

EFFECTS OF TECHNOLOGY ADOPTION, E-COMMERCE, AND PROCESS EFFICIENCY ON AGRIBUSINESS SUPPLY CHAIN PERFORMANCE

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ABSTRACT

Digital transformation in the agricultural sector has become an essential driver of agribusiness supply chain improvement, particularly in regions facing structural productivity challenges such as West Java. This study specifically aims to examine how agricultural technology adoption, e-commerce utilization, and process efficiency influence agribusiness supply chain performance, while explicitly identifying the extent to which digital-based practices strengthen operational integration among agribusiness actors. Unlike previous studies that focus only on one or two aspects of digitalization, this research offers novelty by simultaneously analyzing three key digital transformation dimensions and empirically testing their combined contribution to agribusiness supply chain performance in a developing-country context. Using a quantitative survey approach involving 120 agribusiness respondents selected through purposive sampling, the study employs multiple linear regression to validate the proposed model. The findings show that technology adoption significantly enhances productivity and accuracy in land and resource management; e-commerce utilization expands market reach and improves transaction efficiency; and process efficiency accelerates product flow within the supply chain. All classical assumption tests confirm the model's validity and reliability. This research contributes new empirical evidence on how integrated digital transformation initiatives strengthen agribusiness supply chain performance, offering practical insights for policymakers, agro-entrepreneurs, and digital agriculture developers.

Keywords: Agricultural technology adoption; E-Commerce; Process efficiency; Supply chain performance

INTRODUCTION

The growth of Indonesia's agribusiness sector is now faced with a variety of complex and cross-cutting challenges. One of the primary issues is suboptimal supply chain efficiency where the supply chain process from farmer to end consumer is time-consuming, costly, and beset with high post-harvest losses. Besides, limited access to modern technology is a key constraint for farmers and agribusiness players in terms of improving productivity and competitiveness (Aulia *et al.*, 2024). Most of these small and medium-sized enterprises (SMEs) continue to rely on cumbersome, and less efficient methods that are sensitive to changes in the environment. In addition, high market volatility, in input prices and the demand for products, also makes incomes unpredictable in agribusiness. With these issues in consideration, the performance of



the agribusiness supply chain is a priority not only to strengthen national food security but also to increase production efficiency, business viability, and eventually, the well-being of farmers, the leading vanguard of the agribusiness system (Syahputra *et al.*, 2023; Aulia *et al.*, 2023a).

The digital transformation presents potential solutions to some of the conventional problems which have been holding back the agribusiness sector's development, such as low levels of productivity, resource wastage, and limited availability of information (Junaidi *et al.*, 2022). Among these is the purchase of modern agricultural technology, such as the installation of soil sensors capable of measuring moisture and nutrient levels in real time, drones for efficient monitoring of fields, and automated irrigation systems that may regulate the delivery of water according to the demand of the crops (Kushariyadi *et al.*, 2024b). Such technology not only improves decision-making accuracy in the field but also renders land utilization cheaper and more sustainable. These innovations make production processes more precise, faster, and responsive to changing environmental conditions such as intense weather or pest infestation, greatly improving efficiency, crop quality, and the competitiveness of agribusiness products in domestic and global markets (Zulham *et al.*, 2022). For this reason, digitalization of agriculture is an important pillar in building a modern, responsive, and information-based agribusiness system (Aulia *et al.*, 2023a).

Furthermore, using e-commerce offers far broader and more efficient marketing channels to small, medium, and large agribusinesses. With internet-based sites, farmers and businesses are no longer exclusively dependent on conventional distribution channels, which are often time- and profit-margin-costly (Nasution, 2023). With e-commerce, they are able to supply products directly to final consumers domestically and regionally, thereby reducing on distribution costs and increasing product value sold. Its other benefits include price transparency and simplified transaction processes, from payment and purchase order to tracing shipments (Kushariyadi *et al.*, 2024a). In addition to increasing market access, e-commerce enables agribusiness firms to create brands, foster closer customer relationships, and adapt product offerings more effectively in response to market needs (Melinda *et al.*, 2024). Thus, e-commerce digital marketing is a key driver of agribusiness supply chain upgrading (Sukmaya & Jakiyah, 2021).

The second most important factor to improve agribusiness performance is operational process efficiency, including all stages, right from harvesting and storage to packaging, in a bid to get the product to the end-customer. Every stage of the value chain has the ability to generate waste or delays unless well managed (Daina *et al.*, 2024). Therefore, process improvements through standardized procedures, the use of automation technology, and the implementation of appropriate logistics management can significantly reduce operational costs, minimize crop damage or loss, and accelerate delivery times (Sudirjo *et al.*, 2023). Process efficiency is also closely linked to customer satisfaction, as products are received in better condition and in a shorter timeframe. In the context of increasingly open competition, especially in the global market, an efficient supply chain is a strategic advantage that enables Indonesian agribusiness products to compete in terms of quality, timeliness, and price (Sulandjari *et al.*, 2022).

However, to date, there has been little research that comprehensively examines the combined influence of agricultural technology adoption, e-commerce utilization, and process efficiency on agribusiness supply chain performance in Indonesia. Most previous studies tend to discuss each variable separately, without considering the interaction and simultaneous contribution of all three in forming a resilient and adaptive supply chain system (Hendy *et al.*, 2020). For example, previous studies emphasized the role of e-commerce in increasing market access for horticultural products, while others focused on the impact of agricultural technology adoption on land productivity. Meanwhile, previous studies discussed the influence of logistics process efficiency on food supply security but did not directly link it to technology integration and marketing

digitalization (Madyatmadja *et al.*, 2020). Therefore, there is still considerable research potential to examine these three variables simultaneously within a single analytical model to provide a more comprehensive picture of the determinants of agribusiness supply chain success in the era of digital transformation (Ishlah *et al.*, 2025).

While several studies have separately examined the impact of technology, e-commerce, or efficiency on the agribusiness sector, few have examined all three simultaneously and in an integrated manner within the context of agribusiness supply chain performance, particularly in Indonesia (Novessro *et al.*, 2025; Syahputra *et al.*, 2023; Junaidi *et al.*, 2022; Zulham *et al.*, 2022). Most previous studies have also not considered process efficiency as a stand-alone variable in their analysis, despite its crucial role in ensuring the sustainability of supply and competitiveness of agribusiness products. Furthermore, there is no empirical approach that integrates the perspectives of digitalization and supply chain management within a quantitative model based on field data. The novelty of this study lies in its simultaneous examination of technology adoption, e-commerce use, and process efficiency within a single empirical model an approach that has not been conducted in Indonesian agribusiness supply chain research or previous study, while previous study discussed partially effect of each variable toward supply chain performance. Another novelty is we discuss the model in the context of agribusiness in Indonesia.

Based on this, this study aims to: (1) analyze the influence of agricultural technology adoption on agribusiness supply chain performance; (2) analyze the influence of e-commerce utilization on agribusiness supply chain performance; and (3) analyze the influence of process efficiency on agribusiness supply chain performance. The main contribution of this study is to provide empirical evidence on how the combination of technology adoption, marketing digitalization, and operational process improvement can drive improved agribusiness supply chain performance, which can serve as a strategic reference for policymakers, business actors, and advanced researchers in designing a more resilient and adaptive agribusiness system in the era of digital transformation.

METHOD

Data collection in this study followed a structured and clearly defined procedure to ensure the credibility and accuracy of the information gathered from agribusiness actors in West Java. The research employed a quantitative survey method using a validated online questionnaire developed based on indicators adapted from prior empirical studies relevant to digital agriculture, supply chain performance, and technology adoption. Before full distribution, the questionnaire underwent expert judgment by two agribusiness academics and one industry practitioner to ensure clarity, content validity, and contextual relevance. Data were collected from January to March 2025, during which the questionnaire was disseminated through multiple controlled channels, including farmer groups, agribusiness cooperatives, digital agricultural forums, and professional WhatsApp communities associated with agricultural extension officers. These platforms were selected to ensure that respondents were genuinely involved in agribusiness operational activities.

To avoid duplicate responses and enhance reliability, each participant was required to log in using a verified email address, and screening questions were included at the beginning of the instrument to confirm eligibility based on criteria such as type of agribusiness, operational experience, and involvement in supply chain activities. The timing of data collection was intentionally aligned with planting and harvesting cycles in West Java so that respondents could provide accurate information reflective of ongoing operational conditions. Of the total responses received, only 120 completed questionnaires that met all eligibility and completeness criteria were included in the final analysis. This multi-stage approach strengthens data credibility and ensures that the dataset properly represents the target population.

Population and Sampling

The population in this study were West Java agribusiness actors, that is, farmers, farm managers, and distributors/marketing actors of agricultural products. The sample in this case consisted of 120 respondents who were selected using a purposive sampling technique. This technique was used to ensure that respondents were indeed relevant to the research objective. The respondent selection criteria were: (1) a minimum of two years of experience in running an agribusiness, and (2) the use of agricultural technology or electronic means such as e-commerce, automated irrigation systems, land monitoring software, or distribution management systems in daily operations. The selection of the above criteria was an attempt to obtain valid and representative information from agribusiness players who had implemented a digital strategy in supply chain operations.

Data Analysis Techniques

This study use three independent variables and one dependent or focal variable. Three independent variables are Technology Adoption, E-Commerce, and Process Efficiency, while dependent variable is Agribusiness Supply Chain Performance. The data gathered by the administration of the questionnaire were analyzed using multiple linear regression techniques to identify the effect of each of the independent variables on the dependent variable. Prior to the use of regression analysis, classical assumptions tests were conducted to verify whether the data were satisfying statistical requirements to generate a valid regression model and could be accurately interpreted. Classical assumption tests utilized for this research are normality, multicollinearity, and heteroscedasticity tests.

Normality test is carried out to test whether the residual data of a regression model is normally distributed. The test is done using the Kolmogorov-Smirnov method. If the significance value is greater than 0.05, then it shows that the data is normally distributed. Multicollinearity test is performed to see whether there is any high correlation between independent variables within a regression model. Multicollinearity can result in unstable and problematic regression estimates. For performing the test, the Variance Inflation Factor (VIF) and Tolerance values are examined. If the VIF value is below 10 and the Tolerance value is above 0.10, then it can be stated that there is no multicollinearity between the independent variables. The heteroscedasticity test aims to determine whether there is inequality in the variance of the residuals for each predictor value. Heteroscedasticity can cause coefficient estimation to be inefficient. This test is performed using the Glejser method, which involves regressing the absolute value of the residuals against the independent variables. If the significance value is >0.05 , the data is declared free of heteroscedasticity (homoscedastic), and the regression model meets this assumption. By ensuring that the data passes all the classical assumption tests, the results of the regression analysis obtained will be more reliable and statistically valid for drawing conclusions in this study.

To test the research hypotheses, multiple linear regression analysis was performed using SPSS version 25. The following regression model was used:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon$$

With the following information:

- Y = Dependent variable
- X_1 = Agricultural Technology Adoption
- X_2 = E-Commerce Utilization
- X_3 = Process Efficiency
- β_0 = Constant
- $\beta_1, \beta_2, \beta_3$ = Regression coefficient of each independent variable
- ε = Error term

RESULTS AND DISCUSSION

The characteristics of the respondents in this study reflect the diverse backgrounds of the agribusiness actors who participated in the survey. Based on gender, the majority of respondents were male (78 people) and 42 (35%) were female. This indicates that men still play a more dominant role in agribusiness activities, especially in production and distribution. In terms of age, most respondents were in the 30–45 age range (50%), which is a productive age group and typically has sufficient work experience and is open to the use of technology. Meanwhile, 34 respondents (28.3%) were under 30 years old, and 26 respondents (21.7%) were over 45 years old. This age gap indicates that the agribusiness sector these days interacts with multiple generations, including the younger generation who are just starting to get involved in innovation and digitalization.

Table 1. Characteristics of Respondents

Characteristics	Category	Frequency (n)	Percentage
Gender	Male	78	65.0%
	Female	42	35.0%
Age	< 30 years	34	28.3%
	30-45 years	60	50.0%
	> 45 years	26	21.7%
Type of Business	Production	58	48.3%
	Distribution/Marketing	38	31.7%
	Other	24	20.0%

Source: Data Processed, 2025

From the perspective of business type, the respondents were divided into three broad categories. Fifty-eight (48.3%) respondents were associated with production industries like agricultural cultivation and animal breeding. Conversely, 38 individuals (31.7%) engaged in distribution or marketing, for instance, post-harvest processing and selling agribusiness products. The remaining 24 individuals (20%) were in other classes, for example, agribusiness services, agricultural input suppliers, or advisory services. All these characteristics together indicate that the sample in this study is representative of the significant actors in the agribusiness supply chain. This diversity also provides a clear synopsis for empirically investigating the contribution of technology, e-business, and process efficiency to the performance of supply chains. Productivity.

Classical Assumption Test

Before conducting the multiple linear regression analysis, several classical assumption tests were performed to ensure that the regression model met the statistical requirements for validity and reliability. The normality test using the Kolmogorov–Smirnov statistic showed a significance value above 0.05, indicating that the residuals were normally distributed. Multicollinearity testing demonstrated that all independent variables had tolerance values greater than 0.10 and VIF values below 10, confirming the absence of multicollinearity among agricultural technology adoption, e-commerce utilization, and process efficiency. The heteroscedasticity test using the Glejser method revealed that none of the independent variables had a significance value below 0.05, suggesting that the residual variance was homogeneous across predictor values. In addition, the scatterplot pattern further supported the conclusion that no heteroscedasticity problem was present. These combined results confirm that the regression model satisfies all classical assumptions including normality, multicollinearity, and homoscedasticity, thereby validating its suitability for inferential analysis in this study.

Normality Test

The Kolmogorov-Smirnov test was employed to determine whether or not the residual data of the regression model were normally distributed, one of the classical linear regression assumptions. The test results had a significance value of 0.112, above 0.05 threshold. This implies that there is no sufficient evidence against the null hypothesis (H_0) of the residual data being normally distributed. Thus, it can be safely assumed that the data applied in this study meets the normality assumption, where regression analysis proceeds to the subsequent phase without compromising the basic assumptions of the model.

Multicollinearity Test

Multicollinearity test results reveal that the Variance Inflation Factor (VIF) for all independent variables are ranging from 1.21 to 2.34, and the Tolerance value of each variable is greater than 0.10. Both these measures signify that the issue of multicollinearity is not present in the used regression model. Multicollinearity is a situation in which the independent variables are highly correlated, leading to instability in the estimation of the regression coefficient. But since all VIF <5 and Tolerance >0.10, it can be inferred that every independent variable is statistically unique and its contribution towards the dependent variable can be interpreted meaningfully.

Heteroscedasticity Test

The Glejser test is used to detect the presence of heteroscedasticity, a condition in which the variance of the residuals is not constant across all predicted values, which can interfere with the validity of the regression results. In this study, the Glejser test results show that the significance value of all independent variables is greater than 0.05, meaning there is no strong evidence to reject the null hypothesis (H_0) that heteroscedasticity does not occur. Thus, it can be concluded that the regression model meets the assumption of homoscedasticity, so that the relationship between the independent and dependent variables can be interpreted more accurately and is not biased due to deviations in residual variance.

Multiple Linear Regression Result

The results of the multiple linear regression analysis, derived from primary survey data collected from 120 agribusiness respondents in West Java and processed using SPSS version 25, indicate that agricultural technology adoption, e-commerce utilization, and process efficiency significantly influence agribusiness supply chain performance. The regression model used in this study demonstrates strong explanatory power, as shown by the coefficient of determination (R^2) of 0.651, indicating that 65.1% of the variance in agribusiness supply chain performance can be explained collectively by agricultural technology adoption, e-commerce utilization, and process efficiency. The Adjusted R^2 value of 0.642 further confirms the stability of the model after adjusting for the number of predictors, showing that the explanatory ability remains robust even when accounting for model complexity. The F-test result also supports the significance of the overall model, with an F-statistic value of 72.814 and a significance level of $p < 0.001$, demonstrating that the three independent variables simultaneously exert a statistically significant influence on agribusiness supply chain performance. These results collectively confirm that the regression model is appropriate, well-fitted, and capable of providing reliable insights into the factors that shape supply chain performance within the agribusiness sector. Following is the regression equation obtained from the unstandardized coefficients (β) of the multiple linear regression analysis conducted using SPSS version 25 based on primary survey data:

$$Y = 1.213 + 0.324X_1 + 0.289X_2 + 0.412X_3$$

The t-test was utilized in the present study to identify the individual effect of each independent variable on the dependent variable, i.e., agribusiness supply chain performance. The test is used to determine whether each independent variable, individually, plays a significant role in improving supply chain performance. The test results show that all three independent variables, agricultural technology adoption, e-commerce usage, and process efficiency have significance values of less than 0.05, which means they all have significant impacts on the dependent variable. Agricultural technology adoption enhances production and distribution activities' efficiency and accuracy, e-commerce usage enhances market access and speeds up transactions, and process efficiency directly impacts reducing the cost of operations and enhancing delivery speed. These findings show that improving agribusiness supply chain performance is not the result of one variable but is the result of the combined integration of these three factors.

Table 2. T-Test Results

Independent Variables	T-Count	Sig.	Description
Agricultural Technology Adoption	3.481	0,001	Significant
E-Commerce Utilization	2.987	0,004	Significant
Process Efficiency	4.105	0,000	Significant

Source: Data Processed, 2025

The Technological Adoption variable had a t-value of 3.481 with a significance value of 0.001, which is significantly less than 0.05. From the results, technology application in agricultural operations affects agribusiness supply chain performance. The more extensive the application of technology, such as advanced heavy equipment, automated irrigation systems, sensors for soil sensing, monitoring drones, and data-driven apps, the more efficient the processes of supply and agricultural production. Technology not only speeds up the cycle of planting-to-harvest but also increases the predictability and reliability of production harvests. This efficiency facilitates more stable supply of products to markets, in sufficient quantity, and in a shorter timeframe. Therefore, technology adoption is the most critical factor in creating a more responsive, competitive, and sustainable agribusiness supply chain.

Further, E-commerce usage variable showed a t-value of 2.987 and significance level of 0.004, which ensured that the variable has a statistically significant contribution towards enhancing agribusiness supply chain performance. These results corroborate the fact that digital platform usage in the marketing and sales activity of agribusiness products contributes significantly towards distribution system efficiency. E-commerce enables businesses to expand access to markets, accelerate cycles of transactions, and reduce reliance on conventional distribution channels, which are complex, lengthy, and expensive. Through virtual channels, agribusiness products can be marketed directly to ultimate consumers without going through multiple middlemen, thus not only reducing cost but maximizing profit margins as well. Furthermore, computer-based systems promote information openness and flexibility in demand and supply management, thereby ultimately boosting the supply chain's responsiveness and flexibility to market forces.

Efficiency variable of the process had the highest t-value of 4.105 and its significance level of 0.000, implying that this variable has the greatest effect on agribusiness supply chain performance. These results emphasize the utmost importance of operation optimization in all stages of agribusiness activities, from storage and packaging to transportation and stocking. Efficiency in such stages directly affects the speed, precision, and reliability of product delivery to market. By having streamlined processes and minimized waste, the supply chain becomes more efficient to meet demand changes and disruptions in logistics. Second, a positive regression coefficient for all variables indicates that advancements in any sector, technology, e-commerce, or process efficiency will contribute to overall supply chain performance.

Specifically, the highest coefficient of 0.412 in the process efficiency variable indicates its highest contribution among the variables. They demonstrate how internal operating efficiencies play a vital role in establishing a robust, effective, and sustainable agribusiness supply chain.

Effects of Technology Adoption, E-Commerce, and Process Efficiency on Agribusiness Supply Chain Performance

The research findings demonstrate that the application of agricultural technology significantly improves the performance of the agribusiness supply chain, supporting previous research that has highlighted the contribution of technology adoption in improving land efficiency and agricultural productivity. Agricultural technology, such as soil sensors, drones, weather forecasting apps, and smart irrigation systems, allows farmers to monitor and manage resources more precisely. Such technologies render agricultural operations more measurable and integrated, from the design of planting and management of crops to distribution after harvesting. As such, agricultural technology adoption impacts not just the efficiency of production but also the speed of product distribution, competitiveness improvement, and sustainability of supply chains in general.

The findings of this study are strongly aligned with the research objectives, which aimed to examine how agricultural technology adoption, e-commerce utilization, and process efficiency influence agribusiness supply chain performance in West Java. The regression results clearly support these objectives by demonstrating that all three variables exhibit positive and significant effects on supply chain performance, confirming that the empirical data collected from 120 respondents directly reinforces the theoretical assumptions underlying the research model. These findings are consistent with previous studies that emphasize the importance of technology readiness and information sharing in enhancing supply chain performance (Hendy *et al.*, 2020) as well as technology-based efficiency improvements in agribusiness management (Zulham *et al.*, 2022). The magnitudes of the regression coefficients also provide important insights. The coefficient for agricultural technology adoption, which shows the strongest influence among the three predictors, is in line with prior research indicating that technology application significantly improves productivity and operational performance among agribusiness and MSME actors (Aulia *et al.*, 2023b). The significant effect of e-commerce utilization likewise corresponds with earlier findings that digital platforms and online marketing channels enhance market access and distribution efficiency (Madyatmadja *et al.*, 2020). Meanwhile, the positive contribution of process efficiency aligns with existing literature highlighting that streamlined operational workflows and supply chain integration play a critical role in improving overall performance outcomes (Syahputra *et al.*, 2023).

Although all findings in this study are significant, their magnitudes vary in a way that reflects realistic field conditions; for instance, the somewhat smaller coefficient of e-commerce utilization compared to technology adoption may be attributed to uneven digital literacy among farmers or infrastructural constraints in rural areas. Similar patterns have been reported in previous studies on MSMEs and agribusiness, which show that technology-based initiatives often produce uneven impacts due to differences in human capital readiness and partnership quality (Aulia *et al.*, 2024). Importantly, no unexpected or insignificant findings emerged, which indicates a consistent relationship between digital transformation practices and supply chain outcomes, aligning with earlier evidence that emphasizes the role of operational integration and partnership mechanisms in strengthening business and supply chain performance (Syahputra *et al.*, 2023). The alignment of all coefficients with both theoretical expectations and empirical literature further strengthens the argument that digital adoption provides measurable value in agribusiness operations, as also demonstrated in studies highlighting the effectiveness of technology application and process efficiency improvements in agribusiness management (Zulham *et al.*, 2022).

Overall, the discussion integrates the study's objectives, findings, and theoretical foundations, demonstrating that the empirical data robustly support the intended contributions of this research.

E-commerce adoption was also shown to significantly influence the performance of the agribusiness supply chain, which is aligned with current literature indicating that digital platforms can expand market breadth and accelerate transaction activities (Madyatmadja *et al.*, 2020). For agribusiness, especially for fresh produce with limited shelf life, distribution accuracy and speed are critical, and this finding is consistent with previous studies showing that digital systems improve coordination and responsiveness across supply chain actors (Novessro *et al.*, 2025). E-commerce enables farmers or producers to sell their products directly to retailers or consumers, avoiding long and slow intermediaries and hence minimizing product damage, decreasing logistics costs, and enhancing profit margins, which echoes earlier evidence that user trust, digital experience, and online transaction systems strengthen operational efficiency and performance outcomes (Pramudito *et al.*, 2023). With the adoption of e-commerce, agribusinesses can also access real-time sales data, forecast demand, and adjust production more responsively, ultimately strengthening the efficiency and effectiveness of the overall supply chain.

Process efficiency has been proven to be a key factor in improving agribusiness supply chain performance, in line with previous findings that emphasize that operational process improvements directly impact customer satisfaction and reduce distribution costs (Hendy *et al.*, 2020). Efficiency at every stage, from post-harvest handling, storage, packaging, and shipping, allows products to reach the market in optimal condition and on time, which is consistent with earlier evidence that the use of operational technologies and standardized systems enhances efficiency and effectiveness in agribusiness management (Zulham *et al.*, 2022). Well-organized processes also reduce the potential for product loss, delays, and additional costs caused by inefficiencies, reinforcing prior research that highlights how improved process reliability and system experience contribute to better performance outcomes (Pramudito *et al.*, 2023). Therefore, agribusiness companies that consistently apply efficiency principles can improve supply reliability, maintain product quality, and strengthen competitiveness in both domestic and international markets.

The combination of these three variables, agricultural technology adoption, e-commerce utilization, and process efficiency, demonstrates that the integration of digital innovation and operational improvements is essential for building a resilient agribusiness supply chain. These findings emphasize that technology will not deliver maximum impact without being supported by efficient processes, and vice versa. Agribusiness companies that strategically adopt technology and simultaneously optimize their internal processes will have greater adaptability, accelerate response times to market changes, and improve customer satisfaction. Therefore, the synergy between digital innovation and operational efficiency is the key foundation for agribusiness success in the digital era and competitive global market.

The results of this research are mostly concordant with the earlier research, primarily because of a new mixed-methods approach adopted in the analysis. The presence of technology adoption, which was recognized as a major factor affecting the performance of agribusiness supply chain, corroborates the previous studies that, *inter alia*, pointed out the need for digital tools and ICT readiness in the sharing of information and overall effectiveness of the operations (Zulham *et al.*, 2022; Junaidi *et al.*, 2022). Correspondingly, the positive influence of e-commerce use is also consistent with earlier studies that have highlighted its role in the access to larger markets and improved distribution (Sukmaya & Jakiyah, 2021; Nasution, 2023). Nonetheless, the e-commerce impact was less in comparison with technology adoption, which indicates the prevailing problem of digital literacy and infrastructure, and thus, the earlier research done in third-world countries is still valid. Moreover, since process efficiency is a significant factor that affects supply chain performance, it once again confirms the

previous findings that have recognized operational efficiency as a performance-improvement driver (Sudirjo *et al.*, 2023; Daina *et al.*, 2024). The findings add to the literature by demonstrating that supply chain performance in the agribusiness sector is not an issue of separated digital actions but rather the result of overlapping and supportive measures of technology adoption, e-commerce, and efficient operational processes.

This study also shows that the human factor, particularly digital literacy and operational skills, remains a major challenge in optimizing technology implementation in the agribusiness sector. Although technology is readily available and proven beneficial, without the support of competent human resources, its utilization will not be maximized. Therefore, going forward, close collaboration between the government, industry players, and academics is needed to design targeted and sustainable training programs. Furthermore, developing policies that encourage innovation and supporting equitable digital infrastructure are key to expanding technology adoption in the Indonesian agribusiness ecosystem in an inclusive and sustainable manner.

CONCLUSION

This research demonstrates that the adoption of agricultural technology, the use of e-commerce, and process efficiency significantly impact the performance of the agribusiness supply chain. These three variables not only have an impact individually but also complement each other, creating a faster, more cost-effective, and more reliable agribusiness distribution system. Agricultural technology heightens productivity and timeliness of harvest, e-commerce enhances access to markets and accelerates transactions, and process efficiency prevents waste and delivers products to the consumer in optimal condition. This synergy renders agribusiness more competitive against rising market complexities.

The implication of this research is that agribusiness firms should successfully adopt relevant farm technology, utilize e-commerce websites as good marketing tools, and continually optimize processes to become competitive. Digital transformation should be a core component of the central strategy in supply chain management in agribusiness, especially in the area of market dynamics and complex production problems. Policymakers and the government will also have to provide concrete support through need-based training programs, rural digital infrastructure access, and innovation incentives that impact productivity and efficiency. Thus, agribusiness supply chain improvement strategies are not solely in the interest of individual business entities but are a core part of establishing a sustainable and inclusive national agribusiness environment.

The policy recommendations of this study are directly supported by its empirical findings. Since agricultural technology adoption shows the strongest influence on supply chain performance, policymakers should prioritize programs that expand farmers' access to digital and mechanized agricultural technologies, as these have been proven in this study to improve productivity and operational accuracy. The significant effect of e-commerce utilization also justifies policies that strengthen farmers' digital literacy, marketplace integration, and access to secure online transaction systems, given their demonstrated contribution to greater market reach and transaction efficiency. Additionally, the positive impact of process efficiency highlights the need for logistical support, improved post-harvest handling, and infrastructure development to reduce delays and optimize product flow. Because all three variables significantly enhance supply chain performance, an integrated policy framework that advances technology adoption, digital market access, and operational efficiency is empirically supported by this study and essential for strengthening regional agribusiness competitiveness.

The limitations of this study lie in its geographic scope, which only covered West Java. Therefore, generalizing the findings to other regions in Indonesia requires

caution. Furthermore, the data obtained using a self-report method via an online questionnaire is subject to biased perceptions or subjective interpretations by respondents. Therefore, future research is recommended to expand the scope of the study, including regions with different agribusiness characteristics, and to use a longitudinal approach to evaluate the long-term impact of technology adoption, e-commerce, and process efficiency on agribusiness supply chain performance in greater depth and comprehensiveness.

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