Empowering Smallholder Coconut Farmers Through E-Commerce: A Preliminary Study on Current Business Models, Opportunities, and Digital Readiness in Malaysia

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ABSTRACT

The Malaysian coconut industry is dominated by smallholder farmers who face structural challenges, including low profit margins, reliance on middlemen, and limited access to wider markets. The purpose of this study is to explore the potential of e-commerce adoption to transform the sector by enabling direct market access, increasing price transparency, and supporting value-added processing. A mixed-method approach was employed, comprising focus group discussions (FGDs) and a survey involving 274 coconut farmers and industry stakeholders. The findings reveal two prevailing business models: a traditional middlemen-driven supply chain and a cooperative-led model that supports industrial processing for products like coconut milk, virgin coconut oil, and copra. While 72.6% of farmers have experience with online purchasing, only 13.5% have attended e-commerce training, indicating a significant digital knowledge gap. Despite these challenges, 71.2% of farmers expressed readiness to adopt e-commerce if supported with proper training, infrastructure, and financial resources. The study highlights the importance of developing a structured and inclusive e-commerce ecosystem facilitated through cooperative engagement, supportive policy frameworks, and targeted investment in digital capacity-building. The results offer practical insights into how digital transformation can enhance the competitiveness and sustainability of Malaysia's coconut industry while empowering smallholder farmers to improve their economic resilience.

Keywords: E-commerce adoption, coconut industry, smallholder farmers, digital transformation, agricultural marketing, value-added processing

Introduction

Agriculture has long been the foundation of global economies, providing necessary goods for both consumption and industrial use. In Malaysia, the coconut industry has been a key part of the nation's agriculture, significantly helping rural economies and supplying various coconut products, including coconut oil, coconut milk, virgin coconut oil, and coconut water (Zakaria et al., 2024). However, despite its potential, the Malaysian coconut industry faces ongoing problems. These include lower production, increased competition from palm oil farms, and limited market access for small farmers (Omar & Fatah, 2021; Zainol et al., 2023). Also, Malaysia's heavy reliance on coconut imports from nearby countries like Indonesia and Thailand to meet local demand further affects the profits and sustainability of local farmers (Philippine Coconut Authority, 2021).

Amidst these challenges, a rise in global demand for coconut products, especially in the growing health and wellness area, offers a good opportunity. Consumers are increasingly interested in organic and natural products, which creates a good situation for the modernization and growth of Malaysia's coconut industry (Lilavanichakul, 2020). At the same time, e-commerce has become a powerful tool in agriculture, with the ability to change market access, improve supply chain efficiency, and encourage economic growth (Banerjee, Mishra, Debnath, & Choudhury, 2019). Using digital technologies, specifically e-commerce, in agricultural practices has been shown to improve production and profits for farmers and agricultural businesses. Notably, e-commerce helps to improve supply chain efficiency, expand market reach, and increase profits for small farmers (Nurjati, 2021). This digital change has shown its ability to reduce dependence on middlemen, allow direct sales between producers and consumers, and promote better financial sustainability in the agriculture sector (Kusumawati et al., 2022).

This study has three main objectives. First, it aims to assess the current state of Malaysia's coconut industry and identify the challenges faced by small-scale farmers within traditional market structures. Second, it seeks to examine the role of e-commerce in transforming agricultural value chains and evaluate its current level of adoption. Third, it aims to determine the readiness of industry players for e-commerce and identify the barriers hindering its implementation. Based on these objectives, the research will analyze findings from coconut industry stakeholders, assessing readiness for digital commerce and identifying key barriers. It will provide recommendations to promote e-commerce adoption, driving sustainable growth and competitiveness in the coconut sector.

Literature Review

The Role of E-Commerce in Agricultural Development

E-commerce has significantly changed the agricultural sector by improving market access, lowering transaction costs, and making value chains more efficient. Using agricultural e-commerce (AE) in supply chains has allowed small farmers to connect directly with consumers, avoiding traditional middlemen (Kusumawati et al., 2022). Studies show that AE increases transparency, ensures fairer pricing, and improves efficiency in agricultural supply chains—factors that are very important for perishable goods like coconuts, fruits, and vegetables (Nurjati, 2021).

The use of e-commerce in agriculture has great potential in developing economies, including Malaysia, Indonesia, and Thailand. Governments and private sector efforts have increasingly supported digital agricultural solutions to address market issues. For example, the Indonesian government has used agricultural e-commerce to improve market access and financial inclusion for farmers (Nurjati, 2021). Similarly, Malaysia's Agrobazaar Online, an initiative by the Federal Agricultural Marketing Authority (FAMA), helps farmers market their products digitally (Zakaria et al., 2024).

E-commerce plays a key role in modernizing agricultural practices and improving market access for farmers. Through online platforms, farmers can sell their products directly to consumers, reducing dependence on middlemen and increasing profit margins (Lin et al., 2024). The digital change in agriculture has also made it easier to share information about best practices, pricing trends, and supply chain management (Huang, Su, Huang, & Liu, 2022). Additionally, e-commerce platforms allow small farmers to reach national and international markets, expanding their reach and customer base (Cuiping, Yu, & Junyao, 2024). Furthermore, the use of e-commerce in agriculture has led to the development of digital marketplaces that improve the efficiency of agricultural trade (Wang & Huang, 2018). By using digital payment systems and logistics solutions, e-commerce reduces post-harvest losses and improves the overall efficiency of the agricultural supply chain (Tanos, Man, & Nawi, 2024). This digital integration has also encouraged sustainable agricultural practices by promoting transparency and traceability in the food production process (Anthony, Divyapratha, & Geretharan, 2024)."

Challenges in Agricultural E-Commerce

While agricultural e-commerce offers many benefits, its widespread use faces significant problems, especially for small farmers. One main issue is the ongoing digital gap. Many rural farmers, particularly in developing countries, lack access to reliable internet and necessary digital tools (Ellawala & Sachitra, 2021). This is made worse by limited digital skills, which prevent them from effectively using online platforms (Huang et al., 2022). For example, even with improved internet access in countries like Indonesia, rural farmers still struggle with technological obstacles, hindering their use of digital platforms (Kusumawati et al., 2022; Nurjati, 2021).

Logistics and supply chain problems also slow down the growth of agricultural e-commerce. Agricultural products, such as coconuts, dairy, and fresh produce, which spoil easily, need efficient cold chain logistics and strong delivery networks (Yang, 2023). However, poor rural logistics and high transportation costs in regions like Malaysia and Indonesia create major barriers to smooth e-commerce operations (Nurjati, 2021). Ensuring on-time delivery while keeping product quality is a key concern.

Trust and security concerns also present big challenges. Farmers and consumers often hesitate to do online transactions because they fear fraud, inconsistent product quality, and payment insecurity (Banerjee et al., 2019). To address these concerns, some countries, like Indonesia, have set up platform verification systems and included customer reviews to

build trust and encourage more e-commerce use (Zakaria et al., 2024; Kusumawati et al., 2022). The preference for physically checking products before buying further complicates the trust issue in online agricultural transactions Regulatory and financial barriers further limit the growth of agricultural e-commerce. Small farmers often struggle with compliance issues related to taxes, food safety standards, and international trade rules (Nehru, Nagaraja, Dp, Taluk, & Naik, 2017). Strict tax rules, high taxes on online agricultural sales, inconsistent financial policies, and limited access to banking are common challenges in Southeast Asian countries, including Indonesia and Malaysia (Nurjati, 2021). Also, the dominance of large agricultural businesses on e-commerce platforms may push small farmers to the side, limiting their competitiveness in digital markets (Yusoff, Zainol, Ridzuan, Ismail, & Afthanorhan, 2021). Overcoming these regulatory limits and policy inconsistencies is essential for creating a more inclusive and fair agricultural e-commerce system

Opportunities in Agricultural E-Commerce

Even with the difficulties in agricultural e-commerce, the sector offers considerable opportunities for growth and innovation. The increased use of smartphones and digital payment methods among farmers has greatly helped the expansion of online agricultural trade (Zheng, Yu, & Fu, 2023). Mobile e-commerce apps allow small farmers to create direct connections with consumers, lowering transaction costs and increasing income levels (Lin et al., 2024). Also, the spread of social commerce platforms like Shopee, Lazada, and Tokopedia provides affordable channels for direct-to-consumer (D2C) sales, enabling farmers to reach wider markets (Lilavanichakul, 2020).

The rising demand for organic, health-focused, and high-quality agricultural products, including specialized coconut products, offers important market opportunities for farmers using e-commerce (Pragadeesh, Sebastian, Bhuvaneswari, & Selvi, 2022). By taking advantage of these specific markets, farmers can diversify their income sources and improve their ability to withstand market changes (Anthony et al., 2024). This trend matches the general move towards adding value in agriculture, where e-commerce helps integrate advanced technologies like blockchain and smart contracts (Wan-Mohtar et al., 2023). These technologies increase transparency and accountability throughout the agricultural supply chain, ensuring fair pricing and reducing fraudulent transactions.

Furthermore, agricultural e-commerce acts as a driver for rural development. It generates new job opportunities in various areas, including logistics, digital marketing, and agricultural technology services (Alouw & Wulandari, 2020). This digital transformation not only boosts economic activity but also creates a more active and connected rural economy. By utilizing the potential of e-commerce, farmers can overcome traditional market limitations and contribute to the sustainable growth of the agricultural sector.

E-Commerce in the Coconut Industry: Regional Best Practices

Several countries have shown the potential of e-commerce to change their coconut industries, providing helpful examples for Malaysia. For instance, Indonesia has actively supported agricultural e-commerce through platforms like Agromaret, Kecipir, and Tanihub, which link small farmers with city consumers and improve market access. These efforts have significantly helped rural economic growth (Kusumawati et al., 2022).

Likewise, the Philippines, as the world's top exporter of coconuts, has used e-commerce to increase international sales and strengthen its value chain. Government programs, led by the Philippine Coconut Authority, have simplified exports and promoted coconut products through digital marketing efforts (Philippine Coconut Authority, 2021).

In Thailand, the "Thailand 4.0" plan highlights the importance of agricultural digitalization. This strategy focuses on developing agricultural online marketplaces and digital payment systems to modernize the sector (Lilavanichakul, 2020). Also, Vietnam's government-supported digital trade platforms have enabled coconut farmers to sell their products online, which has increased both domestic sales and export opportunities (Vietnam News, 2022)."

The State of E-Commerce in Malaysia's Coconut Industry

Malaysia's coconut industry, traditionally a key part of its agricultural sector, experiences structural problems marked by low domestic production, high reliance on imports, and fragmented supply chains. Despite these issues, the industry is undergoing a significant change, with e-commerce playing an increasingly important role in its development (Zainol

et al., 2023). While its use is less than in neighboring countries like Indonesia and the Philippines, recent government actions and changing market trends indicate strong growth potential.

E-commerce platforms offer a way to address these problems by improving market access for small farmers. By avoiding traditional middlemen, farmers can sell directly to both local and international buyers, increasing price transparency and reducing distribution network inefficiencies (Omar & Fatah, 2021). The growing global demand for value-added coconut products, such as virgin coconut oil, coconut sugar, and coconut flour, further highlights the potential for farmers to use e-commerce platforms for effective marketing (Mardesci, Santosa, Nazir, & Hadiguna, 2021). Additionally, improvements in digital marketing and social media have allowed coconut businesses to promote their products more effectively, increasing consumer awareness and demand (Yusoff et al., 2021).

However, the industry faces problems related to technology use and logistics. Many small coconut farmers lack the necessary digital skills and infrastructure to effectively participate in e-commerce (Tanos et al., 2024). Logistics issues, such as high transportation costs and quality assurance in online transactions, also present major obstacles to widespread use (Ellawala & Sachitra, 2021).

To fully realize the potential of e-commerce in Malaysia's coconut sector, it is essential to implement supportive policy actions and encourage industry collaboration. Taking inspiration from successful models in Indonesia, the Philippines, and Thailand, Malaysia can develop a strong and sustainable agricultural e-commerce system that improves export competitiveness, supports small farmers, and promotes value-added production. Government actions aimed at supporting digital change in agriculture, combined with increasing consumer preference for coconut products, are expected to drive further growth (Wan-Mohtar et al., 2023). By using e-commerce solutions, the Malaysian coconut industry can improve its competitiveness, enhance value chain efficiency, and contribute to rural economic development (Zainol et al., 2023).

Theoretical Foundation: The Technology–Organization–Environment (TOE) Framework

To better understand the factors influencing e-commerce adoption in the agricultural sector, particularly among smallholder coconut farmers, this study adopts the Technology–Organization–Environment (TOE) framework developed by Tornatzky and Fleischer (1990). The TOE framework provides a comprehensive model for analyzing how three key contexts—technological, organizational, and environmental—influence the adoption and implementation of technological innovations within firms and institutions.

In the technological context, factors such as perceived usefulness, ease of use, and compatibility of e-commerce platforms are critical for adoption. For smallholder farmers, this includes access to digital tools, internet connectivity, and knowledge of digital platforms. Existing studies (e.g., Tanos et al., 2024; Huang et al., 2022) highlight how the lack of familiarity with digital interfaces and concerns about trust and security inhibit usage, aligning with technological readiness concerns.

The organizational context refers to the characteristics of the farming enterprises or cooperatives, such as size, resource availability, managerial support, and digital literacy. In the Malaysian coconut industry, most smallholder farmers operate independently with minimal cooperative support (Zainol et al., 2023), which constrains their organizational readiness for e-commerce. The limited engagement with formal training and digital platforms reflects a broader issue of weak internal capacity and leadership in managing digital transformation (Yusoff et al., 2021).

The environmental context involves external pressures such as market competition, consumer demand, government support, and infrastructure. The growing global market for value-added coconut products creates a favorable external environment for digital sales channels (Mardesci et al., 2021), but the lack of robust e-commerce infrastructure and uneven government support, particularly in rural East Malaysian regions, poses significant challenges (Zakaria et al., 2024). Moreover, comparison with neighboring countries like Indonesia and the Philippines underscores the importance of supportive national policies and public-private partnerships in enabling successful adoption (Nurjati, 2021).

By applying the TOE framework, this study offers a structured explanation of the readiness and barriers to e-commerce adoption in the Malaysian coconut sector. It enables a holistic view that considers not just technological capabilities,

but also organizational preparedness and external conditions—factors that are essential for designing effective intervention strategies and policy recommendations.

Methods

This study adopts a mixed-method approach, integrating Focus Group Discussions (FGDs) and survey-based data collection to explore the potential of e-commerce in Malaysia's coconut industry. The methodology encompasses both qualitative and quantitative dimensions, aiming to capture insights on business models, challenges, and farmer profiles, while also assessing income levels and e-commerce awareness among smallholder farmers.

Research Design and Data Collection

Four FGDs were conducted across various locations, involving smallholder coconut farmers, agricultural officers, and industry stakeholders. These discussions aimed to identify current business models in coconut farming, challenges related to market access, pricing, and supply chain efficiency, as well as farmers' perceptions and barriers to e-commerce adoption. The FGDs took place in Bagan Datuk, Perak (June 2023 and September 2024), Sabak Bernam, Selangor (July 2023), Samarahan, Sarawak (October 2023), and Kudat, Sabah (November 2023).

In addition to the FGDs, a structured survey was administered to gather baseline data on smallholder coconut farmers. The survey explored farmer demographics, including age, education level, farm size, and income levels, alongside the types of coconuts cultivated, marketing strategies, current business practices, and knowledge of and willingness to adopt e-commerce. The survey was conducted through face-to-face interviews using a structured questionnaire, with enumerators appointed in each state to ensure accuracy and reliability.

Sampling Strategy and Population

The study's sampling frame was based on the Department of Agriculture (DoE) database, which lists smallholder coconut farmers in Malaysia. Collaborating with Lembaga Pertubuhan Peladang Kawasan (LPPK), whose field staff maintain direct relationships with coconut farmers, the research team ensured better participation and response rates. Of the total population of 26,074 farmers, 379 were targeted as the sample size, distributed across states using convenience sampling. Notably, 274 farmers responded, resulting in a response rate of 72.3%.

The sample distribution by state is summarized as follows: Sabah (188), Sarawak (147), Perak (17), Selangor (5), and other states in smaller proportions.

Data Analysis

Qualitative data from focus group discussions (FGDs) were analyzed using Microsoft Copilot to systematically organize themes and sub-themes. Copilot facilitated the synthesis of key patterns, refinement of hierarchical structures, and enhancement of thematic clarity, particularly in identifying recurring themes related to business models, marketing strategies, and barriers to e-commerce adoption.

Meanwhile, survey data were analyzed using SPSS software to generate descriptive statistics, including frequency distributions, averages, and percentages, providing a comprehensive profile of farmers and assessing their digital readiness

Results

Demographic and Economic Profile of Smallholder Coconut Farmers

The average age of small coconut farmers in Malaysia is 54 years, indicating an older workforce that could affect the industry's long-term stability. In terms of education, 71.2% of those surveyed have completed the Malaysian Standard Certificate of Education (SPM), while 21.5% hold diplomas, and 7.3% have lower secondary education (SRP/PMR). However, limited business and digital knowledge among farmers reduces their ability to use modern marketing approaches and effectively participate in e-commerce solutions.

The size of farms among those surveyed varies between 5 and 15 hectares, with differences based on region and farming methods. The average monthly income from coconut farming is relatively low, ranging from RM500 to RM1,000. This low income forces many farmers to grow additional crops such as black pepper and bananas to increase their earnings. Additionally, coconut pricing is mainly decided by middlemen, with 92.6% of prices being based on size and largely set by suppliers (32%) and wholesalers (23%). Regarding crop types, 49.8% of farmers grow Mataq coconuts, mainly used for coconut water, while 19.8% grow Malayan Tall coconuts, which are mostly processed for coconut milk."

Assessing the Current State of Malaysia's Coconut Industry and Problems Faced by Smallholders in Traditional Market Structures

The Malaysian coconut industry mainly consists of small farmers working within traditional supply chains, which often limit their earnings. Two main business models were found in the industry. The first model, which lacks industrial processing in its supply chain, mainly serves the market for fresh coconuts, coconut water, and direct local sales. In this model, the farmer's role is mostly limited to harvesting coconuts, which are then sold based on size and perceived quality to middlemen. These middlemen, acting as large buyers, usually offer prices that are significantly below market value, thus limiting the farmer's financial gains. The middlemen then distribute these coconuts to a network of wholesalers, retailers, and restaurants, eventually selling them to final consumers. However, this structure has inherent limitations. The most notable is the excessive control exercised by middlemen over pricing, which effectively reduces the farmers' negotiating power. Furthermore, the industry faces strong competition from imported coconuts, especially from neighboring countries, which puts downward pressure on local prices. A significant lack of value-added processing capabilities further worsens these issues, forcing farmers to rely on selling raw coconuts and missing out on the potential for higher profits achievable through processing. This dependence on middlemen is clearly shown by the fact that over 55% of farmers rely on these intermediaries for sales, while the 31% who try direct sales face major logistical and financial barriers, making it very difficult to expand their operations independently.

The above scenarios, as mentioned by some of the participants, are as follows:

> Mr M: "*We're just small farmers—cut the coconuts and sell to the middlemen. They're the ones who decide the price—sometimes way lower than market rate. Selling on our own is tough, costs are high, and it's a headache to manage. Plus, we don't have any machines to process and turn it into other products, so we're stuck selling raw coconuts only*"
>
> Mr P: "*From the old days until now, we just sell coconuts and wait for the price set by the middlemen. They take it and sell it for a lot, but we get so little. Doing our own processing? No way—we don't have the machines or the capital. It's really hard if we have to do everything ourselves*"

Conversely, the second business model includes industrial processing in its supply chain, which allows for the creation of value-added products such as coconut milk, virgin coconut oil (VCO), and desiccated coconut. In this model, farmers deliver their harvested coconuts to cooperatives or designated collection centers. Here, the raw materials are transformed into a variety of products, including coconut milk for the food industry, VCO for health and cosmetic uses, and copra for pharmaceutical uses. These processed goods are then distributed to both domestic and international markets through manufacturers and exporters. While this model offers the potential for increased profitability through value addition, it also presents its own set of challenges. These include high transportation and processing costs, the need for strict compliance with export market standards, and the significant capital investment required for acquiring and maintaining advanced processing technologies. Nevertheless, farmers who participate in cooperatives can use

collective bargaining and bulk sales to lessen some of these challenges, enabling them to achieve higher profitability through industrial processing.

The scenario of the second model as stated by the participants are as follows:

> *Quote 1:"Can sell to the factory, yes—but not everyone can. They want big volume, consistent supply. If you just have a few hundred coconuts, they won't even look at you. You need to already have a steady deal with them, otherwise very difficult."*
>
> *Quote 2: "After we harvest the coconuts, we send them to the collection center. There, they cut, remove the husk, and separate them. The hard ones are made into copra, the fresh ones become coconut milk or VCO. Then they sell to factories or export. But the process is not cheap—you need machines and must follow overseas standards. But if we do it together in a cooperative, it's not so heavy for one person."*

Beyond these two main models, the traditional market structure creates additional obstacles that hinder the growth and sustainability of the coconut industry. The farmers' heavy reliance on middlemen continues to limit their ability to control pricing, as these intermediaries often set prices based solely on the size of the coconuts. The underuse of value-added processing, which could significantly increase farmers' incomes, persists due to the high costs associated with logistics and equipment, leaving the majority of farmers dependent on selling raw coconuts. The situation is further worsened by limited government and cooperative support. For instance, only 6.4% of farmers receive aid from PPK (Farmers' Organization Authority), 2.3% from cooperatives, and 1.9% from FAMA (Federal Agricultural Marketing Authority). Moreover, the industry suffers from a critical lack of formal storage and distribution systems, particularly in regions such as Kudat, Sabah, and Samarahan, Sarawak. The influx of coconut imports from Indonesia further lowers local farmer profits, especially in areas like Sarawak, where ongoing shortages require such imports.

Examining the Role of E-Commerce in Transforming Agricultural Value Chains and Evaluate Its Current Level of Adoption

E-commerce has significant potential to change Malaysia's coconut industry by reducing dependence on middlemen and allowing farmers to directly interact with consumers and businesses. Digital trade can also enable the marketing of processed coconut products, such as coconut milk, virgin coconut oil, and desiccated coconut, to international markets. Additionally, e-commerce can introduce price transparency, giving farmers the ability to negotiate better deals. Despite these opportunities, current e-commerce practices in Malaysia are still limited. While 72.6% of farmers have experience with online buying, only 13.5% have attended e-commerce training programs. Farmers mainly use platforms like WhatsApp (67%) and Facebook (59%) for communication rather than organized e-commerce activities, while formal platforms such as Shopee (27.5%) and Lazada (20%) are underused.

One of the participant Mr Z from Bagan Datuk has mentioned that:

> *"E-commerce is good. If we use it properly, we can sell directly without depending on middlemen. We can set our own price and talk straight to the buyer. But many of us, like me, are not used to using Shopee, we usually just use WhatsApp because it's easy. To use it properly, we need some guidance or training*

To investigate the potential of e-commerce in modernizing Malaysia's coconut industry, the study looked at successful practices in neighboring countries. In Thailand, government-supported e-commerce platforms and digital training programs have allowed farmers to access direct online markets, increasing profits and involvement. Similarly, the Philippines has implemented digital trade strategies that enable direct global sales of coconut products. Government-backed e-commerce efforts in the Philippines have successfully connected farmers with international buyers, streamlining exports and increasing profits.

Determining Readiness and Barriers for E-Commerce Adoption

The study revealed that 71.2% of farmers showed interest in e-commerce training, indicating a strong potential for digital use. However, significant obstacles remain. Limited digital skills prevent farmers from effectively handling online sales and using e-commerce platforms. Concerns about trust and security, such as fears of online fraud and unsafe payment systems, further discourage adoption. Additionally, logistical problems continue due to the lack of an organized e-commerce logistics system designed for small coconut farmers. Finally, limited understanding of how e-

commerce can increase income acts as another challenge, highlighting the need for focused outreach and educational programs.

One of the farmers representatives in Kudat, Mr T, has mentioned that:

> "*Actually, many of us farmers are really interested to learn about e-commerce. We know it can help us, but honestly, most of us are not confident using those online platforms. We worry about scams, payment issues, and how to send the products safely. Some still don't really understand how it can increase income. What we need is proper training and someone to guide us step by step*"

Discussions

The findings of this study emphasize the structural inefficiencies in Malaysia's coconut industry, especially the dependence on traditional supply chains that limit profits for small farmers. This matches literature that points out the negative impact of middlemen on farmer earnings and market access (Kusumawati et al., 2022). The two main business models identified—one focused on fresh coconut sales through middlemen and another involving industrial processing for value-added products—show the contrasting economic potential of traditional versus modernized agricultural practices. The first leads to reduced profits due to the control exerted by middlemen, as shown by the fact that over 55% of farmers depend on middlemen for sales, often receiving prices well below market value. Meanwhile, the second offers an opportunity for higher revenue through value addition, though it is limited by logistical costs, regulatory compliance, and capital requirements (Omar & Fatah, 2021).

These business models, while informative, also indicate clear policy gaps. In particular, farmers operating in remote or underdeveloped areas such as Kudat and Samarahan face greater difficulty accessing cooperative processing facilities, digital platforms, and reliable logistics networks. Therefore, government policies should prioritize equitable infrastructure development and provide logistical subsidies or shared services for these marginalized areas. Establishing regional value-chain clusters equipped with basic processing tools and cold storage can reduce post-harvest loss and improve farmgate prices.

E-Commerce as a Transformative Opportunity

E-commerce can transform Malaysia's coconut industry by eliminating middlemen, enabling direct transactions, and increasing price transparency. The study finds that 71.2% of farmers express interest in e-commerce training, but only 13.5% have received such training. Instead, most rely on informal digital channels like WhatsApp (67%) and Facebook (59%) rather than structured platforms such as Shopee (27.5%) and Lazada (20%). Similar patterns are seen in research on digital skills and trust barriers in agricultural e-commerce (Nurjati, 2021). Neighboring countries like Thailand and the Philippines have successfully implemented government-backed digital marketplaces, increasing market access and streamlining exports (Lilavanichakul, 2020). Malaysia could benefit from similar strategies.

To maximize the transformative potential of e-commerce, policy frameworks must address **digital inclusion**. There is a need for targeted digital literacy programs tailored to older farmers, many of whom may not have formal ICT training. These programs should be integrated with existing extension services and delivered through trusted agricultural institutions or cooperatives. In underdeveloped areas, mobile-based learning modules and in-person support could bridge the digital knowledge gap and encourage broader e-commerce participation.

Challenges in E-Commerce Adoption

While e-commerce presents growth opportunities, several barriers must be addressed. Digital skills remain a challenge, with only 13.5% of farmers having attended e-commerce training. Studies show that targeted digital training can enhance farmers' ability to leverage e-commerce for profit (Huang et al., 2022). Trust and security concerns, including fears of fraud and unreliable payments, further discourage participation. Secure payment gateways, platform verification methods, and user education can mitigate these concerns (Banerjee et al., 2019). Additionally, logistical challenges hinder scalability. The study reveals that 31% of farmers attempting direct sales face significant logistical and financial constraints. The lack of a well-developed e-commerce logistics system for small coconut farmers results in high transportation costs and quality assurance issues. Literature suggests that integrating local distribution centers and strategic partnerships with logistics providers can help overcome these obstacles (Yang, 2023).

To support these farmers, especially in isolated regions, a logistics enablement program led by the government or in partnership with logistics firms can be introduced. This could include rural aggregation hubs, cold chain investments, and last-mile delivery support. These logistical enhancements would reduce transaction friction and product spoilage, making e-commerce a more viable channel for perishable goods like coconuts.

Government and Industry Collaboration

A key gap identified is the limited support from agricultural agencies and cooperatives. With only 6.4% of farmers receiving aid from PPK, 2.3% from cooperatives, and 1.9% from FAMA, there is an urgent need for policy-driven actions to facilitate e-commerce adoption (Zainol et al., 2023). Comparative studies from Indonesia and the Philippines highlight the effectiveness of government-backed e-commerce platforms, financial incentives, and infrastructure development in transforming agricultural trade (Nurjati, 2021; Philippine Coconut Authority, 2021). Malaysia can adopt similar measures to improve digital access and facilitate small farmers' participation in online markets. Cooperative empowerment must be central to this approach. Cooperatives can serve as intermediaries to aggregate supply, manage digital storefronts, and train members. Government incentives should support the digital transformation of cooperatives, particularly in East Malaysia, where the organizational capacity is often weaker. Encouraging youth participation in cooperative leadership and integrating ICT platforms into cooperative operations can help bridge generational and technological gaps.

Building a Sustainable E-Commerce Ecosystem

The study finds that value-added processing presents a significant opportunity for increased profitability, yet many farmers lack the resources to participate. The reliance on raw coconut sales remains a major limitation, despite the growing demand for processed products like coconut milk and virgin coconut oil. Providing financial assistance for processing facilities and incentivizing cooperative models can bridge this gap (Mardesci et al., 2021). Additionally, the dominance of informal digital transactions limits scalability. Expanding the use of formal e-commerce platforms like Shopee and Lazada can create a more structured marketplace for coconut products (Tanos et al., 2024). Strengthening digital infrastructure and marketing strategies will be essential in making e-commerce a viable business model for small farmers.

Beyond infrastructure and training, the long-term sustainability of e-commerce adoption depends on multi-stakeholder collaboration. Partnerships between farmers, cooperatives, logistics providers, ICT developers, and policymakers should be institutionalized through public-private initiatives. These collaborations can ensure continuity, innovation, and market expansion, especially for premium coconut products with export potential.

Conclusion and Recommendation

The Malaysian coconut industry, primarily composed of small farmers, faces structural challenges that limit its growth. Traditional supply chains controlled by middlemen restrict profits and market access, preventing farmers from maximizing their earnings. This study highlights key issues, including low digital skills, middlemen dependency, and limited value-added processing, all of which hinder industry competitiveness. However, e-commerce presents a promising solution. As seen in neighboring countries, e-commerce can enhance market access, improve price transparency, and facilitate direct transactions. The willingness of many farmers to adopt e-commerce indicates readiness for digital transformation, but existing barriers must be addressed to realize its full potential.

One of the most pressing needs is the enhancement of digital skills and infrastructure. Government agencies should take the lead in investing in comprehensive e-commerce training programs tailored to small farmers. These initiatives should not only focus on basic digital literacy but also include practical training on how to effectively use structured e-commerce platforms. Additionally, improving digital infrastructure, particularly in rural farming areas, is crucial to ensuring reliable internet access and seamless online transactions. Policies must also be developed to address concerns related to trust and security, including the implementation of secure payment systems and platform verification measures to mitigate fraud risks.

Beyond digital literacy, the industry must focus on value-added processing to improve profitability. The study reveals that many farmers remain dependent on raw coconut sales, despite the growing demand for processed products such as coconut milk, virgin coconut oil, and desiccated coconut. Providing financial assistance for processing facilities,

coupled with access to technical expertise and market intelligence, can empower farmers to transition into higher-value product segments. Cooperatives and farmer networks should be strengthened to facilitate knowledge sharing, resource pooling, and coordinated e-commerce adoption, further increasing the competitiveness of Malaysian coconut products.

The expansion of formal e-commerce platforms is another critical factor in unlocking the potential of the coconut industry. Many farmers currently rely on informal digital transactions through social media, which limits scalability and price competitiveness. Encouraging the use of established e-commerce platforms such as Shopee and Lazada can create a more structured and transparent marketplace. At the same time, targeted marketing strategies should be developed to enhance product visibility and promote Malaysian coconut products to both local and international buyers.

Collaboration among stakeholders is essential for successful digital transformation. Government agencies, cooperatives, agricultural businesses, and farmers must work together to ensure a smooth transition to e-commerce. Policymakers should foster partnerships between farmers and e-commerce platforms while offering incentives to logistics providers to improve supply chain efficiency and reduce costs. Strengthening these efforts will help build a sustainable and competitive coconut industry, empowering small farmers, enhancing Malaysia's position in the global coconut market, and fostering long-term industry growth and sustainability.

Limitations and Future Studies

This preliminary study provides valuable insights into the potential of e-commerce adoption among smallholder coconut farmers in Malaysia. However, several limitations must be acknowledged.

First, the study primarily involved smallholder farmers, suppliers, and a limited number of local government agency representatives. The absence of key stakeholder groups, particularly ministry-level policymakers, coconut processors, exporters, and digital platform providers which constrains the study's ability to capture a comprehensive view of the broader policy, market, and supply chain dynamics that influence e-commerce development in the coconut industry.

Second, the study adopted a convenience sampling approach, which, while practical, may limit the generalizability of the findings. Although the sample closely mirrors the actual population, where Sabah and Sarawak account for 89% of the national coconut smallholder population, the geographical concentration of 63% of respondents from these two states may underrepresent smaller farming communities in Peninsular Malaysia that may face different challenges or possess varying levels of digital readiness.

Third, the study's reliance on qualitative methods, especially focus group discussions, while rich in contextual detail, limits the statistical generalizability of the findings across the broader stakeholder population.

Future research should address these limitations by adopting stratified or proportionate random sampling to ensure balanced regional representation. Moreover, expanding the respondent base to include a broader spectrum of stakeholders—such as policymakers, cooperative leaders, processors, and logistics providers—would provide a more holistic understanding of the e-commerce ecosystem. The integration of mixed-methods approaches, combining large-scale quantitative surveys with in-depth qualitative inquiry, will enhance the robustness, validity, and applicability of future findings.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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