IAIC Transactions on Sustainable Digital Innovation (ITSDI)
Vol. 6, No. 2, April 2025, pp. 205∼214
E-ISSN: 2715-0461 P-ISSN: 2686-6285, DOI:10.34306

Digital Onboarding in Agricultural Platforms and its Impact on Agricultural Productivity

Richard Andre Sunarjo[1*], Tri Pujiati[2], Dwi Apriliasari[3], Marviola Hardini[4],
[1]Faculty of Economics and Business, University of Raharja, Indonesia
[2]Faculty of Social and Cultural Sciences, Universitas Trunojoyo Madura, Indonesia
[3]Faculty of Science and Technology, University of Raharja, Indonesia
[4]Faculty of Science and Technology, Ijiis Incorporation, Singapore
[1]richard.sunarjo@raharja.info, [2]tri.pujiati@trunojoyo.ac.id, [3]dwi.apriliasari@raharja.info, [4]marviolagraceh@ijiis.asia
***Corresponding Author**

Article Info

Article history:

Submission January 02, 2025
Revised February 20, 2025
Accepted April 15, 2025
Published April 25, 2025

Keywords:

Digital Onboarding
Precision Agriculture
Sustainable Farming
Agricultural Technology
Decision Support System

ABSTRACT

This study explores the transformative role of digital onboarding in the agricultural sector, emphasizing its potential to bridge the digital divide, enhance productivity, and promote sustainability. **By integrating advanced technologies such as** Artificial Intelligence (AI), blockchain, and the Internet of Things (IoT), digital onboarding provides a pathway for stakeholders to adopt precision agriculture. It also helps overcome key obstacles such as limited digital skills and unequal access to tools or infrastructure. The research extends digital ecosystem theory by framing onboarding as a practical pathway for building inclusive and resilient farming systems. It highlights the importance of integrating technological innovations with policy frameworks and capacity building initiatives to ensure equitable benefits for smallholder farmers and marginalized groups. **A qualitative and analytical approach was** employed, synthesizing insights from scientific literature, case studies, and expert reviews. The study examines global agricultural digital platforms such as Estagrx to evaluate the effectiveness of digital onboarding strategies in diverse geographical and socio-economic contexts. **Findings reveal that** digital onboarding strengthens agricultural system robustness by enhancing stakeholder engagement, improving supply chain transparency, and optimizing resource utilization. Additionally, it supports sustainable agricultural practices through precision techniques that reduce wastage and conserve resources. **The study concludes that** addressing barriers such as cultural resistance and socioeconomic disparities requires collaborative efforts among governments, private sectors, and international organizations to scale digital solutions for agriculture effectively.

This is an open access article under the CC BY 4.0 license.

DOI: https://doi.org/10.34306/itsdi.v6i2.688
This is an open-access article under the CC-BY license (https://creativecommons.org/licenses/by/4.0/
©Authors retain all copyrights

1. INTRODUCTION

The agricultural sector is at a critical juncture, driven by the unexpected convergence of revolutionary technologies such as Artificial Intelligence (AI), blockchain, the Internet of Things (IoT), and precision agriculture, as innovations that merely reshape traditional farming paradigms and also create revolutions of productivity, sustainability, and resource allocation on a precision scale [1, 2, 3]. The path to fully implementing these breakthroughs is fraught with complications, where the majority portion of the global farming population faces systemic barriers such as a lack of digital literacy, insufficient infrastructure, and unequal access to advanced equipment. In this environment, digital onboarding the methodical integration of stakeholders into digital ecosystems has emerged as a critical strategy for addressing these difficulties. This approach not only fosters inclusivity but also unleashes the transformative potential of digital technologies in agriculture, offering a crucial pathway to address pressing issues like food security, environmental sustainability, and rural development [4, 5]. This research gains heightened relevance as global agriculture faces dual disruptions one from rapid digital transformation and the other from intensifying climate variability. The simultaneous emergence of digital ecosystems and environmental unpredictability necessitates adaptive strategies like digital onboarding that can respond swiftly and inclusively. This makes the present investigation not only timely but also essential in shaping resilient agricultural futures [6, 7].

Digital onboarding serves as a hub, connecting farmers, agribusiness stakeholders, and agricultural institutions with the benefits of contemporary technologies. In this study we frame digital onboarding as a three step continuum access, adoption, and adaptation where each phase sequentially strengthens ecosystem resilience through deeper digital engagement and continuous feedback loops [8]. Digital onboarding needs to foster stakeholder engagement with agriculture on digital literacy and provide a tailored support framework. This process empowers stakeholders to nimbly navigate and adopt innovations ranging from data driven decision making platforms to real time supply chain monitoring systems [9]. The implications of digital onboarding extend beyond individual stakeholders by enhancing systemic resilience and equipping the entire agricultural ecosystem to adapt to climate variability, market fluctuations, and resource constraints [10, 11]. Other impacts, such as The synergistic deployment of emerging technologies optimizes resource utilization and underpins long term sustainability.

The deployment of digital onboarding strategies encounters multifaceted challenges such as cultural resistance, socioeconomic disparities, and skepticism towards technological solutions often impede adoption. The digitalization system divided between developed and developing regions exacerbates inequalities, particularly placing smallholder farmers at risk of exclusion from technological advancements [12, 13, 14]. Addressing these barriers necessitates a comprehensive approach that encompasses robust policy frameworks, capacity building initiatives, and investments in digital infrastructure.

This alignment between technological innovation and policy action ensures that digital onboarding is not merely a technological upgrade but a holistic transition supported by regulation and inclusion mandates [15, 16]. Collaborative efforts among governments, private sectors, and international organizations are imperative to ensure that digital onboarding strategies are accessible, scalable, and tailored to meet the diverse needs of agricultural communities across varying geographies [17, 18].

Figure 1. Sustainable Development Goals

This study aligns with several Sustainable Development Goals (SDGs), including SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 9 (Industry, Innovation and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 17 (Partnerships for the Goals). Figure 1 illustrates how digital onboarding in agriculture contributes to these goals by enabling inclusive access to technology, improving productivity, and supporting sustainable practices [19, 20, 21].

This study endeavors to scrutinize the role of digital onboarding in bridging the digital divide within agriculture while emphasizing its ramifications for enhancing productivity, sustainability, and market accessibility. This study investigates the predominant barriers to digital adoption in agriculture, examining how digital onboarding strategies can effectively address these challenges. It further explores how initiatives aimed at enhancing digital literacy can empower marginalized groups, particularly women and youth, while also considering the critical role of policy frameworks and infrastructure investments in scaling digital agricultural solutions [22, 23]. By engaging with these core inquiries, the research contributes to the broader discourse on sustainable agriculture by offering evidence-based insights and strategic recommendations that support the development of an inclusive, technology-driven agricultural future [24, 25].

2. LITERATURE REVIEW

2.1. Digital Technologies

Digital technologies are conceptualized as an infrastructure encompassing Internet connectivity, energy and smartphone applications tailored for agricultural objectives, provided users possess sufficient accessibility, training and support. Utilizing the distinction between embedded and non embedded innovations (a critical framework), digital technologies can be categorized into two primary classifications which are those integrated within physical artifacts (for instance, farm machinery or sensors) and non embedded software tools (which include farm advisory applications and online platforms). The former category precision agriculture employs a confluence of technologies to generate, gather and analyze data; these include remote sensing, wireless sensors, drones and robotics [26, 27, 28].

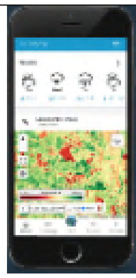
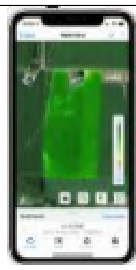
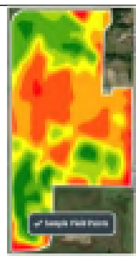
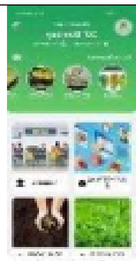
2.2. Digital Technologies

In the early 1990s, agricultural systems were introduced by public entities to address poverty and strengthen rural economies. These systems focused on data collection, information generation, packaging, and dissemination, aiming to minimize search costs and improve market efficiencies in agriculture. However, they struggled to deliver services effectively due to their ineffective business model. Since 2010, digital agricultural systems have been adopted by a new wave of agritech companies to simplify marketplace transactions and streamline agricultural trade financing. These platforms are strategically designed to expand market access, improve information flow, and enhance decision making efficiency for farmers [29, 30].

The broader implications of digital onboarding extend beyond mere agricultural productivity; economically, it has the potential to invigorate rural economies by creating novel tech-centric opportunities while addressing labor displacement through skill enhancement programs. Environmentally, the infusion of digital tools into agricultural practices supports precision techniques that curtail wastefulness, conserve water resources, and reduce carbon emissions. Socially, democratizing access to technology empowers historically marginalized groups within agricultural systems promoting equity and inclusivity. However, realizing these multifarious benefits mandates ongoing engagement with stakeholders alongside a steadfast commitment to dismantling systemic inequalities through adaptive solutions that resonate with the evolving needs of the agricultural sector [31].

Table 1 presents selected digital agriculture platforms that offer farmers agronomic and farm management information based on their data. These platforms range from corporate owned solutions, such as Climate Corp., to nonprofit initiatives like FaST. They support data-driven decision making and provide tailored digital services across diverse regional and ownership models [32, 33, 34].

Table 1. Selected Global Agriculture Platforms

Platform	URL	Region	Ownership	Screenshot
FaST	`https://fastplatform.eu`	EU	Public	
Climate Corporation	`https://climate.com`	EU	Private	
New Vision Coop	`https://www.newvision.coop`	USA	Private	
Estagrx	`https://www.estagrx.com`	USA	Private	

As shown in Table 1, the selected digital platforms demonstrate a broad spectrum of infrastructural components and technological capabilities that are actively utilized in modern agricultural systems. These platforms not only exemplify the diversity of tools available for digital onboarding, but also reflect how both public and private sector stakeholders leverage such infrastructures to enhance data accessibility, operational efficiency, and informed decision making at the farm level.

3. RESEARCH METHODOLOGY

A qualitative multiple case study approach was employed to examine the onboarding practices of digital platforms in agriculture. As summarized in Table 1, the selected platforms represent a range of digital infrastructures supporting farm-level decision making and data accessibility. Data were collected from official reports, white papers, and platform dashboards of Estagrx, The Climate Corporation, New Vision Coop, and FaST during the period 2022–2024.

We applied directed content analysis to identify patterns related to access, adoption, and adaptation within these platforms. To ensure the validity of interpretations, expert validation was conducted through six semi structured interviews with professionals involved in digital agriculture [35, 36].

4. RESULTS AND DISCUSSION

The findings from the qualitative analysis and expert validation highlight the layered structure of digital onboarding platforms in agriculture. These layers include data engineering, analytics, and user interfaces, which collectively enable access, adoption, and adaptation. The architecture facilitates seamless integration of services and ensures scalable support for various agricultural stakeholders.

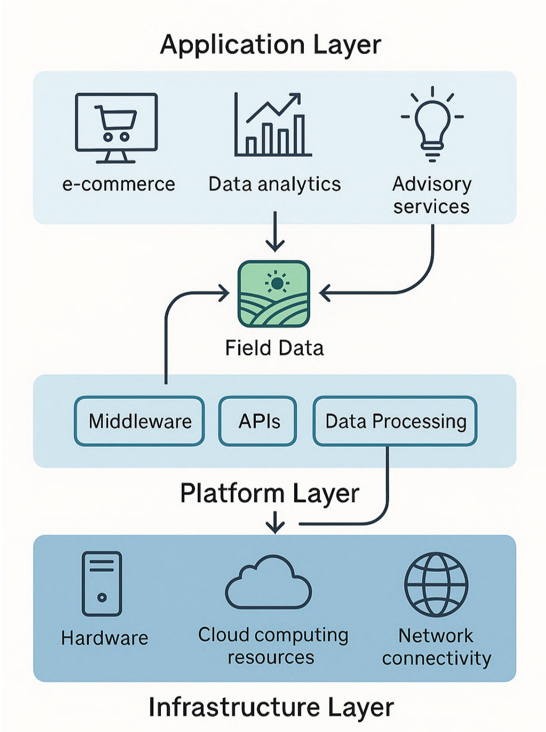


Figure 2. Digital Platform Architecture Illustrating Layers that Support Agricultural Onboarding.

This section addresses the research question of how digital onboarding enhances farm level decision making and system resilience. Figures 1 and 2 are analyzed to show how platform and DSS architectures reflect the onboarding continuum access, adoption, and adaptation as introduced in the conceptual framework [37, 38]. A digital platform system architecture as shown in Figure 1 serves as the foundational framework enabling the seamless integration of diverse components, ensuring effective operations and scalability. At its core, the architecture typically consists of three main layers namely the infrastructure layer, the platform layer, and the application layer. The infrastructure layer includes hardware, cloud computing resources, and network connectivity, which together form the physical and virtual environment that supports platform operations. The platform layer provides essential middleware, APIs, and data processing capabilities, enabling interaction between applications and infrastructure. The application layer contains user facing applications and services tailored to meet specific needs, such as e-commerce, data analytics, or content delivery. These layers collectively create a modular and interoperable system, allowing for rapid innovation and adaptability in dynamic digital ecosystems [39, 40, 41].

Scalability and interoperability are critical features of an effective digital platform system architecture. Scalability ensures that the system can handle increasing loads by horizontally or vertically scaling resources, while interoperability allows diverse systems and technologies to communicate seamlessly within the platform. Advanced digital platforms often adopt microservices architecture, breaking down applications into smaller, independently deployable components to enhance flexibility and fault tolerance. Furthermore, data flow management and security mechanisms, such as encryption and access control, are integrated to ensure data integrity and compliance with regulatory standards. Together, these architectural elements foster innovation, improve user experiences, and provide a competitive advantage in todays highly connected and rapidly evolving digital landscape [42, 43].

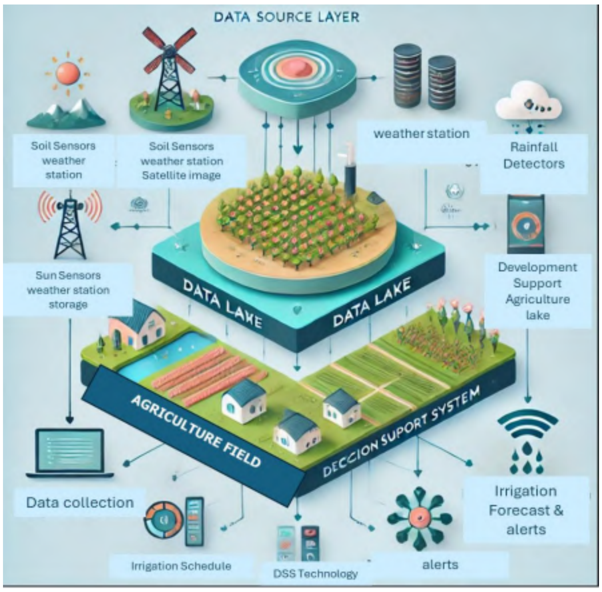


Figure 3. DSS architecture supporting data driven farm decisions.

Figure 2 not only maps the data flow but also highlights feedback loops that translate raw field data into actionable insights, thus illustrating how DSS operationalizes the three step digital onboarding continuum introduced earlier. The integration of Decision Support Systems (DSS) in agriculture, as illustrated in Figure 3, revolutionizes data driven farming. The ”Data Source Layer” consolidates inputs from various technologies such as soil sensors, weather stations, satellite imagery, and field drones. This data undergoes processing in the ”Data Lake” phase, where raw inputs are unified, 6 cleaned, and standardized for advanced analysis. By structuring the data efficiently, DSS ensures seamless communication across APIs, laying the foundation for actionable insights [44, 45, 46].

In the ”DSS Techniques” phase, cutting-edge methods like crop yield prediction, pest detection, irrigation scheduling, and disease forecasting optimize agricultural operations [47, 48]. These insights are presented through an intuitive ”DSS Interface” featuring mobile apps, web dashboards, and timely alerts, enabling farmers to make informed decisions. Such systems not only improve productivity but also promote sustainable agricultural practices, reducing resource wastage and ensuring food security [49, 50, 51].

5. MANAGERIAL IMPLICATIONS

The integration of DSS in agriculture presents actionable opportunities for policymakers, agribusinesses, and farmers. By adopting DSS, stakeholders can streamline resource allocation, predict climate impacts on crop yields, and manage pest outbreaks proactively. Governments can prioritize investments in data infrastructure and training programs to ensure smallholder farmers benefit from these technologies. Agribusinesses, in turn, can leverage predictive analytics to reduce supply chain inefficiencies and ensure sustainability. These actions collectively enable more resilient and profitable agricultural practices aligned with global sustainability goals. To operationalize these actions, we outline a three phase roadmap pilot, scale up, institutionalization backed by KPIs such as a 15% yield gain and 20% input cost reduction within three seasons, enabling stakeholders to track ROI and sustain investment.

6. FUTURE RESEARCH

Future research should focus on the scalability of DSS in diverse agricultural ecosystems, particularly in developing nations. Investigations into the integration of artificial intelligence and machine learning within DSS could provide further advancements in predictive capabilities. Additionally, exploring the economic feasibility of DSS adoption for smallholder farmers, including subsidized models or public private partnerships, could ensure equitable access. Longitudinal studies assessing the long term impacts of DSS on agricultural yields, environmental health, and farmer livelihoods would also enrich current knowledge.

7. CONCLUSION

Decision Support Systems (DSS) have proven to be transformative in modern agriculture, offering tools that align technology with sustainability goals. Despite their promise, digital adoption remains hindered by persistent challenges such as infrastructure limitations, digital illiteracy, and platform distrust especially among smallholder communities. Onboarding strategies that prioritize ease of access, contextual digital literacy, and locally relevant features have shown effectiveness in improving participation and transparency across agricultural platforms. Mobile-based DSS tools, in particular, have provided inclusive solutions that benefit marginalized groups like women and youth.

This study underscores the importance of connecting technological innovation with policy frameworks and infrastructure development. It highlights how cross-sector collaboration between governments, private actors, and civil society is essential to scaling digital solutions that are both equitable and efficient. By integrating diverse data sources and applying predictive analytics, DSS not only enhances farm level decision making but also strengthens overall system resilience and transparency in agricultural value chains.

Moving forward, sustained innovation and investment in agricultural DSS are needed to address global challenges such as climate variability, resource scarcity, and food insecurity. Future research should explore adaptive onboarding models across different agro-ecological and socio-economic contexts, while also evaluating long-term outcomes. These efforts will be key to building a more inclusive, data driven agricultural future for the next generation of farmers.

8. DECLARATIONS

8.1. About Authors

Richard Andre Sunarjo (RA) https://orcid.org/0009-0007-7349-2375

Tri Pujiati (TP) https://orcid.org/0009-0002-6067-6259

Dwi Apriliasari (DA) https://orcid.org/0000-0001-5597-0475

Marviola Hardini (MH) https://orcid.org/0000-0003-3336-2131

8.2. Author Contributions

Conceptualization: RA; Methodology: TP, DA and MH; Software: TPN dan MH; Validation: RA; Formal Analysis: RA, TP and DA; Investigation:TP, DA, and MH; Resources: TP; Data Curation: DA; Writing Original Draft Preparation: RA and MH; Writing Review and Editing: RA, DA, and MH; Visualization: RA; All authors, RA, TP, DA and MH, have read and agreed to the published version of the manuscript.

8.3. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

8.4. Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

8.5. Declaration of Conflicting Interest

The authors declare that they have no conflicts of interest, known competing financial interests, or personal relationships that could have influenced the work reported in this paper.

REFERENCES

[1] M. H. R. Chakim, P. A. Sunarya, V. Agarwal, I. N. Hikam *et al.*, “Village tourism empowerment against innovation, economy creative, and social environmental,” *Aptisi Transactions on Technopreneurship (ATT)*, vol. 5, no. 2sp, pp. 162–174, 2023.

[2] I. Ara, L. Turner, M. T. Harrison, M. Monjardino, P. deVoil, and D. Rodriguez, “Application, adoption and opportunities for improving decision support systems in irrigated agriculture: A review,” *Agricultural Water Management*, vol. 257, p. 107161, 2021.

[3] I. Tomashuk, S. Koliadenko, and M. Burdak, "The impact of digital innovations on the development of agricultural business," *Baltic Journal of Economic Studies*, vol. 11, no. 1, pp. 361–375, 2025.

[4] Y. Durachman, A. S. Bein, E. P. Harahap, T. Ramadhan, and F. P. Oganda, "Technological and islamic environments: Selection from literature review resources," *International Journal of Cyber and IT Service Management*, vol. 1, no. 1, pp. 37–47, 2021.

[5] J. D. Borrero and J. Mariscal, "A case study of a digital data platform for the agricultural sector: A valuable decision support system for small farmers," *Agriculture (Switzerland)*, vol. 12, no. 6, 2022.

[6] R. Abiri, N. Rizan, S. K. Balasundram, A. B. Shahbazi, and H. Abdul-Hamid, "Application of digital technologies for ensuring agricultural productivity," *Heliyon*, vol. 9, no. 12, 2023.

[7] T. Handra and V. P. K. Sundram, "The effect of human resource information systems (hris) and artificial intelligence on defense industry performance," *IAIC Transactions on Sustainable Digital Innovation (ITSDI)*, vol. 4, no. 2, pp. 155–163, 2023.

[8] J. D. Borrero and A. Zabalo, "An autonomous wireless device for real-time monitoring of water needs," *Sensors (Switzerland)*, vol. 20, no. 7, pp. 1–16, 2020.

[9] D. J. Choruma, T. L. Dirwai, M. J. Mutenje, M. Mustafa, V. G. P. Chimonyo, I. Jacobs-Mata, and T. Mabhaudhi, "Digitalisation in agriculture: A scoping review of technologies in practice, challenges, and opportunities for smallholder farmers in sub saharan africa," *Journal of Agriculture and Food Research*, vol. 18, p. 101286, 2024.

[10] E. P. Lestari, S. D. W. Prajanti, F. Adzim, E. Primayesa, M. I. A.-B. Ismail, and S. L. Lase, "Understanding technopreneurship in agricultural e-marketplaces," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 6, no. 3, pp. 369–389, 2024.

[11] J. Forney and L. Epiney, "Governing farmers through data? digitization and the question of autonomy in agri-environmental governance," *Journal of Rural Studies*, vol. 95, pp. 173–182, 2022.

[12] M. Kenney, H. Serhan, and G. Trystram, "Digitalization and platforms in agriculture: organizations, power asymmetry, and collective action solutions," ETLA Working Papers, Tech. Rep., 2020.

[13] S. Purnama and W. Sejati, "Internet of things, big data, and artificial intelligence in the food and agriculture sector," *International Transactions on Artificial Intelligence*, vol. 1, no. 2, pp. 156–174, 2023.

[14] S. Hackfort, "Patterns of inequalities in digital agriculture: A systematic literature review," *Sustainability (Switzerland)*, vol. 13, no. 22, 2021.

[15] J. Barungi, A. K. Ssebwana, J. Okonya, and J. W. Recha, "Enhancing digital literacy of potato farmers in the utilization of the viazi soko and agribora platforms for market linkages in kenya," 2025.

[16] A. Pambudi, O. Wilson, and J. Zanubiya, "Exploring the synergy of global markets and digital innovation in business growth using smartpls," *IAIC Transactions on Sustainable Digital Innovation (ITSDI)*, vol. 6, no. 1, pp. 106–113, 2024.

[17] E. Jones-Garcia and V. V. Krishna, "Farmer adoption of sustainable intensification technologies in the maize systems of the global south. a review," *Agronomy for Sustainable Development*, vol. 41, no. 1, 2021.

[18] A. Beriya, "India digital ecosystem of agriculture and agristack: An initial assessment," ICT India Working Paper, Tech. Rep., 2022.

[19] N. Lutfiani, S. Wijono, U. Rahardja, A. Iriani, and E. Nabila, "Artificial intelligence based on recommendation system for startup matchmaking platform n," in *IEEE Creative Communication and Innovative Technology (ICCIT)*, vol. 2, 2022, pp. 1–5.

[20] A. Márton, "Steps toward a digital ecology: ecological principles for the study of digital ecosystems," *Journal of Information Technology*, vol. 37, no. 3, 2022.

[21] A. I. L. Wibowo, A. D. Putra, M. S. Dewi, and D. O. Radianto, "Differences in intrinsic value with stock market prices using the price earning ratio (per) approach as an investment decision making indicator (case study of manufacturing companies in indonesia period 2016-2017)," *Aptisi Transactions On Technopreneurship (ATT)*, vol. 1, no. 1, pp. 82–92, 2019.

[22] V. Meilinda, S. A. Anjani, and M. Ridwan, "A platform based business revolution activates indonesia's digital economy," *Startupreneur Business Digital (SABDA Journal)*, vol. 2, no. 2, pp. 155–174, 2023.

[23] S. Ajambo, S. Ogutu, E. Birachi, and E. Kikulwe, *Digital agriculture platforms: Understanding innovations in rural finance and logistics in Uganda's agrifood sector*. Intl Food Policy Res Inst, 2023, vol. 5.

[24] N. Singh and K. Dey, "A typology of agricultural market information systems and its dimensions: Case

studies of digital platforms," *Electronic Markets*, vol. 33, no. 1, p. 42, 2023.

[25] F. M. Wuaten, "The role of sustainable finance and technology at bank bjb in supporting the" sustainable development goals"," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 5, no. 1Sp, pp. 97–108, 2023.

[26] G. E. Mushi, G. D. M. Serugendo, and P. Y. Burgi, "Digital technology and services for sustainable agriculture in tanzania: A literature review," *Sustainability (Switzerland)*, vol. 14, no. 4, pp. 1–17, 2022.

[27] G. E. Dawson Jr, J. A. V. Antunes Jr, D. Wegner, and V. S. Adami, "Creating a digital platform for the agricultural cooperative system through interorganizational collaboration," *Journal of Rural Studies*, vol. 110, p. 103388, 2024.

[28] N. P. L. Santoso, R. Nurmala, and U. Rahardja, "Corporate leadership in the digital business era and its impact on economic development across global markets," *IAIC Transactions on Sustainable Digital Innovation (ITSDI)*, vol. 6, no. 2, pp. 188–195, 2025.

[29] U. Rahardja, A. N. Hidayanto, P. O. H. Putra, and M. Hardini, "Immutable ubiquitous digital certificate authentication using blockchain protocol," *Journal of Applied Research and Technology*, vol. 19, pp. 308–321, 2021.

[30] A. Krishnan, K. Banga, and M. Mendez-Parra, "Disruptive technologies in agricultural value chains," *Insights from East Africa. Working paper*, vol. 576, 2020.

[31] N. Singh and S. Kapoor, "Configuring the agricultural platforms: farmers' preferences for design attributes," *Journal of Agribusiness in Developing and Emerging Economies*, vol. 14, no. 5, pp. 1176–1194, 2024.

[32] I. Shantilawati, O. I. Suri, R. A. Sunarjo, S. A. Anjani, and D. Robert, "Unveiling new horizons: Ai-driven decision support systems in hrm-a novel bibliometric perspective," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 7, no. 1, pp. 252–263, 2025.

[33] M. Remondino and A. Zanin, "Logistics and agri-food: Digitization to increase competitive advantage and sustainability. literature review and the case of italy," *Sustainability (Switzerland)*, vol. 14, no. 2, 2022.

[34] R. R. Shamshiri, B. Sturm, C. Weltzien, J. Fulton, R. Khosla, M. Schirrmann, S. Raut, D. H. Basavegowda, M. Yamin, and I. A. Hameed, "Digitalization of agriculture for sustainable crop production: a use-case review," *Frontiers in Environmental Science*, vol. 12, pp. 1–32, 2024.

[35] U. Rahardja, T. Hongsuchon, T. Hariguna, and A. Ruangkanjanases, "Understanding impact sustainable intention of s-commerce activities: The role of customer experiences, perceived value, and mediation of relationship quality," *Sustainability*, vol. 13, no. 20, p. 11492, 2021.

[36] L. P. Dewanti, L. Sitoayu, and A. Idarto, "Digital tele-counseling for sustainable maternal health services in indonesia focus on telelactation," *IAIC Transactions on Sustainable Digital Innovation (ITSDI)*, vol. 6, no. 1, pp. 10–20, 2024.

[37] N. Singh and K. Dey, "A typology of agricultural market information systems and its dimensions: Case studies of digital platforms," *Electronic Markets*, vol. 33, no. 1, 2023.

[38] A. C. Cob-Parro, Y. Lalangui, and R. Lazcano, "Fostering agricultural transformation through ai: an open-source ai architecture exploiting the mlops paradigm," *Agronomy*, vol. 14, no. 2, p. 259, 2024.

[39] E. Dolan, S. Kosasi, and S. N. Sari, "Implementation of competence-based human resources management in the digital era," *Startupreneur Business Digital (SABDA Journal)*, vol. 1, no. 2, pp. 167–175, 2022.

[40] Z. Tao and J. Chao, "Unlocking new opportunities in the industry 4.0 era, exploring the critical impact of digital technology on sustainable performance and the mediating role of gscm practices," *Innovation and Green Development*, vol. 3, no. 3, p. 100160, 2024.

[41] S. Evseeva, O. Evseeva, A. Burmistrov, and M. Siniavina, "Application of artificial intelligence in human resource management in the agricultural sector," in *E3S Web of Conferences*, vol. 258. EDP Sciences, 2021, p. 01010.

[42] D. Jonas, E. Maria, I. R. Widiasari, U. Rahardja, T. Wellem *et al.*, "Design of a tam framework with emotional variables in the acceptance of health-based iot in indonesia," *ADI Journal on Recent Innovation*, vol. 5, no. 2, pp. 146–154, 2024.

[43] T. Wang, X. Xu, C. Wang, Z. Li, and D. Li, "From smart farming towards unmanned farms: A new mode of agricultural production," *Agriculture (Switzerland)*, vol. 11, no. 2, pp. 1–26, 2021.

[44] A. Gabriel and M. Gandorfer, "Adoption of digital technologies in agriculture—an inventory in a european small-scale farming region," *Precision Agriculture*, vol. 24, no. 1, pp. 68–91, 2023.

[45] D. Apriani, A. Williams, U. Rahardja, A. Khoirunisa, and S. Avionita, "The use of science technology in

islamic practices and rules in the past now and the future," *International Journal of Cyber and IT Service Management*, vol. 1, no. 1, pp. 48–64, 2021.
[46] L. Xie, B. Luo, and W. Zhong, "How are smallholder farmers involved in digital agriculture in developing countries: A case study from china," *Land*, vol. 10, no. 3, pp. 1–16, 2021.
[47] D. D. Mühl and L. De Oliveira, "A bibliometric and thematic approach to agriculture 4.0," *Heliyon*, vol. 8, no. 5, 2022.
[48] M. R. Anwar and L. D. Sakti, "Integrating artificial intelligence and environmental science for sustainable urban planning," *IAIC Transactions on Sustainable Digital Innovation (ITSDI)*, vol. 5, no. 2, pp. 179–191, 2024.
[49] e. a. Gao, "Digital agricultural technology services and farmers' willingness to adopt digital production technologies," *Frontiers in Sustainable Food Systems*, 2024.
[50] F. P. Oganda, N. Lutfiani, Q. Aini, U. Rahardja, and A. Faturahman, "Blockchain education smart courses of massive online open course using business model canvas," in *2020 2nd International Conference on Cybernetics and Intelligent System (ICORIS)*. IEEE, 2020, pp. 1–6.
[51] D. Hernandez, L. Pasha, D. A. Yusuf, R. Nurfaizi, and D. Julianingsih, "The role of artificial intelligence in sustainable agriculture and waste management: Towards a green future," *International Transactions on Artificial Intelligence*, vol. 2, no. 2, pp. 150–157, 2024.