

Technology Adoption for Agricultural Products in Developing Countries: A Systematic Literature Review Approach

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Abstract. This article explores the adoption of new technologies and market developments in the food industry, focusing on agricultural products in developing countries. The first goal of this study is to find food preservation technologies that will keep agricultural products fresh till they reach the final consumer. The second goal of this article is to identify a marketplace for expediting distribution so that consumers can readily purchase the products. We did a systematic literature review, focusing on technological adoption in agriculture products. The results demonstrate the necessity for and changing customer behavior toward technology use in the food business. This study will contribute to the current literature on relevant themes, which may be useful for future research.

1 Introduction

In several developing countries, the food supply chain is a very important economic industry. However, various problems arise. Farmers find it difficult to distribute their products to the market because the shelf life of commodities is short. Farmers in some areas are forced to discard their crops because the quality deteriorates after a few days of not being sold at the market. this situation has caused new concerns related to food supply, processing, distribution, and demand [1].

Recent studies have focused on the factors that lead to the adoption of agricultural technology [2-3]. Identifying the determinants of agricultural technology adoption has emerged as an important area of research in agricultural economics and development studies. Several researchers have determined that knowing determining factors is important for explaining effective strategies that can promote technological innovation among farmers. The adoption of modern agricultural technology significantly increases productivity, sustainability, and overall output. This can provide a strong basic for policymakers to focus on the background that leads to adoption decisions among farmers. In addition, this explanation also helps governments and organizations in developing and implementing policies or strategies that aim to increase agricultural production. Several factors such as

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socioeconomic status, access to resources, education level, and institutional support that can influence farmers decision, policymakers, and researchers can develop better strategies to help integrate innovative practices into the agricultural system. Therefore, further research on these determining factors is not only important for academic groups, but also for the practical implementation of technology in the agricultural sector, which plays a role in food security and economic development.

Related to the market, [4] identify oligopsony as a key concern in emerging countries' agricultural market systems. In an oligopsony market, traders exert vertical control over farmers due to their market dominance. [5] that traders have the market power to purchase things at reduced prices, even below marginal values. Research indicates that ICTs improve agri-food chains for smallholder farmers in Africa, Asia, and Latin America [6-8]. Using ICTs can help increase prices, manage sales, identify buyers, and create products that meet consumer expectations (quality, health, and safety norms). The use of ICTs in agricultural markets reduces asymmetric information, improves price transparency, and increases farmer participation and bargaining [9-10].

The findings of various research studies have identified key factors that influence the adoption of agricultural technology; however, the practical relevance of these findings at the national level remains constrained due to the heterogeneity of the studies conducted. This underscores the need for a comprehensive study that synthesizes the outcomes of multiple investigations conducted across the country. Despite this necessity, there exists a paucity of research employing meta-analysis or systematic reviews to thoroughly explore the determinants of agricultural technology adoption at the national level. Consequently, this meta-analysis aims to address these informational gaps by identifying the factors that influence the adoption of agricultural technologies in Ethiopia. This approach proves to be significantly more effective than relying on individual studies, as it provides policymakers with consolidated insights into the determinants of agricultural technology adoption. Furthermore, the primary objective of this research is to identify optimal technologies that can enhance the longevity of agricultural products by improving distribution processes, while also ensuring the secure and fresh delivery of these products to consumers.

2 Literature review

2.1 Technology adoption

Technology has a huge impact on business around the world that cannot be denied the use of technology has opened a new world full of insights and opportunities for technology companies, helping to gain a better understanding of consumers, improve products and services, and optimize operations. Technology adoptions is a term that describes the acceptance, integration, and use of new technologies in society [2]. Innovation is a significant business challenge, even though it is considered important for growth and sustainability [3]. However, companies still face challenges in determining what is needed for innovation succeed [4], especially in the context of the Covid-19 pandemic.

The adoption of industry 4.0 consists of a multifaceted framework that connects various resources essential for its successful implementation. Key components such as production system, human resources, project management, management leadership, green logistics, and environmentally friendly design play an important in supporting this transition. The application of information technology, big data analytics, and cooperative relationships can improve operational efficiency and organizational adaptability. Research explains the positive relationships between industry 4.0 adoption and sustainable production practices. When an organization successfully implements industry 4.0 principles, it is a better position

to implement sustainable production methods that aim to promote the development of circular economy capabilities. This interrelated correlation illustrates the importance of utilizing advanced technological resources to support sustainability and reduce waste in industrial processes. Furthermore, industry 4.0 has the potential to encourage sustainable production, highlighting the importance for organizations to prioritize such innovations in their strategic planning and operational framework. Overall, developing a beneficial relationship between industry 4.0 and sustainable production is important for improving circular economy capabilities and achieving long-term environmental and economic sustainability.

This study used the framework of The Context of Technological Innovation [6], namely TOE framework. There are three elements of a firm's context that influence the process of technology adoption, i.e., organizational context, technological context, and environmental context.

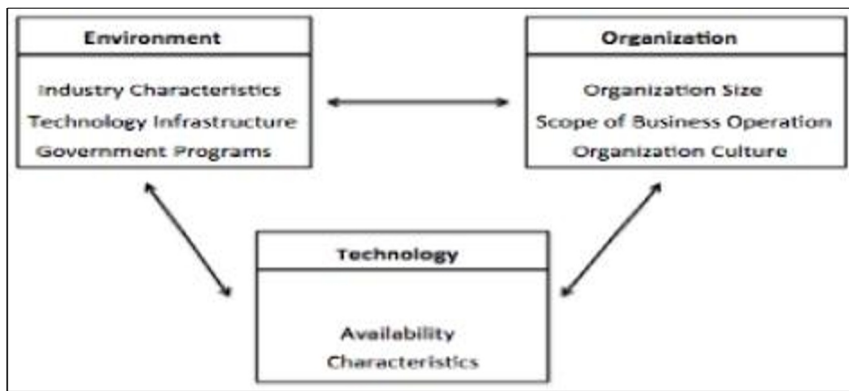


Fig. 1. The Context of Technological Innovation adjusted [6].

Organizational context is defined in terms of several measures, i.e., organization size, business operations scope, and the culture in organization. Technological context describes both the internal and external technologies relevant to the firm. The theory considers it separately from the environmental context for being focused on how technology features may influence the technology adoption process. Environmental context explains how the firm conducts its business and dealing with government. This context presents both constraints and opportunities for the technological adoption of the firm.

A study found that farmers' decisions to embrace agricultural technology are influenced by their land ownership, finance access, distance to the nearest market, and animal keeping. They also stated that agricultural technology adoption has a large and favourable impact on farmer revenue. Another study conducted by [7-8] on the adoption of enhanced white haricot beans found that different factors influenced the decision to adopt the white haricot bean variety. The study discovered that the frequency of extension visits, land size allocated to haricot beans, agricultural income, price perception, training obtained, and perception of the crop's fertility enhancement benefit positively influenced farmers' decision to adopt improved varieties, whereas distance to market, ownership of haricot bean farmland, and nutritional perception of the crop negatively influenced farmers' decision.

3 Methodology

This segment utilizes a one-step method to compile the best technology to extend the life of the agricultural product and focus on the efficiency in the distribution process. In this one-step method, the database about existing articles is gathered and analysed. These articles are treated as "primary material" in this paper [9]. The combination of literature review method

and content analysis is the established method to guide the number of papers [8]. In this literature review, international databases were searched for papers studying the role of various technologies in the distribution of agricultural products after the developing countries pandemic. The keyword searches were “Technology”, “developing countries”, “Agricultural Product”, “Logistics”, “Internet of Things”, “Big data”, “Blockchain”, “Robots”, and “Drone”.

This study uses literature consisting of articles published in peer-reviewed journals, which are considered the main foundation of this academic research due to their rigorous evaluation process. In addition, this study also includes various forms of grey literature, including book chapters and documents such as conference paper, working paper, and institutional reports. It should be noted that the literature collected consists of a mixture of works that have undergone peer review and those that have not. Specifically, working papers and reports have been published by research organization or government agencies, while others originate from non-governmental organizations (NGOs). Therefore, the scope of the sample analysed in this study was deliberately made broad, not limited to studies that have undergone a peer-review process, thus providing an opportunity for a more comprehensive understanding of the topic under study.

After searching for related literature, the following step was to screen for research that may be used. The following inclusion and exclusion criteria were applied. First, research titles were evaluated for appropriateness with this SLR. As a result, 10 of the 46 studies identified through the literature search were eliminated since they were done in industrialized countries. Second, abstracts from 46 papers were critically analysed. Studies on non-agricultural technology uptake have been dismissed. As a result, 22 papers were omitted from the full text assessment for eligibility. Third, 22 studies were evaluated for full-text eligibility. Ten further studies were excluded based on the availability of important variables. Finally, 12 studies that met the inclusion and exclusion criteria were selected and used.

4 Result

Numerous empirical investigations have explored the determinants of agricultural technology adoption in developing nations. Findings consistently indicate that demographic, institutional, and socioeconomic factors significantly influence the uptake of enhanced and innovative agricultural technologies. However, there exists a notable gap in research concerning the factors affecting the adoption of specific agricultural technologies at the national level. This study aims to identify the key drivers of agricultural technology adoption while also examining the underlying factors that influence the adoption of agricultural market technologies within countries from 2010 to 2018. To achieve this, twelve original studies were selected for comprehensive analysis, providing a foundation for understanding the complex interplay of influences on technology adoption in the agricultural sector.

The majority of technological adoption studies have focused on factors affecting better seed variety. Nine of the twelve studies included in this meta-analysis focused on the factors influencing improved seed variety. A few studies have looked at the factors of the agricultural technology package (seed, fertilizer, and herbicides). Two studies studied the factors that influence the adoption of diverse agricultural technologies.

5 Discussion

In this section, the purpose of this study was to identify technology used in agricultural products through the existing literature.

5.1 Product's packaging

5.1.1 Smart packaging technology

In the developing countries pandemic, packaging is more important to ensure the safe use of food and to keep it fresh in response to long shipping delays caused by lock-in [2]. Modified atmosphere packaging (MAP) and active packaging (AP) have been widely used to extend the storage life of fresh food. MAP technology includes changing the gas composition in the package, Through limited metabolism, microbial and enzymatic activity.

5.1.2 Smart freezing and thawing technology

Frozen preservation consists mostly of freezing, freezing storage, and thawing to keep food fresh. Conventional freezing methods include blast, immersion, fluidized bed, and low-temperature freezing, whereas new-style freezing employs ultrasound, ultra-high voltage, pulsed electric field, ultra-low temperature, high-voltage electrostatic field, and radio frequency [3].

5.1.3 Smart Hyperspectral Imaging System (HIS) technology

It quickly offers trustworthy and precise information about structure, composition, physicochemical, and sensory qualities, eliminating the need for sample preparation and direct human engagement. Furthermore, it works well with heterogeneous materials.

5.1.4 High Pressure Processing (HPP) technology in food industry

The US Food and Drug Administration has officially approved HPP as a non-thermal pasteurization technology that can replace traditional pasteurization in the food industry. HPP has been widely used in the production of packaged vegetables, fruits, meat, seafood and dairy products. Utilization of technological developments such as smart packaging, smart freezing and thawing technology, smart hyperspectral imaging system (HIS), high pressure processing (HPP), and Blockchain technologies is used to help agricultural products last longer, so that they remain in good condition when accepted by consumers.

5.1.5 Blockchain technologies

In responding to the challenges during the developing countries pandemic, China and India utilize digital technologies such as blockchain technology [13]. Blockchain technology could modify the structure of the agricultural product supply chain [6, 14]. Tracking food data and farm operations will be very useful, so this will help increase trust among various stakeholders in the agri-food system [14].

5.2 Marketplace in accelerating distribution

5.2.1 Drone food delivery services

Unmanned Aerial Vehicles (UAVs) or drones have emerged as a transformative force in the food delivery industry. This technology offers various advantages over traditional delivery methods. One of the benefits of using UAVs for food delivery is their ability to provide fast

delivery. This is because drone avoid ground traffic and can deliver food directly to their destination, significantly reducing delivery times. This solution is particularly valuable for people living in urban areas where unavoidable traffic congestion can hinder delivery. One country that has implemented this technology is South Korea. Yogiyo, one of the largest food delivery companies in the country, has successfully tested drone technology for food delivery. The results of this trial show that UAVs can improve service efficiency. The findings from this trial support the claim that delivery food services using UAVs are far superior to other methods. In addition to reducing delays caused by traffic jams, drone have the flexibility to deliver goods anytime and anywhere. Therefore, food delivery services using UAV technology represent a significant advancement in food delivery logistics. With the development of technology, the use of drone-based delivery services will become increasingly widespread, transforming the food delivery system for consumers and business alike.

5.2.2 Autonomous delivery robot (ADR) technology

Notably, major logistics companies such as Amazon, FedEx, Starship, and Nuro have initiated the deployment of SADR in various urban environments across the United States, demonstrating a delivery capacity that can range from hundreds to thousands of packages per day. The effective implementation of ADR services necessitates coordination between logistics service providers and governmental organizations to align with consumer expectations and needs. In recent years, the emergence of Autonomous Delivery Robots (ADRs) has revolutionized the logistics and delivery industry. ADRs are fundamentally categorized into two distinct types: road-based ADRs, which navigate through vehicular traffic, and sidewalk-based ADRs (SADR), which operate on pedestrian pathways. The deployment of SADR by industry leaders such as Amazon, FedEx, Starship, and Nuro highlights a growing trend in urban logistics, aiming to enhance delivery efficiency and meet the increasing demands of consumers. A significant aspect of integrating ADR technology into urban environments involves understanding public acceptance and consumer behaviour towards these innovative delivery systems. A pivotal research study conducted in Portland in 2020 addressed this necessity by examining consumer preferences, trust, attitudes, and willingness to pay (WTP) regarding ADRs. The study utilized a sample size of 483 consumers to gather comprehensive data reflecting public sentiment towards ADR technology. The findings of the research underscore the importance of consumer insights in shaping the future deployment strategies of ADRs, ensuring that they not only satisfy logistical requirements but also resonate positively with the public. As the landscape of logistics continues to evolve with the adoption of ADR technology, it is imperative for logistics service providers and governmental entities to collaborate effectively. By focusing on consumer expectations and preferences, stakeholders can enhance the acceptance and success of ADR systems. Future research should continue to explore these dynamics as ADR technology becomes increasingly integrated into everyday life, offering a glimpse into the future of urban delivery systems.

5.2.3 The mobile food delivery application (MFDAs)

A study involving 3,606 consumers in the United Kingdom, Italy, Brazil, and South Korea explain the impact of the pandemic on online food delivery services, particularly in developing countries. Based on this study, the pandemic has not only increased spending and frequency of use of these services, but has also had a positive impact on consumers, with 57% of respondents expressing a positive view of online food delivery. This phenomenon illustrates the high likelihood of repeat use of the same services, as consumers continue to

seek convenient meals during the pandemic. In addition, research conducted in the United States explains a shift in consumer behaviour with 41.7% of respondents indicating their intention to use food delivery services while at home during pandemic. These findings emphasize the transformative impact of the pandemic on consumer habits and the increasing dependence on food delivery service as a novelty during these unprecedented times.

5.2.4 Online food delivery

The online food delivery (FD) sector has demonstrated a remarkable capacity for innovation and market expansion, actively engaging in the development of new consumer markets and fostering distinct consumption habits among its clientele. As we look toward the future of online food delivery, it becomes increasingly important to navigate this evolving landscape with a focus on sustainability that benefits all stakeholders involved. Continuous evaluation of current practices is essential; we must engage in critical reflection to determine whether improvements can be made to enhance the overall service and experience. Notably, China currently holds a dominant position in the online food delivery market, boasting the largest market share globally. The United States follows closely behind, while countries such as India and Brazil are emerging as significant players, exhibiting rapid growth rates exceeding 9% compound annual growth rate. This growth trajectory underscores the necessity for stakeholders to remain vigilant and adaptable in their strategies to capitalize on the dynamic nature of the online food delivery industry.

5.2.5 Robots

Robots is one of the maximum critical era software at some point of developing countries. In a few countries, robots are utilized by logistical software to distribute meals among quarantined people [10]. This era is extra useful due to the fact play a function in controlling social interplay and making people tailored with new coronavirus [11].

5.3 Improving the market infrastructure

Governments in developing countries struggle to provide infrastructure, making procurement a recurrent issue. Due to this issue, people's capacity to meet Farmers' access to market information is being hindered, as reported by [6]. Infrastructure plays a crucial role in educating farmers on profitable crops, reducing transportation costs and margins, and preventing price volatility [12-13].

According to [14], farmers require communication networks as their primary infrastructure. As proved under extreme circumstances, effective communication throughout the COVID-19 epidemic has helped maintain price stability and mitigate the negative effects of reduced production volume. Accessibility in rural areas relies on energy and network connectivity, which enable farmers to use various communication tools. Farmers should have access to reliable and timely information, not necessarily sophisticated instruments

6 Conclusion

The developing countries pandemic has an impact on various aspects, one of which is the distribution of fresh agricultural products. Based on the analysis of various studies Companies need to focus on two things, their packaging technology that ensure the goods remain fresh until goes to consumers and the second is to utilize the existence of a marketplace in accelerating the distribution of goods. To ensure agricultural products can last

longer and be accepted in good condition by consumers. Companies need to utilize technology in food industries such as smart packaging, smart freezing and thawing, smart hyperspectral imaging system (HIS), high pressure processing (HPP), and blockchain technology. The technology is proven to make the product last longer. Furthermore, in accelerating the distribution process and ensuring food remains safe, the marketplace can use drone technology, autonomous delivery robots (ADR), the mobile food delivery application (MFDAs), online food delivery, and robot technology.

The Internet of Things (IoT) includes cloud computing, artificial intelligence (AI), big data analysis, simulation and other technologies, which help to realize the digitization in the agricultural product and distribution. The existence of the Internet of Things technology helps and promotes the processes of the food industry, such as planning, traceability, innovation, increased visibility, autonomous control and monitoring, and enhanced monitoring.

This research focuses on identifying the suit technology in distributing agricultural products so that consumers receive foods in good condition. For further research is expected to analyse the role of the marketplace as a medium of marketing agricultural products directly to the end user. In addition, further research can determine the right food processing technology so that agricultural products such as vegetables or fruits can remain fresh to the end user without using preservatives.

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