Smart Technology Adoption in Food Supply Chain to Tackle Climate Change: Practice in Small-Holder Farmers and SME

Adrin R. Rauf, Adigna P. Inanka, Auditia Anwar, and Febriantina Dewi(✉)

School of Business, IPB University, Bogor, Indonesia
febriantinade@apps.ipb.ac.id

Abstract. By 2050 it is estimated that the world will need 70% more food production. SDG number 2 agenda is to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture. On the other hand, SDG number 12 aims to ensure the good use of resources, improve energy efficiency, and sustainable infrastructure, and providing access to basic services, green and decent jobs, and ensure a better quality of life for all. Unsustainable patterns of consumption and production are the root cause of climate change. The challenges of agriculture in the future are related to demography, scarcity of natural resources, climate change, and food waste which further exacerbate the problem of hunger and food scarcity. A disruptive system that involves the efforts of several actors, namely the government, investors, and innovative agricultural technology is needed. In this case, the diffusion of innovation becomes very important. despite the smartphone technology adoption in Indonesia already reach the Late Majority, however, the relevant studies show that the digital literacy of small-holder farmers and SMEs in the food industry is still low when it comes to the utilization of smart technology to optimize the operations to ensure the implementation of sustainable production and consumption to tackle climate change.

Keywords: Agriculture · Climate Change · Food Industry · Smart Technology · Small-holder Farmer · SME · Sustainability

1 Introduction

In 2015, the United Nations (UN) launched the 2030 sustainable development agenda called the Sustainable Development Goals (SDG) which consists of 17 sustainability goals. The targets of the agenda are set to be achieved by 2030 [1]. Goal number 2 of the 2030 SDG agenda is to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture. In 2014, it was estimated that there were 607 million people worldwide who were severely malnourished due to hunger, and by 2020 the number of people suffering from malnutrition due to hunger worldwide would increase to around 720–811 million people due to the COVID-19 pandemic [2]. This condition causes the opportunity to achieve target number 2 of the 2030 SDG agenda increasingly thin.

S. Jahroh et al. (Eds.): BIEC 2022, AEBMR 236, pp. 317–324, 2023.
https://doi.org/10.2991/978-94-6463-144-9_31

By 2050 it is estimated that the world will need 70% more food production. Meanwhile, agriculture's contribution to global GDP has declined to just 3%, a third of which occurred just a few decades ago. The reality is that very few innovations have taken place in the related industries, which in most cases is no indication that food scarcity and hunger will not be a problem in the coming decades [3]. This situation becomes a real justification that the world needs a drastic change in the management of the food supply chain.

On the other hand, SDG number 12 titled "responsible consumption and production", aims to ensure the good use of resources, improve energy efficiency, and sustainable infrastructure, and providing access to basic services, green and decent jobs, and ensure a better quality of life for all. Unsustainable patterns of consumption and production are the root cause of climate change. Earlier studies show that food waste is the main challenge in managing the food supply chain, in which 13.3% are wasted after harvesting and before reaching retail markets, while another 17% are wasted at the consumer level [4].

In Indonesia, the number of SMEs reaches 64.2 million, which contributes 61.07% to the total gross domestic product (GDP). In addition, SMEs can absorb 97% of the total national workforce [5]. However, this type of food processing SMEs produces large quantities of waste worldwide, where SMEs consequently create a large share of waste in the environment [6, 7].

We have heard more and more about Industry 4.0 jargon in the last five years, especially since the acceleration of digital communication and information technology that the whole world experienced simultaneously during the COVID-19 pandemic period forced people in almost all countries to adapt quickly to the demands of digitalization. Many activities that previously had to be carried out face-to-face have become remote due to the demands of health protocols.

Industry 4.0 jargon was first coined at the Hannover Messe event, which took place on April 4–8, 2011 in Germany [8]. Prof. Dr.-Ing. Detlef Zuhlke in his opening said that the 4th industrial revolution is underway and driven by internet technology. He defines four key paradigms in Industry 4.0 as follows:

- Smart Products. An intelligent product with a memory capable of being actively part of the system so that it can learn patterns to optimize itself.
- Smart Machines. The machine is capable of self-regulating itself within the production network and thus can achieve flexible and agile manufacturing processes. This machine becomes a Cyber-Physical System (CPS) with autonomous components and local control intelligence that enables the machine to communicate with other machines, production lines, and products through open networks and semantic descriptions.
- Smart Planners. Intelligence capable of managing production activities based on real-time production data.
- Smart Operators. Utilization of technology to understand production activities through context-sensitive information and enrichment of the real world with virtual information, also known as augmented reality (AR). As a result, the increasing technical complexity can be managed to make better decisions and achieve better operations.

The biggest question when we discuss the application of smart technology 4.0 in Indonesia is: what is the current level of adoption of smart technology 4.0 in Indonesia for managing the food supply chain?

2 Methods

A literature review approach was used to understand all the relevant information related to smart technology adoption in SMEs and Small-Holder farmers in Indonesia. The author used ProQuest, MDPI, and Hindawi platforms to search for relevant literature using several keywords: Food Supply Chain, Small-Holder Farmer, Smart Technology, Sustainability, SME, and Technology Adoption. The search was limited to literature that was published in the past 5 years and had gone through peer-reviewed processes. Apart from the literature review mentioned earlier, the author also searches for literature that has been proven and used as the known theory relevant to this research, information shared through credible news publications, a white paper released by a governmental research agency, as well as the information available for public from governmental reports.

3 Result and Discussion

The challenges of agriculture in the future are related to demography, scarcity of natural resources, climate change, and food waste which further exacerbate the problem of hunger and food scarcity. The author considers the need for a disruptive system that involves the efforts of several actors, namely the government, investors, and innovative agricultural technology. In this case, the diffusion of innovation becomes very important.

According to Rogers [9], diffusion is the process by which an innovation is communicated through certain channels over some time among the members of a social system. It can be concluded that the key elements of the diffusion of new ideas are the existence of innovation, communication channels, time resources, and social systems. This process is highly dependent on social capital.

To achieve the SDG 2030 agenda, the management of agricultural operations needs to be carried out differently, especially with increasingly advanced technologies such as sensors, equipment, machines, and information technology. Future agriculture will use advanced technologies such as robots, temperature and humidity sensors, aerial imaging, and GPS technology. This state-of-the-art equipment and robotic systems and precision farming will help agriculture become more profitable, efficient, safe, and environmentally friendly.

A study [10] evaluating the "Petani Go Online" program launched by the Ministry of Communication and Information of the Republic of Indonesia (Kominfo) in the application of information and digital technology applications to increase agricultural and farmer productivity shows that the level of socialization the program is not optimal. Some of the main obstacles found are that there are still many farmers who are not familiar with computer programs and digital technology. The study concludes that a strategy is needed to disseminate the program to farmers through video graphics uploaded via YouTube so that information is easier to disseminate, ready to be received and distributed to nearly 90 thousand villages in Indonesia.

Based on the news reported by Antara news [11], research by the Centre for Indonesian Policy Studies (CIPS) shows that the productivity of rice, soybeans, and shallots has tended to be sloping in recent years, and only corn productivity has shown an increasing trend until 2019. In this study, CIPS concluded that the adoption of digital technology in the upstream agricultural process needs to be increased to improve productivity, while on the downstream side the presence of this digital technology will assist farmers in accelerating market penetration. Fundamental challenges faced by farmers in Indonesia in the application of digital technology, for example, the inadequate agricultural infrastructure that supports and the lack of understanding of digital literacy. In addition, the technology in question is also usually relatively difficult to reach farmers because the price is too high and not necessarily by the scale of their business, which makes them reluctant to adopt the technology.

According to BPS data, the generation of farmers aged under 40 years in the agricultural sector is only 8 percent of the total number of farmers in Indonesia, the majority of Indonesian agricultural sector workers are over 45 years old. This is a challenge when faced with the need to adopt industrial technology 4.0 into the agricultural sector in Indonesia.

According to the 2014 Agricultural Census, 72.1% of agricultural land in Indonesia is family farmland. Around 98% of the family farms are smallholder farmers with a land area of fewer than 0.5 hectares [12]. A large number of smallholders in Indonesia is also a challenge when they want to adopt digital technology if it is linked between the investment costs for adopting these innovations and the scale of agricultural land exploitation.

Within the framework of the diffusion of innovation theory mentioned above, according to Rogers, the attributes of innovation that determine the rate of adoption are (1) relative benefits, (2) compatibility, (3) complexity, (4) ease of testing, (5) ease of observation. The author argues that with the fact that the majority of farmers in Indonesia are non-millennial generation farmers who manage family farms with an area classified as small, then the innovation that can encourage adoption is digital-based but uses technology that is familiar, easy to access, and relatively beneficial. diverse. For example, a smartphone-based digital application that helps farmers optimize planting schedules, calculate fertilizer allocations, scan soil conditions, connect with agricultural crop suppliers and buyers, and provide weather information. Because smartphones can be used by farmers not only for agricultural activities but also as a basic means of daily communication, the authors argue that the relative benefits that farmers can receive are getting bigger. In addition, the compatibility, complexity, and ease of testing and observing smartphones can also be considered something now commonplace.

Rogers also argues that mass communication media are more effective in creating knowledge of innovation, but interpersonal communication channels are more effective in influencing the decision to adopt an innovation. With this foundation, the authors believe that appropriate technology based on smartphones will be more easily adopted by farmers because the existence of smartphones is easier in creating interpersonal communication which in turn accelerates the adoption of innovations.

Judging from the time element in the diffusion of innovations, Rogers divides the categories of innovation adopters into (1) Innovators, (2) Early Adopters, (3) Early

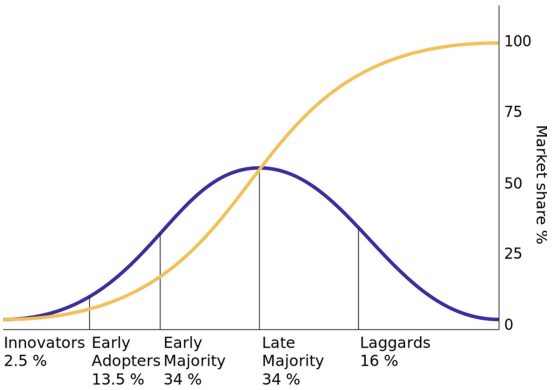

Fig. 1. Categories of Innovation Adopters (source: Rogers, 2003)

Majority, (4) Late Majority, and (5) Laggards. Figure 1 illustrates the distribution of innovation adopters.

Smartphones are not new in Indonesia; a study shows that the smartphone penetration rate in Indonesia in 2020 has reached more than 60% of the population [13]. This is reinforced by studies that show that the level of internet penetration in Indonesia at the beginning of 2022 has reached more than 70% of the population [14]. So if it is related to Fig. 1, the author concludes that currently in Indonesia smartphones have entered the Late Majority category so it can be a justification that smartphones can be an appropriate technology for farmers that is quite easy to adopt.

In the social system element, Rogers divides the types of innovation decisions into (1) optional innovation-decision driven by individual decisions, (2) collective innovation-decision where innovation decisions are the result of the consensus of members of a social system, and (3) authority innovation-decision where innovation decisions are made by a group of individuals who influence a particular social system. Referring to the socio-agricultural system in Indonesia, the author believes that the collective innovation-decision model and the authoritative innovation-decision model are the most suitable to be applied in Indonesia. This type of collective innovation decision is suitable to be applied to farming communities that have structured "paguyuban" organizations or groups in cooperatives. However, the majority of Indonesian people have paternalistic social relations, it is also appropriate to implement authoritative innovation decisions that make the head of the farmer's family or an elder in the farming community group the decision maker. Once again, the author believes that smartphones are a technology that is also quite easy to be used as the basis for making innovation decisions either through group consensus or represented by influential groups.

A study [15] related to green innovation adoption by SMEs within the food processing industry in Indonesia further confirms the above-mentioned argument about social system elements within small-holder farmers. The study found that pro-green leaders, green human capital, and green marketplace orientation affect green innovation adoption amongst food processing SMEs. This result is consistent with the prediction of the current study, which emphasized the critical position of absorptive ability and

pro-green leader as drivers of the adoption of green innovation amongst food processing SMEs, especially from the perspective of an emerging market country such as Indonesia. Understanding this model can assist in developing programs that could facilitate SMEs in adopting green innovation in their companies. A pro-green leader significantly affects green innovation adoption. Developing the mind-set, attitude, and behavior of pro-green leaders can be carried out by increasing the absorptive capacity of food processing SMEs through various methods, such as training and workshops. This study shows that pro-green leadership can combine human capital and market orientation culture to encourage green innovation adoption amongst food processing SMEs.

Another study [16] focusing on a systematic literature review about sustainability practice in SMEs shows that the results point to the important role that external factors and internal factors play in influencing SMEs to take on sustainability-oriented initiatives and work toward sustainability goals. Overall, the findings suggest that research on SME sustainability has received limited attention. The study also provided evidence of the main limitations and gaps, identifying opportunities for future research. Evidence of this underdeveloped field of research ranges from the recentness of the existing literature reviews to the lack of critical research. Another aspect that was deemed a fruitful line of research concerns the relationships between intellectual capital and its management and sustainability in SMEs. The study concludes that endeavours such as this focusing on sustainability management methods would amount to a line of research with considerable practical impacts.

4 Conclusion

Based on the discussion and the earlier studies, we can conclude that despite the smartphone technology adoption in Indonesia already reach the Late Majority, however, the relevant studies show that the digital literacy of small-holder farmers and SMEs in the food industry is still low when it comes to the utilization of smart technology to optimize the operations to ensure the implementation of sustainable production and consumption to tackle climate change.

5 Recommendation

What are the next steps to be able to advance agriculture and SMEs in Indonesia in adopting smart technology 4.0? We strongly recommend the government through the Ministry of Communication and Informatics and the Ministry of Agriculture must cooperate with smartphone manufacturers based in Indonesia to create smartphones that have technical specifications that can help manage small-holder agriculture and SMEs in the food industry in Indonesia. The government also needs to work with digital-based start-ups that focus on creating applications that can help farmers and SME owners implement precision farming and smart operations through their smartphones. Incentives that can be provided by the government can be in the form of value-added tax exemptions and luxury goods on smartphones aimed at supporting farmer and SME owner activities. Research [17] using a systematic literature review method shows that there are 12 articles related to

smartphone-based agricultural applications, 6 smartphone-based agricultural management applications, 3 smartphone-based information system applications, and 4 service expansion applications. agriculture [11]. This fact strengthens the author's opinion that smartphones are the closest gateway to Smart Technology 4.0 for small-holder farmers and SME owners in Indonesia.

References

1. https://sdgs.un.org/goals
2. https://sdgs.un.org/goals/goal2
3. De Clerq, M., Vats, A., Biel, A. 2018. Agriculture 4.0: The Future of Farming Technology. World Government Summit
4. https://sdgs.un.org/goals/goal12
5. http://umkm.depkop.go.id/
6. Tevapitak, K., & Helmsing, A. H. J. (2019). The interaction between local governments and stakeholders in environmental management: The case of water pollution by SMEs in Thailand. Journal of Environmental Management, 247, 840–848. https://doi.org/10.1016/j.jenvman.2019.06.097
7. Van Dyk, J. S., Gama, R., Morrison, D., Swart, S., & Pletschke, B. I. (2013). Food processing waste: Problems, current management, and prospects for utilization of the lignocellulose component through enzyme synergistic degradation.Renewable and Sustainable Energy Reviews, 26, 521–531. https://doi.org/10.1016/j.rser.2013.06.016
8. https://www.automation.com/en-us/articles/2014-1/the-4th-industrial-revolution-industry-40-unfoldin
9. Rogers, Everett M. 2003. Diffusion of Innovations, fifth ed. New York: Free Press.
10. Maulani, G., Hardini, M., Aini, Q., Rahardja, U., Izzaty, R., Santoso, N. 2020. Educating Farmers Using Participatory Rural Appraisal Construct. 5th International Conference on Informatics and Computers.
11. https://www.antaranews.com/berita/2763769/cips-sektor-pertanian-perlu-segera-adopsi-teknologi-digital
12. https://www.litbang.pertanian.go.id/buku/toward-resilience-food/TRANSFORMING-SMALLHOLDER-FA
13. https://databoks.katadata.co.id/datapublish/2022/03/23/ada-2047-juta-pengguna-internet-di-indonesia-awal-2022#:~:text=Jika%20dibandingkan%20dengan%20tahun%202018,juta%20orang%20pada%20Januari%202022
14. https://databoks.katadata.co.id/datapublish/2021/07/01/daftar-negara-pengguna-smartphone-terbanyak-indonesia-urutan-berapa
15. Najib, M., Fahma, F., Abror, A., & Suhartanto, D. (2022). Organizational Capability, Market Perspective, and Green Innovation Adoption: Insight From Indonesian Food Processing Small and Medium-Sized Enterprises. Journal of Small Business Strategy, 32(2), 51–66.
16. Martins, A.; Branco, M.C.; Melo, P.N.; Machado, C. Sustainability in Small and Medium-Sized Enterprises: A Systematic Literature Review and Future Research Agenda. Sustainability 2022, 14, 6493. https://doi.org/10.3390/su14116493
17. https://www.hindawi.com/journals/js/2015/195308/