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MAPPING SUPPLY CHAIN ACTORS' READINESS ON NEW TECHNOLOGY IN FRESH FRUIT AND VEGETABLE TRACEABILITY SYSTEM

Anggia Rifani*, **Nur Hasanah, Raden Dikky Indrawan**

School of Business, IPB University
Jl. Pajajaran Bogor 16151, Indonesia

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ABSTRACT

Background: While IoT and blockchain technologies are widely promoted to improve traceability in fresh produce supply chains, empirical evidence on stage-based differences in technology readiness remains limited. This gap is particularly relevant in multi-stage agri-food systems where actor heterogeneity may shape digital adoption dynamics.
Purpose: This study aims to analyze stage-based patterns of technology readiness and technology acceptance among fresh fruit and vegetable supply chain actors in West Java, Indonesia.
Finding/Result: The results of the analysis indicate that actors in the downstream stages of the supply chain (distribution and marketing, as well as consumption (B2B)) are more prepared to adopt technology compared to those in the upstream stages (production and post-harvest storage). Optimism, perceived ease of use, perceived usefulness, and intention to use technology are relatively high across all stages. However, discomfort and insecurity regarding technology remain significant challenges in the initial stages of the supply chain.
Conclusion: Digital traceability adoption in fresh produce supply chains requires stage-sensitive strategies due to heterogeneous readiness conditions across operational stages.
Original/Value (State of the art): This study contributes to technology readiness research by empirically demonstrating stage-based heterogeneity within a single regional agri-food supply chain system.

Keywords: blockchain, fruit and vegetable supply chains, Internet of Things (IoT), technology readiness and acceptance, traceability system.

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* Corresponding author:
Email: anggiaarifani@apps.ipb.ac.id, rdikky@apps.ipb.ac.id

INTRODUCTION

Food is a fundamental necessity in human life and is formally recognized in Indonesia as a basic human right under Law No. 7 of 1996. Despite improvements in national hunger indicators as reflected in Indonesia's 2023 Global Hunger Index (GHI) score of 17.6, categorized as moderate hunger (Global Hunger Index, 2023), food systems remain vulnerable to economic pressures, policy shifts, natural disasters, and health crises (McClements et al. 2021). The COVID-19 pandemic further exposed structural weaknesses in global food supply chains, disrupting distribution systems and increasing food waste (Park, 2020). These conditions highlight that food security challenges are not solely associated with production capacity but are also closely linked to supply chain coordination, transparency, and risk management across actors.

Food supply chains are riskier and more complex than other industries (Ernawati, 2021). This also leads to the involvement of more parties in the food supply chain processes. Each actor in the food supply chain is responsible for ensuring food product safety and minimizing risks associated with consumer health (Ernawati, 2021). Food supply chain actors are also required to manage food products with specialized handling that varies for each category of food product, marketing, and distribution. Therefore, an appropriate system is necessary to maximize outcomes and minimize future uncertainties.

In general, food supply chains consist of five stages: production, post-harvest and storage, processing and packaging, distribution and marketing, and consumption (BAPPENAS, 2021). However, the diverse types and categories of food products differentiate the supply chain processes. One category of food with a highly complex supply chain is fresh fruits and vegetables. Fresh fruits and vegetables have shorter shelf lives (Ihsan and Derosya, 2024) and are easily damaged and sensitive to environmental conditions (Tagarakis et al. 2021). Between 2000 and 2019, 36% of food waste came from fresh fruits and vegetables (BAPPENAS, 2021). The main factors causing this waste include inefficient storage and distribution processes, with poor coordination and packaging as the primary drivers (Balci and Tuna, 2021).

These causes are closely related to the efficiency of managing and distributing fresh fruits and vegetables. Traceability in the fresh fruits and vegetables supply chain is a crucial element. Traceability enables access to product information throughout all stages of the supply chain (Tagarakis et al. 2021) and enhances food safety, inventory management, and product quality (Aung and Chang, 2014). Traceability systems in food supply chains have two primary schemes: logistical traceability and quality and safety traceability (Folinas et al. 2006). Advances in technology have significantly impacted this system. Technologies like the Internet of Things (IoT) and blockchain facilitate the implementation of such systems. IoT is a concept where specific objects can transfer data over the internet without requiring human-to-human or human-to-computer interaction (Yudhanto and Azis, 2019). Sensors within IoT technology can provide real-time information about food products during production, storage, and distribution (Badrun and Manaf, 2021). Data obtained from IoT usage can be compiled into blockchain systems. Blockchain is a decentralized database management scheme (Prilliadi, 2022). Through blockchain, data transparency increases, thereby enhancing trust among stakeholders. The integration of these two technologies simplifies traceability processes.

However, technological availability does not guarantee successful implementation. The effectiveness of IoT and blockchain-based traceability systems depends on the readiness and acceptance of supply chain actors. In multi-stage supply chains such as fresh fruit and vegetable cold chains, differences in digital literacy, infrastructure access, and operational capability may influence how technology is adopted across stages.

Globally, prior studies have primarily focused on the technical feasibility and operational benefits of IoT and blockchain integration in food supply chains. For instance, research conducted in India demonstrated that IoT-based smart irrigation systems improved production quantity and quality while reducing water and energy consumption (Dagar et al. 2018). Blockchain has been examined as a mechanism for ensuring data authenticity and decentralized verification (Bruce, 2013), as well as for enhancing transparency and trust in food supply chain management (Sharma et al. 2020). While these studies confirm the technological potential and performance advantages of digital systems, they largely emphasize system architecture, operational efficiency, and validation mechanisms rather than assessing actor-level readiness prior to implementation.

In the Indonesian context, existing studies similarly highlight the operational benefits of digital technologies. IoT has been applied to monitor water quality, enable real-time water control, support centralized management, and maintain irrigation infrastructure (Badrun and Manaf, 2021). It has also been utilized to monitor temperature and humidity in post-harvest drying facilities (Yusuf, 2022). Blockchain applications have been implemented in vegetable traceability systems, such as hydroponic supply chains (Suroso et al. 2021). However, despite these technological applications, traceability practices in many food supply chains remain predominantly manual (Suroso et al. 2021), and national reports indicate persistent barriers related to technological access, digital capability, and investment readiness among food industry actors (KEMENPERIN, 2018).

Existing Indonesian studies mainly discuss technological potential or general adoption intention, but lack systematic profiling of technology readiness and acceptance across different supply chain stages. Empirical evidence remains limited regarding whether upstream actors (production and post-harvest) and downstream actors (distribution and B2B consumption) demonstrate similar readiness configurations or exhibit stage-specific heterogeneity. Consequently, the maturity level of technology readiness in Indonesian fresh fruit and vegetable supply chains remains insufficiently mapped.

To address this gap, this study maps the technology readiness and technology acceptance configuration of fresh fruit and vegetable supply chain actors in West Java using the Technology Readiness and Acceptance Model (TRAM) (Lin et al. 2007). Rather than testing causal relationships, this research adopts a descriptive profiling approach to identify differences in optimism, innovativeness, discomfort, insecurity, perceived usefulness, perceived ease of use, and intention to use technology across supply chain stages.

This study aims to provide an empirical overview of readiness levels and stage-based differences in technology acceptance within the fresh produce supply chain context. The findings are expected to serve as a foundational reference for understanding the current maturity condition of digital readiness among supply chain actors in West Java.

This research focuses on supply chain actors of fresh fruits and vegetables in West Java. This province was chosen because it is a major producer of fresh fruits and vegetables with the infrastructure and technological access necessary to support traceability implementation (BPS Jabar, 2024). These conditions present opportunities for further research on technological adoption in the traceability systems of fresh fruit and vegetable supply chains.

METHODS

This study employed a quantitative descriptive research design to map technology readiness and technology acceptance configurations among fresh fruit and vegetable supply chain actors in West Java. Although the Technology Readiness and Acceptance Model (TRAM) is commonly applied in causal and predictive research, this study adopts TRAM as a multidimensional measurement framework rather than a structural hypothesis-testing model. The objective is exploratory, focusing on profiling stage-based heterogeneity in readiness and acceptance levels.

Data were collected through structured online questionnaires distributed between August and November 2024. The population consisted of actors operating across five supply chain stages: production; post-harvest and storage; processing and packaging; distribution and marketing; and consumption (B2B) (BAPPENAS, 2021).

Respondents were determined by calculating the sample size using the formula from Hair et al. (2014), where the maximum number of samples is calculated as: n = 10 (maximum) × the number of indicators. With 38 indicators in this study, the total number of respondents is 380. Since the research covers five supply chain stages, quota sampling was applied to determine the respondent quota for each stage. Quota sampling is a technique for determining a population sample with specific characteristics up to a desired number (Sugiyono, 2013). The quotas were determined based on regional statistical data and the fresh fruit and vegetable production results at each stage and district/city in West Java. The respondent quota for each stage is as follows: production (95 respondents), post-harvest and storage (76 respondents), processing and packaging (76 respondents), distribution and marketing (76 respondents), and consumption (B2B) (57 respondents), totaling 380 respondents.

The variables and indicators were adapted from established theoretical scales. The Technology Readiness dimensions (optimism, innovativeness, discomfort, and insecurity) were derived from the Technology Readiness Index (TRI 2.0) developed by Parasuraman and Colby (2015). The Technology Acceptance constructs (perceived ease of use, perceived usefulness, and intention to use) were adapted from the Technology Acceptance Model (TAM) proposed by Davis (1989) and integrated in the Technology Readiness and Acceptance Model (TRAM) by Lin et al. (2007). Contextual modifications were applied to align the items with the fresh fruit and vegetable supply chain setting without altering their conceptual meaning. The variables and indicators are in Table 1.

All indicators were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Composite scores for each construct were calculated by averaging their respective indicator scores. Negative constructs (discomfort and insecurity) were reverse-coded to maintain a consistent interpretation of higher scores as indicating higher readiness.

Table 1. Research variables and indicators

Variable	Code	Indicator	Reference
Positive Technology Readiness			
Optimism	OPT1	Product security	(Parasuraman and Colby, 2015)
	OPT2	Efficiency of distribution processes	
	OPT3	Easier product control	
	OPT4	Better alignment with customer needs	
	OPT5	Meets product quality standards	
	OPT6	Improves communication and coordination	
	OPT7	More accurate market demand forecasting	
Innovativeness	INV1	First to use new technology	
	INV2	Willing to try new technology	
	INV3	Enjoy challenges involving new technology	
	INV4	Easier to use technology compared to others	
	INV5	Likes advanced technology	
	INV6	Technology helps improve service quality	
	INV7	Technology is beneficial in this job	
Negative Technology Readiness			
Discomfort	DIS1	Usage instructions are not written in simple language	(Parasuraman and Colby, 2015)
	DIS2	Too complex and difficult to integrate	
	DIS3	Prefer early-stage technology	
	DIS4	Technology can create risks to products	
	DIS5	Feel left behind in understanding new technology	
Insecurity	INS1	Dependence on technology	
	INS2	Concern about disruption to product quality	
	INS3	Negative impact of technology on the environment	
	INS4	Difficulty adapting to technology	
	INS5	Concern about misuse of personal information	
Technology Acceptance			
Perceived ease of use	PEU1	Flexibility in task completion	Davis (1989)
	PEU2	Efficiency of the production process	
	PEU3	Easy to understand and use	
	PEU4	Able to optimize the production process	
	PEU5	Overall, the technology provides convenience	

Table 1. Research variables and indicators (continue)

Variable	Code	Indicator	Reference
Perceived usefulness	PU1	Ensures product quality meets standards	Davis (1989)
	PU2	Provides better control and information	
	PU3	Optimizes product delivery processes	
	PU4	Facilitates product authenticity verification	
	PU5	Reduces product waste	
	PU6	Reduces the risk of defective or damaged products	
Intention to Use	IU1	Use the technology when the opportunity arises	Davis (1989)
	IU2	Interest in using the technology	
	IU3	Use technology to increase sales	

Prior to descriptive analysis, measurement validity and reliability were assessed using SmartPLS version 3.0. Convergent validity was evaluated using outer loading and Average Variance Extracted (AVE). Indicators with loading values above 0.70 were retained, and AVE values exceeding 0.50 indicated adequate convergent validity (Ghozali, 2014). Internal consistency reliability was evaluated using Composite Reliability (CR > 0.70) and Cronbach's Alpha ($\alpha > 0.60$). All constructs met the recommended thresholds, indicating satisfactory reliability.

Data processing and analysis were performed using several analytical tools. In general, this research utilized descriptive analysis. Descriptive analysis was used as a method for analyzing the data obtained through questionnaires completed by respondents to describe phenomena objectively, comprehensively, and informatively (Kemp et al. 2018). In this analysis, the Top-Bottom Two Boxes method was employed to assess the distribution of respondents' answers for each indicator. The Top-Bottom Two Boxes method involves combining the "agree" and "strongly agree" responses, as well as the "disagree" and "strongly disagree" responses, while keeping the "neutral" responses separate. This analysis provides an overview of respondents' opinions by categorizing their responses into "disagree," "neutral," and "agree." Additionally, the Top-Bottom Two Boxes analysis was performed alongside crosstabulation.

Crosstabulation analysis was conducted to identify distributional patterns of readiness and acceptance across supply chain stages. The objective was to explore stage-based heterogeneity descriptively rather than to test statistical independence. Then, from the four dimensions of technology readiness and the perceptions of technology acceptance, the Technology Readiness and Acceptance Model (TRAM) is formed, with the model presented in Figure 1. In this research, TRAM is employed as a multidimensional measurement framework rather than as a structural or predictive model. The framework serves to organize and categorize readiness and acceptance constructs for descriptive profiling across supply chain stages. The objective is not to test causal relationships among variables but to map configuration patterns of technology readiness and acceptance within heterogeneous supply chain actors.

RESULTS

Respondent Profile

This study involved 380 respondents from the five stages of the fresh fruit and vegetable supply chain. Most respondents were within the 35–54 age range, indicating that the sample largely consisted of individuals in productive working age groups actively involved in operational activities. In terms of gender, the majority of respondents were male 61.8%, reflecting the gender composition commonly observed in agricultural and supply chain operations. Regarding education level, the majority of respondents had a high school education, with 206 individuals (42.4%). Furthermore, based on business scale, the majority of respondents came from medium-sized businesses, totaling 172 individuals (45.3%), followed by small-scale businesses with 166 individuals (43.6%). Respondents from large-scale businesses had the smallest percentage, at 11.1%. These characteristics suggest that the supply chain is largely composed of small- to medium-scale actors with moderate formal education backgrounds, which may influence their level of digital literacy and technological readiness across different supply chain stages.

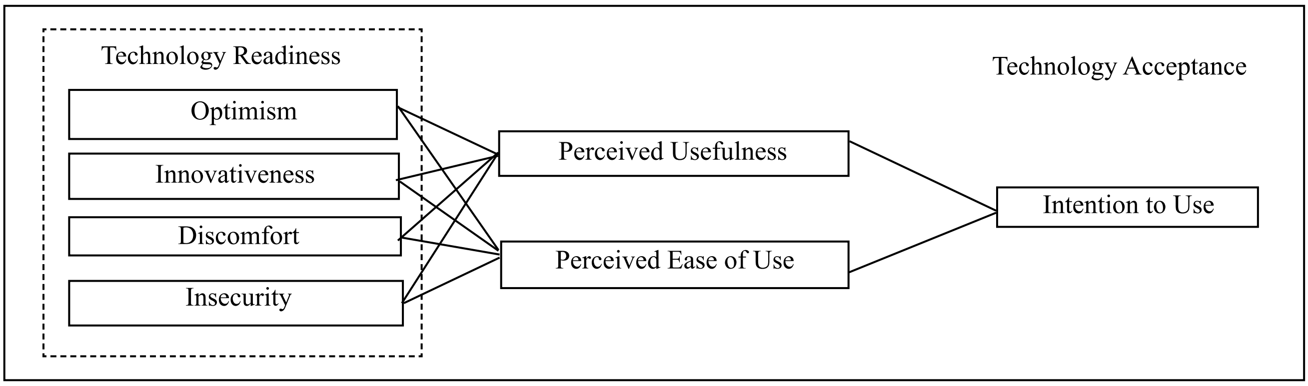

Figure 1. Technology Readiness and Acceptance Model (TRAM)

Measurement Model Evaluation

The measurement model was evaluated to ensure construct validity and reliability. All outer loadings exceeded the recommended threshold of 0.70, indicating satisfactory convergent validity. The Average Variance Extracted (AVE) values for all constructs were above 0.50, confirming adequate construct validity. Composite Reliability values exceeded 0.70, and Cronbach's Alpha values were above 0.60 for all constructs, demonstrating strong internal consistency. These results indicate that the measurement model is reliable and appropriate for subsequent descriptive analysis. The measurement model was evaluated to ensure construct validity and reliability, and the results are presented in Table 2.

Technology Readiness and Acceptance Across Supply Chain Stages

This section presents the distribution of technology readiness and technology acceptance across the five stages of the fresh fruit and vegetable supply chain. Using the Top-Bottom Two Boxes analysis and cross-tabulation, the study identifies patterns of agreement and variation among supply chain actors. The analysis focuses on stage-based differences in the seven constructs of the Technology Readiness and Acceptance Model (TRAM), namely optimism, innovativeness, discomfort, insecurity, perceived ease of use, perceived usefulness, and intention to use. By examining the distribution patterns across supply chain stages, the study highlights variations in readiness and acceptance configurations between upstream and downstream actors.

Optimism

As presented in Table 3, optimism toward IoT and blockchain implementation is generally high across all supply chain stages. Agreement levels range from 64.7% to 72.7%, indicating that most actors perceive digital traceability technologies positively. Downstream stages, particularly distribution and B2B consumption, demonstrate higher agreement levels compared to upstream stages. In contrast, processing actors exhibit relatively higher neutral responses, suggesting a more moderate or cautious perception toward technological implementation. Overall, disagreement levels remain minimal across all stages, indicating limited resistance toward digital traceability initiatives.

Innovativeness

Innovativeness reflects the willingness of supply chain actors to act as early adopters and pioneers in using IoT and blockchain technologies within the fresh fruit and vegetable supply chain. The distribution of responses across supply chain stages is presented in Table 4. Overall, agreement levels increase progressively from upstream to downstream stages. Production and post-harvest actors show moderate levels of agreement (46% and 47%, respectively), accompanied by relatively high disagreement levels (above 30%). This indicates a more cautious orientation toward adopting new technologies at the upstream stages. In contrast, processing, distribution, and B2B actors demonstrate higher levels of agreement, reaching 57.2%, 61.7%, and 64.8%, respectively. Disagreement levels decline substantially in downstream stages, suggesting greater openness to experimenting with and pioneering new digital technologies. These findings indicate a clear stage-based variation in innovativeness, where downstream actors exhibit stronger readiness to initiate and adopt advanced technological solutions compared to upstream actors.

Discomfort

Discomfort is categorized as an inhibiting dimension within the Technology Readiness framework. Accordingly, higher agreement percentages reflect greater perceived technological complexity and barriers, whereas higher disagreement percentages indicate lower perceived discomfort and stronger readiness. In Table 5, discomfort demonstrates a clear stage-based contrast across the supply chain. Agreement levels are substantially higher in upstream stages, particularly in production (53.1%) and post-harvest (62.5%), indicating that these actors perceive greater technological complexity and operational difficulty in implementing IoT and blockchain systems.

In contrast, downstream stages such as distribution and B2B consumption exhibit high levels of disagreement (58.9% and 60.2%, respectively), suggesting lower perceived technological discomfort. Processing actors occupy a transitional position, with relatively balanced responses across categories. These findings reinforce the structural heterogeneity of technological readiness, where perceived barriers are more pronounced in upstream segments and diminish toward downstream stages.

Table 2. Validity and realibility results

Variable	AVE	Composite Realibility	Cronbachs' alpha
Optimism	0.725	0.949	0.937
Innovativeness	0.725	0.948	0.937
Discomfort	0.728	0.930	0.907
Insecurity	0.719	0.927	0.902
Perceieved ease of use	0.763	0.941	0.923
Perceived usefulness	0.704	0.935	0.916
Intention to use	0.704	0.913	0.858

Table 3. Distribution of responses on optimism across supply chain stages

Supply chain stage	(%)		
	Disagree	Neutral	Agree
Production	1.9	30.0	66.5
Post-Harvest & Storage	1.6	31.3	660
Processing & Packaging	1.9	33.0	64.7
Distribution & Marketing	1.1	27.5	71.0
Consumption (B2B)	1.1	24.3	72.7

Table 4. Distribution of responses on innovativeness across supply chain stages

Supply chain stage	(%)		
	Disagree	Neutral	Agree
Production	32.8	21.2	46.0
Post-Harvest & Storage	36.6	16.4	47.0
Processing & Packaging	20.7	22.1	57.2
Distribution & Marketing	13.5	24.7	61.7
Consumption (B2B)	11.7	23.4	64.8

Insecurity

Insecurity represents an inhibiting dimension of technology readiness. Higher agreement levels indicate higher perceived risks and concerns regarding technology use, whereas higher disagreement levels indicate lower insecurity and greater psychological readiness. Insecurity exhibits a clear stage-based pattern across the supply chain. Upstream actors, particularly in production (59.8%) and post-harvest (56.2%), demonstrate high levels of agreement, indicating stronger concerns regarding dependency, risk, and potential negative impacts of IoT and blockchain technologies. Processing actors show relatively high neutral responses (44.8%), suggesting ambivalent perceptions toward technological risk. In contrast, downstream actors, especially distribution and B2B consumption, display higher levels of disagreement (45.2% and 29.4%, respectively), indicating lower perceived insecurity. These findings reinforce the structural heterogeneity observed across readiness dimensions, where psychological barriers related to risk and uncertainty are more prominent in upstream stages and diminish toward downstream segments.

Perceived ease of use

Perceived ease of use reflects the extent to which supply chain actors believe that the implementation of IoT and blockchain technologies can be easily understood and utilized in their operational activities. This construct captures actors' perceptions regarding flexibility, efficiency, clarity of use, and overall convenience in applying digital traceability systems. The distribution of responses across supply chain stages is presented in Table 7.

Perceived ease of use demonstrates a progressive increase across supply chain stages. Agreement levels rise from 66.1% in production to 90.2% in Consumption (B2B), indicating that downstream actors perceive IoT and blockchain technologies as significantly easier to use. Neutral responses remain relatively higher in upstream stages, suggesting moderate confidence in operational implementation. In contrast, downstream actors report substantially higher agreement levels and minimal disagreement, reflecting stronger technological familiarity and usability perceptions. These findings further support the presence of stage-based heterogeneity in technology acceptance across the fresh fruit and vegetable supply chain.

Table 5. Distribution of responses on discomfort across supply chain stages

Supply chain stage	(%)		
	Disagree	Neutral	Agree
Production	12.2	34.8	53.1
Post-Harvest & Storage	9.9	27.6	62.5
Processing & Packaging	35.1	33.6	31.3
Distribution & Marketing	58.9	23.8	17.3
Consumption (B2B)	60.2	16.9	22.9

Table 6. Distribution of responses on insecurity across supply chain stages

Supply chain stage	(%)		
	Disagree	Neutral	Agree
Production	11.8	28.4	59.8
Post-Harvest & Storage	23.7	20.1	56.2
Processing & Packaging	17.1	44.8	38.1
Distribution & Marketing	45.2	29.8	25.0
Consumption (B2B)	29.4	38.5	21.9

Perceived usefulness

Perceived usefulness reflects the extent to which supply chain actors believe that the implementation of IoT and blockchain technologies enhances their operational performance and improves supply chain outcomes. This construct captures perceived benefits related to product quality, delivery efficiency, authenticity verification, waste reduction, and risk mitigation. The distribution of responses across supply chain stages is presented in Table 8.

Perceived usefulness demonstrates consistently high agreement levels across all supply chain stages. Agreement percentages range from 71.8% to 80.6%, indicating strong recognition of the operational benefits associated with digital traceability technologies. Downstream stages, particularly B2B consumption and distribution, exhibit the highest agreement levels (above 78%), suggesting stronger perceived performance gains in later supply chain segments. Disagreement levels remain minimal across all stages, reflecting a broad consensus regarding the usefulness of IoT and blockchain implementation. These results indicate that perceived usefulness is uniformly high throughout the supply chain, although downstream actors display slightly stronger benefit perceptions.

Intention to use

Intention to use reflects the willingness of supply chain actors to adopt and implement IoT and blockchain technologies in their operational activities. This construct captures behavioral intention related to future technology usage, technological interest, and perceived business performance enhancement. The distribution of responses across supply chain stages is presented in Table 9.

Intention to use shows consistently high agreement levels across all supply chain stages, ranging from 63.2% to 71.7%. Consumption (B2B) actors exhibit the highest intention levels (71.7%), followed by production and distribution stages. Processing actors demonstrate relatively higher neutral responses (35.5%), suggesting moderate hesitation despite recognizing technological benefits. Overall, disagreement levels remain minimal across stages, indicating a generally positive behavioral intention toward adopting IoT and blockchain technologies within the supply chain.

Table 7. Distribution of responses on perceived ease of use across supply chain stages

Supply chain stage	(%)		
	Disagree	Neutral	Agree
Production	5.1	28.8	66.1
Post-Harvest & Storage	0.3	27.4	72.3
Processing & Packaging	2.1	26.1	71.8
Distribution & Marketing	4.2	14.7	81.9
Consumption (B2B)	1.6	8.4	90.2

Table 8. Distribution of responses on perceived usefulness across supply chain stages

Supply chain stage	(%)		
	Disagree	Neutral	Agree
Production	1.9	25.1	73.0
Post-Harvest & Storage	0.2	21.4	78.4
Processing & Packaging	1.9	26.3	71.8
Distribution & Marketing	2.6	19.4	78.0
Consumption (B2B)	1.8	17.6	80.6

Summary of Stage-Based Patterns in Technology Readiness and Acceptance

Table 10 provides a consolidated overview of agreement levels across all technology readiness and acceptance dimensions. The results reveal a consistent pattern of variation across supply chain stages. Positive readiness dimensions, particularly optimism and innovativeness, show higher agreement levels in the distribution and B2B consumption stages compared to production and post-harvest stages. This indicates stronger positive perceptions and a greater willingness to pioneer digital technologies in later stages of the supply chain.

In contrast, discomfort and insecurity represent technological barriers. Higher agreement levels for these constructs indicate stronger perceived complexity, risk, and psychological concern related to technology use. Agreement levels for both constructs are higher in the production and post-harvest stages and decline substantially in the distribution and B2B stages. This suggests that perceived technological obstacles are more pronounced in the earlier stages of the supply chain.

The technology acceptance dimensions, namely perceived ease of use, perceived usefulness, and intention to use, demonstrate generally high agreement levels across all stages. However, the highest levels are consistently observed in the distribution and B2B stages, indicating stronger acceptance and behavioral intention toward digital traceability technologies in those segments. Overall, these findings indicate that digital readiness and technology acceptance are not uniformly distributed across supply chain stages but instead exhibit clear structural variation depending on stage position.

Managerial Implications

The findings indicate that digital readiness within the fresh fruit and vegetable supply chain is not uniform across stages. While optimism and perceived usefulness toward IoT and blockchain technologies are generally high, discomfort and insecurity remain more pronounced in production and post-harvest stages. Therefore, digital transformation strategies should be stage-sensitive rather than uniformly implemented.

For policymakers, efforts should focus on reducing structural barriers through improved digital infrastructure, targeted financial support for small and medium-scale actors, and clearer regulatory frameworks to strengthen data security and trust. Since perceived benefits are already recognized, interventions should prioritize capacity strengthening rather than awareness campaigns alone.

For supply chain actors and technology providers, gradual implementation strategies and user-friendly system design are essential to reduce psychological resistance. Emphasizing practical operational benefits, such as improved product control and reduced waste, may help translate positive perceptions into sustained technology adoption.

Table 9. Distribution of responses on intention to use across supply chain stages

Supply chain stage	(%)		
	Disagree	Neutral	Agree
Production	3.9	27.4	68.8
Post-Harvest & Storage	3.0	28.9	67.6
Processing & Packaging	1.3	35.5	63.2
Distribution & Marketing	3.0	28.5	67.5
Consumption (B2B)	2.4	23.4	71.7

Table 10. Agreement levels across supply chain stages (%)

Variable	Agreement Percentage (%)				
	Production	Post-Harvest	Processing	Distribution	Consumption (B2B)
Optimism	66.5	66.0	64.7	71.0	72.7
Innovativeness	46.0	47.0	57.2	61.7	64.8
Discomfort*	53.1	62.5	31.3	17.3	22.9
Insecurity*	59.8	56.2	38.1	25.0	21.9
Perceived Ease of Use	66.1	72.3	71.8	81.9	90.2
Perceived Usefulness	73.0	78.4	71.8	78.0	80.6
Intention to Use	68.8	67.6	63.2	67.5	71.7

*For discomfort and insecurity, higher agreement indicates stronger perceived barriers

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The findings indicate that technology readiness and acceptance within the fresh fruit and vegetable supply chain vary across operational stages. While optimism, perceived ease of use, perceived usefulness, and intention to use are generally high across respondents, readiness inhibitors such as discomfort and insecurity remain more pronounced in production and post-harvest stages. This suggests that recognition of technological benefits does not automatically eliminate psychological and structural barriers to adoption.

The study highlights that digital readiness within a multi-stage supply chain system is not homogeneous but stage-contingent. Differences in operational roles appear to influence how technology is perceived, accepted, and internalized by actors. These findings emphasize the importance of designing differentiated digital transformation strategies that address stage-specific readiness gaps, particularly in earlier supply chain segments. Overall, this research contributes to the contextual understanding of technology readiness in agri-food systems by demonstrating structural heterogeneity within a single regional supply chain, rather than treating supply chain actors as a uniform adoption group.

Recommendations

There is a need for concrete steps, especially from the government and other policymakers, to design strategies that focus on improving variable indicators that are still low. The high level of discomfort and insecurity towards technology (IoT and blockchain) indicates the need for more intensive education and socialization programs. This education aims to increase public understanding of the benefits, workings, and security of these technologies. This step is expected to not only increase the acceptance of technology but also create an ecosystem that supports the implementation of technology (IoT and blockchain) as a whole in the fresh fruit and vegetable supply chain traceability system.

REFERENCES

Aung, M.M., Chang, Y.S. (2014). Traceability in a food supply chain: Safety and quality perspectives. *Food Control,* 39, 172-184.http://dx.doi.org/10.1016/j.foodcont.2013.11.007

Badrun B., Manaf M. (2021). The development of smart irrigation system with IoT,cloud, and Big Data. *IOP Conference Series: Earth and EnvironmentalScience*. 830(1):012009. https://doi.org/10.1088/1755-1315/830/1/012009

Balci, S.E., Tuna, O. (2021). Investigating logistics-related food loss drivers: A study on fresh fruit and vegetable supply chain. *Journal of Cleaner Production,* 318, 128561. https://doi.org/10.1016/j.jclepro.2021.128561

[BAPPENAS]. (2021). Laporan Kajian Food Loss and Wasre di Indonesia: Dalam Rangka Mendukung Penerapan Ekonomi Sirkular dan Pembangunan Rendah Karbon. Retrieved April 15, 2024, from https://lcdi-indonesia.id/2022/01/31/kelola-mubazir-pangan-food-loss-and-waste-flw-untuk-mendukung-pembangunan-rendah-karbon-dan-ekonomi-sirkular-di-indonesia/

[BPS Jabar] Badan Pusat Statistika Jawa Barat. (2024). Provinsi Jawa Barat dalam Angka 2024.

Retrieved Mei 24, 2024, from 2https://jabar.bps.go.id/publication/2024/02/28/provinsi-jawa-barat-dalam-angka-2024.html

Bruce, J.D. (2013). Purely P2P crypto-currency with finite mini-blockchain. Bitfreak. Info.

Chen, Li. (2010). A technology acceptance model for empirically testing new end-user information systems: Theory and results. *Massachusetts Institute of Technology.*

Dagar, R., Som, S., Khatri, S.K. (2018). Smart farming–IoT in agriculture. 2018 *International Conference on Inventive Research in Computing Applications (ICIRCA): IEEE.* 1052-1056. https://doi.org/10.1109/ICIRCA.2018.8597264

Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340. http://dx.doi.org/10.2307/249008

Davis, F.D., Bagozzi, R.P., Warshaw, P.R. (1989). Technology acceptance model. *Journal of Management Science (JMAS)* 35(8):982-1003. https://doi.org/10.1287/mnsc.35.8.982

Ernawati, E. (2021). Model pengembangan inovasi berbasis jaringan rantai pasok dan kapabilitas organisasi pembelajar (studi kasus industri pangan olahan) (Doctor's disertation). Bogor: Graduate School, IPB University.

[FAO] Food Agricultural Organization. 2023. Retrieved Mei 15, 2024.

Fardi, I. (2014). Manfaat Teknologi Informasi dan Komunikasi (TIK) terhadap bidang pertanian. Sistem Komputer, Fakultas Ilmu Komputer, Universitas Narotama, 1-5.

Folinas, D., Manikas, I., Manos, B. 2006. Traceability data management for food chains. *British Food Journal,* 108(8), 622-633. http://dx.doi.org/10.1108/00070700610682319

[GHI] Global Hunger Index. Indonesia Global Hunger Index. Retrieved Mei 25, 2024 from https://www.globalhungerindex.org/indonesia.html

Ihsan, T., Derosya, V. (2024). Tinjauan strategi pengemasan buah dan sayur dalam memerangi food loss dalam rantai pasokan pascapanen di Indonesia.*Jurnal Ilmu Lingkungan,* 22(4),1078-1087. https://doi.org/10.14710/jil.22.4.1078-1087

Lin, C.H., Shih, H.Y., Sher, P.J. (2007). Integrating technology readiness into technology acceptance: The TRAM model.Psychology & Marketing, 24(7),641-657. http://dx.doi.org/10.1002/mar.20177

McClements, D.J., Barrangou, R., Hill, C., Kokini, J.L., Lila, M.A., Meyer, A.S., Yu, L. (2021). Building a resilient, sustainable, and healthier food supply through innovation and technology. Annual review of food science and technology, 12,1-28. http://dx.doi.org/10.1146/annurev-food-092220-030824

Minta, N.K., and Stephen, O. (2017). Importance-Performance Matrix Analysis (IPMA) of service quality and customer satisfaction in the Ghanaian banking industry. *International Journal of Academic Research in Business and Social Sciences,* 7(7). https://doi.org/ 10.6007/ijarbss/v7-i7/3120

Parasuraman, A., Colby, C.L. (2015). An updated and streamlined technology readiness index: TRI 2.0. *Journal of Service Research,* 18(1), 59–74. https://psycnet.apa.org/doi/10.1177/1094670514539730

Park, W. 2020. The farms growing beneath our cities. BBC. Retrieved 10 April, 2024 from https://www.bbc.com/future/bespoke/followthe-food/the-massive-farms-emerging-beneath-our-cities.html

[PRI] Pemerintah Republik Indonesia. (1996). Undang Undang Republik Indonesia Nomor 7 Tahun 1996 tentang Pangan. Jakarta: Sekretariat Negara

Prilliadi, H. (2022). *Rantai Pasok Pangan Berkelanjutan dengan Penerapan Teknologi Industri 4.0.* Jakarta: BRIN. https://doi.org/10.55981/brin.470

Sharma, A., Jhamb, D., Mittal, A. (2020). Food supply chain traceability by using blockchain technology. *Journal of Computational and Theoretical Nanoscience.* 17(6):2630-2636. https://doi.org/10.1166/jctn.2020.8958

Sugiyono. (2013). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D.* Bandung: Alfabeta.

Suroso, A.I., Rifai, B., Hasanah, N. (2021). Traceability system in hydroponic vegetables supply chain using blockchain technology. *International Journal of Information & Management Sciences*. 32(4). doi:10.6186/IJIMS.20211232(4).0005

Suryana, A. (2014). Menuju ketahanan pangan Indonesia berkelanjutan 2025: tantangan dan penanganannya. *Forum Penelitian Agro Ekonomi*, 32(2), 123-135. https://doi.org/10.21082/fae.v32n2.2014.123-135

Tagarakis, A.C., Benos, mcL., Kateris, D., Tsotsolas, N., Bochtis, D. (2021). Bridging the gaps in traceability systems for fresh produce supply chains: Overview and development of an integrated IoT-based system.Applied Sciences, 11(16), 7596. https://doi.org/10.3390/app11167596

[UN] United Nations. (2023). Sustainable Development Goals. Retrieved 12 April, 2024 from https://sdgs.un.org/goals/goal2

Yusuf, A. (2022). Implementasi Internet of Things pada ruangan pengering berbasis web. *Jurnal Portal Data.* 2(10).