatively descriptively with a thematic synthesis approach to identify patterns of findings, operational challenges, digital exclusion risks, and agendas to improve subsidized fertilizer distribution services for elderly farmers.

List and Synthesis of Articles

Based on the results of the final selection, there are 17 articles that are considered relevant to the topic of digitizing the distribution of subsidized fertilizers. The articles are then synthesized by author and year, research focus, research approach, and key results that contribute to the mapping of the findings of this systematic literature review.

Table 3. Synthesis of Articles

No.	Author and Year	Research Focus	Research Approaches	Results
1	Apriadi et al. (2026)	The Impact of introducing i-Pubers on fertilizer distribution	Descriptive qualitative	i-Pubers enables them to improve the accuracy of reviews, annotations, and monitoring, but their performance is limited by data validation, internet connection, system errors, and limited internet knowledge.
2	Zulhayyir & Nurlia (2025)	Implementation of subsidized fertilizer distribution through Farmer Card	Qualitative	Farmer Cards enhance secure and data-driven distribution, but they face challenges such as lack of awareness among farmers, uneven card distribution, and technical problems.
3	Pambudi (2025)	Strategies to prevent distribution abuse	Mixed methods	Subsidized fertilizer distribution suffers from selection bias, bias, and fragmentation, so changes in governance and oversight are essential.
4	Sulis et al. (2024)	Innovation communication in i-Pubers implementation	Qualitative innovation study /	User acceptance is essential for implementation, and success depends on service quality, ease of use, and responsiveness of farmers.
5	Pratiwi et al. (2022)	Digitalization of agriculture through Kostratani program	Case study	Kostratani strengthens agricultural systems, supports agricultural leadership, and promotes the use of information technology.
6	Hidayat et al. (2024)	Local government supervision in addressing fertilizer shortage	Qualitative	Performance testing should be enhanced through monitoring, standardization, performance appraisal, and leadership.
7	Marcelly et al. (2025)	Evaluation of fertilizer subsidy policy in Padang	Descriptive evaluative	Administrative and technical obstacles still affect the effectiveness of distribution and its impact on farmer productivity and welfare.
8	Wahyudi et al. (2021)	Implementation and challenges of farmer card usage in Ciamis & Pati	Descriptive evaluative	Farmer cards can improve distribution efficiency, but operational issues, user understanding, institutional readiness, and technical problems still remain.
9	Arodha (2024)	Optimal strategy for subsidized fertilizer distribution to farmer groups	Case study	To optimize distribution, network expansion, data integration, improved coordination, and accurate allocation to farmers' organizations are necessary.
10	Suprianto	Effectiveness of	Quantitative	Distribution efficiency depends on

No.	Author and Year	Research Focus	Research Approaches	Results
	(2022)	distribution from distributors to farmers	evaluative	the smoothness of the supply chain, the accuracy of targeting, and the role of kiosks as intermediaries.
11	Lazuardi et al. (2024)	Use of farmer cards in Pasuruan subsidized fertilizer distribution	Descriptive	Farmer cards are a key means of controlling distribution, and this is influenced by the farmer's quota, readiness, and accessibility.
12	Mulupi et al. (2021)	Utilization of subsidized fertilizer and determinants for smallholder farmers in Kenya	Cross-sectional survey	Utilization is influenced by socioeconomic characteristics, program accessibility, and farmer capacity, and accessibility is very important.
13	Kurniawan et al. (2021)	Design of a government-subsidized fertilizer supply chain tracking system	System design research	Web-based tracking systems help farmers access information and improve the efficiency and effectiveness of the supply chain.
14	Setiawan et al. (2021)	Design of a subsidized fertilizer inventory forecasting system	System development research	Safety stock-based forecasting systems assist with distribution records, purchasing planning, and management reporting.
15	Fakiki et al. (2025)	Web-based classification of organic subsidized fertilizer stock allocation	System development / classification model	Naive Bayes classification supports objective, transparent, and efficient classification compared to manual procedures.
16	Ngugi Kiema & (2024)	Use of GIS to improve the efficiency and management of fertilizer distribution.	Spatial analysis / GIS	GIS improves transparency, accountability, logistical efficiency, and farmer access through mapping and dashboards.
17	Yulinchton et al. (2025)	PT Pupuk Indonesia's subsidized fertilizer sales forecast	Quantitative	The weighted average method provides excellent forecasting capabilities, which helps in distribution decision-making and supply management.

The table shows that the literature on subsidized fertilizers focuses not only on the effectiveness of regulation but also on the digitalization of resource distribution, governance reform, technological advancement, enhanced collaboration among stakeholders, and enhanced decision-making capabilities. The majority of the 17 papers discuss data from Indonesia, while several papers from Kenya focus on the concepts associated with charitable giving, efficiency, and good governance. Overall, the review of the literature shows that digitalization contributes to increasing transparency and data security in the supply chain, while at the same time creating new risks at the institutional level and at the consumer level.

Pattern of Digitization of Subsidized Fertilizer Distribution

Comparing the survey results, it becomes evident that although subsidized fertilizer distribution is being implemented in various forms, the pattern of implementation is not uniform. At the operational level, digitalization is enabled through transaction and management applications such as i-Pubers and farmer cards, which facilitate the documentation of supply chains, confirmation of suppliers, and increased supply chain efficiency (Apriadi et al., 2026; Sulis et al., 2024; Zulhayyir & Nurlia, 2025). Furthermore, digitalization is transforming agricultural data and institutional support systems, and Kosratani's program highlights the role of information technology in agricultural data management and operations (Pratiwi et al., 2022).

According to other literature, digitalization is rapidly transforming into a data-driven distribution system. The development of input tracking systems, stock assessment systems, fertilizer distribution systems, and GIS-based mapping systems is establishing subsidized fertilizer management systems as practical systems based on accurate data, distribution planning, and monitoring of fertilizer distribution (Fakiki et al., 2025; Kurniawan et al., 2021; Ngugi & Kiema, 2024; Setiawan et al., 2021). Therefore, the digitalization model presented in these 17 papers represents a shift from an administrative initiative to a diffusion that is gradually measured, documented, and monitored.

However, in the reviewed literature, digitalization has not always been presented at a rapid and transformative level. Digital tools are still only used as tools to optimize traditional workflows and do not transform business processes by improving user experience. This is evident in papers that focus on challenges to implementation, "best" or "best" outcomes, and the need for collaboration between governments, private sector, and private sector (Apriadi et al., 2026; Marcelly et al., 2025; Wahyudi et al., 2021). This highlights the importance of understanding the digitization of subsidized fertilizer distribution not as a last resort and the best solution so far, but as a means of transitioning to new distribution channels.

Operational Challenges in Digital System Implementation

A key take-away from this project is the frequent occurrence of technical glitches when automated machines dispense cash-based fertilizers. According to the findings of Apriadi et al. (2026) several things hamper the performance of the system. These include a mismatch of NIK, schedule, and limited internet connectivity. A study on farmer cards showed similar results which was inadequately implemented due to lack of knowledge of farmers, uneven distribution of cards, and technical difficulties (Zulhayyir & Nurlia, 2025). While digitalization strengthens the government, it also adds layers to the government and relies on incomplete information.

Tackling data management and distribution control issues remains a technical challenge as well. According to Pambudi (2025), cash-based fertilizer management system is susceptible to poor management problems such as misallocation of the resource, change of beneficiary, and misuse of the resource. The research highlights that digitalization has a limited capacity to address structural or long-term problems. But it can work if the initiative has data transparency, an implementation mechanism and long-term monitoring. The internal report identified the difficulties faced by fertilizer suppliers in reaching the last-mile dealers, which creates a disparity

in fertilizer distribution. Arodha (2024) mentions that the issue cannot be solved through technical solutions alone. Distribution mechanisms are required to address problems of logistics, disinformation, and resource constraints.

Poor social connection causes a lack of employment opportunities for many people. For climate change to have a positive impact on environmental pollution, Setiawan et al. (2021) and Yulinchton et al. (2025) argue that environmental protection efforts must be undertaken. Fakiki et al. (2025) suggest that web-based classification models can enhance distribution processes which are generally passive and subjective. The results seem to indicate that one of the principal operational problems in the subsidized fertilizer distribution is decision quality. Consequently, the digital transformation relevant for the distribution of subsidized fertilizers is through digitalization not only of transactions but also of management processes behind it.

Service Accessibility, Digital Literacy, and User Exclusion Risk

Although not all studies can specifically refer to elderly farmers as a sample, the literature review carried out reveals a recurring pattern that notes how user competence significantly alters the accessibility of the digital system. The low level of understanding of farmers regarding agricultural cards and digital procedures that hinder the implementation of the system (Wahyudi et al., 2021; Zulhayyir & Nurlia, 2025). The research conducted by Apriadi et al. (2026) in a study focused on i-Pubers mentions that low digital literacy makes the system efficiency not optimal. The phenomenon described in the preceding section is pertinent to this article. Elderly farmers may be quite likely to face difficulties using app-based mechanisms, electronic verification, or increasingly digitized usage instructions.

Depending on the characteristics of the subsidised fertilizer distribution system, employee burnout may lead to resignation. The findings of Mulupi et al. (2021) show that subsidised use of fertilizer varies depending on which sociodemographic characteristics and program accessibility. This means the availability of fertilizers or subsidy policies alone do not determine effectiveness, rather what determines effectiveness is farmer ability to access the subsidy. Older farmers face an increasingly serious issue as a gap in access to healthcare services may exist between the people who require them and access to the services. This gap is made even wider with age, education level, work experience, and the accessibility of information and communication technologies.

The study on Kostratani shows that extension workers and agricultural service institutions have an important function in assisting farmers and strengthening data-based services (Pratiwi et al., 2022). Similarly, articles on farmer cards and i-Pubers indicate that the success of the implementation of digital systems is greatly influenced by the quality of socialization, kiosk support, and assistance to farmers (Apriadi et al., 2026; Wahyudi et al., 2021; Zulhayyir & Nurlia, 2025). Thus, the discussion on the digitalization of subsidized fertilizer distribution needs to shift from simply "whether the digital system is implemented" to "whether the system is inclusive enough for users with different capacities, including elderly farmers".

Governance, Supervision, and Coordination Between Distribution Actors

The synthesized literature also confirms that the distribution of subsidized fertilizers is a multi-actor governance issue. The government, producers, distributors, kiosks, farmer groups, and farmers are in one interconnected service chain. Therefore, problems at one point will have an impact on another. Pambudi (2025) show that one of the root problems of subsidized fertilizer distribution lies in long-standing systemic maladministration. Hidayat et al. (2024) pointed out that fertilizer shortages should be prevented by strengthening local governments through soft laws and stringent policies. These two studies show that if digitalization takes place without management and governance, the process will only be digitized and will not result in a more effective and efficient process.

From an operational perspective, coordination between actors also emerged as an important element. Arodha (2024) emphasized the need for supply chain mechanisms to improve supply chain efficiency, improve information, and collaborate with farmers' organizations. The tracking method developed by Kurniawan et al. (2021) showed that allocation decisions can be optimized by using information from crop dispersal systems. Ngugi & Kiema (2024) showed that building a dashboard representing the location of farmers using GIS can improve the efficiency of fertilizer distribution and increase transparency and accountability. The results of this research show that knowledge management systems are essential for effective project management, and that all stakeholders should be able to collaborate based on the data collected rather than relying on guesses or handwritten reports.

At the same time, the discussion of governance cannot be separated from the aspect of the accuracy of the targets. Suprianto (2022) points out that efficient distribution still depends on the efficient movement of products from distributors to farmers. Meanwhile, Marcelly et al. (2025) show that technical and administrative constraints can affect the effectiveness of subsidized fertilizer policies on efficacy and safety. Therefore, effective governance of subsidized fertilizer distribution is not only a matter of allocating resources but also how stakeholders collaborate, ensure data integrity, and support users.

Supply Efficiency and Data-Driven Decision-Making

One of the important contributions of the selected articles is the affirmation that the distribution of subsidized fertilizers requires a stronger managerial approach to the planning and supply control aspects. Setiawan et al. (2021) showed that a safety stock-based stock prediction system is able to help record distribution, fertilizer procurement, and managerial reports. Yulinchton et al. (2025) also proved that the Weighted Moving Average forecasting method can be used to predict subsidized fertilizer sales with good predictive capabilities. These two studies emphasize that the success of subsidized fertilizer distribution is not sufficiently supported by distribution policies alone, but also by the quality of forecasting and inventory control.

Furthermore, efforts to improve distribution decisions are also seen in the article Fakiki et al. (2025), which developed a more objective and transparent classification system for the allocation of subsidized organic fertilizer stocks. In a different but interconnected discussion, Kurniawan et al. (2021) through the traceability system showed that the efficiency of the supply

chain is greatly influenced by the system's ability to provide information needed by farmers and distribution actors. When these four articles are read together, it appears that the digitization of subsidized fertilizer distribution is actually moving towards a more analytics-based management model. This is an important development, because fertilizer distribution challenges have often been caused by imprecise supply decisions, limited stock visibility, and weak synchronization between needs and distribution realization.

Inclusive Digital Service Operations in Subsidized Fertilizer Distribution

Taken together, it is seen that the literature on subsidized fertilisers points to one key message: the digitalisation of distribution does promise improvements, but its success is largely determined by the system's ability to remain inclusive. On the one hand, i-Pubers, farmer cards, traceability systems, GIS, stock prediction models, and allocation classification show that technology can improve the accountability, efficiency, and visibility of distribution (Apriadi et al., 2026; Kurniawan et al., 2021; Ngugi & Kiema, 2024; Setiawan et al., 2021). Meanwhile, according to the literature review, data quality, technological know-how, technical difficulties, and inadequate support can hinder the effectiveness of these technologies (Marcelly et al., 2025; Pambudi, 2025; Zulhayyir & Nurlia, 2025).

Based on this theory, this paper explains the distribution process of subsidized fertilizers from a supply chain management perspective. In other words, the performance of a mobile platform should not be measured solely by the quality of the digital tools, but rather evaluated based on its ability to effectively and efficiently support diverse users. To achieve this, four key elements are important. First, the availability of mobile devices, including data quality, efficiency, and organizational participation. Second, the readiness of field operations, including the operational capabilities of the supply chain, inventory management, kiosks, and distributors. Third, the capabilities of users and partners, including awareness regarding farmers, farm managers, farmer organizations, and kiosk operations. Fourth, universal responsibility to provide environmentally friendly solutions without burdening vulnerable groups, particularly large-scale farms.

CONCLUSION

The fertilizer distribution efficiency can be improved through digitalization according to the results of the study. A number of websites like i-Pubers, farmer cards, tracking systems, and GIS can be used for analysis. Nevertheless, success cannot be assured through digital transformation alone. Causes of farm failure, particularly among older farmers, can be due to lack of education, limited labor market and other market constraints. The research results reveal the relevance of networks with four necessary elements such as mission readiness, organizational flexibility, capacity building for partners, and work plan. Efforts must be converged by policymakers and agricultural service providers so that the distribution of subsidized pesticides fosters efficient, equitable and sustainable agricultural development.

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