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MORALITY BEFORE KNOWLEDGE

Enhancing market efficiency for chili farmers through digital auction platforms: A case study of semar-dica apps

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ABSTRACT

Background: The red chili supply chain in the coastal sandy areas of Kulon Progo, Yogyakarta, faces chronic inefficiencies, including volatile prices, lengthy distribution channels, and farmers' dependency on intermediaries. Although traditional auction markets offer more transparent price formation, delayed payments often push farmers back into unfavorable marketing practices. The advancement of digital technology provides new opportunities to enhance market efficiency and empower smallholder farmers. This study aims to analyze the implementation of the Semar-Dica Apps, an Android-based digital auction platform, to design an effective digital marketing system and evaluate its potential to improve market efficiency and farmers' income . **Methods:** A qualitative descriptive approach was employed, supported by participatory action research (PAR) in several chili-producing villages of Panjatan Sub-district, Kulon Progo. Data were collected through field observations, in-depth interviews with key stakeholders, and analysis of relevant secondary data. The analysis involved thematic coding, comparison between conventional and digital auction mechanisms, SMART feasibility assessment, and stakeholder mapping using the Triple Helix model. **Findings**: The Semar-Dica platform demonstrates potential in shortening supply chains, increasing price transparency, and accelerating payment processes. However, challenges remain, including limited digital literacy, operational costs, and competition with local traders. To overcome these barriers, farmer training, video-based guidance, and inclusive stakeholder engagement are necessary. Collaboration with local collectors is also suggested to support smoother adoption. **Conclusion:** The Semar-Dica Apps offer a promising solution for enhancing market efficiency and improving income security for chili farmers. Its success, however, relies on strategic implementation and support from all stakeholders. **Novelty/Originalty of this article:** This study contributes to the discourse on agricultural digitalization by identifying context-specific barriers to adoption and offering targeted, inclusive strategies to facilitate the transition of smallholder farmers to digital marketing platforms

KEYWORDS: agricultural digitalization; delayed payments; digital marketing platforms; digital literacy; supply chains.

1. Introduction

Food is a basic need that must be fulfilled for a country's sustainability. Food needs are met through the agricultural sector (Quirinno et al., 2024). Agriculture plays a key role in economic growth, food security, labor absorption, and providing sources of income for communities (Dewi et al., 2022). This sector absorbs the most labor. According to data from the Central Statistics Agency in 2020, the agricultural sector was one of the few productive

sectors during the Covid-19 pandemic. It grew by 1.75% during the pandemic (BPS Indonesia, 2021). Agriculture has proven to have a comprehensive role in Indonesia's economic growth during the Covid-19 pandemic, including in the Special Region of Yogyakarta (DIY) Province.

In the fourth quarter of 2020, economic growth in the Province of DIY grew by 3.18% compared to the third quarter (BPS DIY, 2021), with the agricultural sector contributing 10.19%. Kulon Progo Regency, especially in the sandy land areas, has great agricultural potential (Sasongko & Soejono, 2021; Amalia et al., 2021). The horticultural sector in Kulon Progo contributed 24.92% to agriculture as a whole, where agriculture contributed 81.78% of the total gross regional domestic product (GRDP) of Kulon Progo Regency in 2020 (BPS Kulon Progo, 2020).

In Kulon Progo Regency, red chili is the primary superior commodity developed on sandy land. In 2020, red chili cultivation covered 423 hectares, with 299 hectares harvested, yielding 7,695.90 tons (Pertapa, 2020). The flow of chili production on sandy coastal land is rapid, from producers to consumers, due to the high demand for chili. Chili is a staple in Indonesian dishes, so demand is always high (Nugroho et al., 2018).

Every year, red chili commodities often face extreme price fluctuations (Susanawati et al., 2020). These fluctuations cause vulnerabilities in marketing. The chili supply chain involves farmers, collectors or brokers, wholesalers, retailers, and consumers (Nurjannah et al., 2024). The chili price is set by collectors or brokers, which raises concerns about the development of chili marketing (Jumiana et al., 2018). The consequence of an increasing supply chain distance is that the selling price to consumers rises, while the purchase price at the farmer level is further depressed. Longer supply chains also make it easier for price manipulation to occur in the market. Farmers often face price manipulation from brokers when selling their crops personally (Rusdiyana, 2015). Farmers commonly experience unfair pricing when selling their products directly to brokers, reinforcing structural inefficiencies in the chili market.

In response, collective resistance among farmers has led to the establishment of auction markets as an alternative marketing mechanism (Rusdiyana et al., 2019). Auction markets determine prices through open bidding between sellers and buyers, promoting greater price transparency and fairness (Syam et al., 2023). They bring together farmer groups and buyers from different regions, helping to shorten supply chains and reduce marketing costs (Nurjannah et al., 2024). The system has been shown to increase farm-gate prices and strengthen farmers' bargaining positions (Kuntadi & Jamhari, 2012). However, conventional auction markets often delay payments by 3–5 days, causing difficulties for farmers who rely on immediate income for daily needs (Purwandani et al., 2016). As a result, some farmers revert to selling to brokers for lower prices simply to access quick cash.

To address these challenges, innovation in auction systems is essential. Some auction markets have adopted digital platforms to facilitate online transactions. One such innovation is the Semar-Dica App, an Android-based digital auction platform designed to improve group marketing for chili farmers in coastal sandy lands. This app aims to increase marketing efficiency, expand market reach, and provide faster access to sales proceeds. By enabling transparent and rapid transactions, Semar-Dica strengthens the institutional capacity of farmer groups and supports their transformation into independent economic actors, in line with government policy (Center for Agricultural Extension, 2011).

Despite these developments, several research gaps remain. There is limited empirical understanding of how digital auction platforms like Semar-Dica function in practice and their actual impact on market efficiency and farmers' income. Specifically, it is unclear how the app facilitates transactions, reduces marketing vulnerabilities, and supports farmer empowerment in sandy land contexts. Therefore, this study seeks to address the following research questions: (1) How can a digital auction system for red chili be effectively designed and implemented through the Semar-Dica App for chili farmers in coastal sandy areas of Kulon Progo? (2) What is the potential of the Semar-Dica App to improve market efficiency and increase the income of red chili farmers in the region?

2. Methods

This research employed a qualitative descriptive method supported by participatory action research (PAR) to explore the innovation of the digital auction market through the Semar-Dica Apps. The study was conducted in coastal sandy land areas of Panjatan Sub-district, Kulon Progo Regency, Special Region of Yogyakarta, where chili farming has been well established. The research focused on examining the auction market mechanism and its transformation through digital innovation to enhance farmers' market access and income. Two types of data were collected in this study: primary data and secondary data.

Primary data were obtained through: 1) field observations in Bugel, Garongan, and Pleret Villages, where auction markets were operational; 2) in-depth interviews with key stakeholders, including chili farmers, auction market managers, agricultural extension agents, and local government representatives. Secondary data were sourced from: 1) official reports from the Central Statistics Agency (BPS), Kulon Progo Regency Government, and the Ministry of Agriculture; 2) scientific journals and research papers relevant to agricultural marketing, digital platforms, and auction systems; 3) policy documents and manuals from auction market institutions and local agricultural extension services; 4) literature on innovation diffusion, digital technology adoption, and agricultural economics. Therefore data were analyzed using a combination of thematic and analytical approaches. First, descriptive qualitative analysis was applied to synthesize interview transcripts, observations, and FGDs. Themes were coded to explore farmers' marketing challenges, auction mechanisms, and readiness for digital adoption. Second, comparative analysis was used to contrast conventional and digital auction market mechanisms in terms of efficiency, payment speed, market coverage, and transparency. Third, SMART analysis (Specific, Measurable, Acceptable, Realistic, Time-bound) was employed to assess the feasibility and strategic implementation of the Semar-Dica Apps in addressing the key marketing problems of chili farmers. Fourth, stakeholder role mapping was conducted based on the Triple Helix collaboration model (university-government-private sector), identifying each actor's contributions and responsibilities in the implementation process.

The methodology also involved structured implementation steps including location surveys, stakeholder socialization, formation of implementation teams, application rollout, technical mentoring, monitoring and evaluation, and projection of future scalability to other commodities. This integrated methodological approach ensures the relevance, accuracy, and strategic alignment of Semar-Dica Apps with the socio-economic conditions of chili farmers on the southern coast of the Special Region of Yogyakarta. It also enables the research to produce both practical and policy-oriented insights for improving market efficiency in Indonesia's horticultural sector.

3. Results and Discussion

3.1 Condition of chili farmers on the southern coast

Farmers on the southern coast of the Special Region of Yogyakarta utilize sandy soil agricultural land along the 110 km coastline, stretching from east to west, with a total area of 3,300 hectares. The width of the sandy coastal land ranges from 1 to 3 km from the coastline. This type of land is classified as suboptimal (Yuwono, 2009). Beach sand soil has a crusty or crumbly structure, high permeability, and available moisture but low field capacity (Herawati et al., 2011). Additionally, coastal land has high salinity levels due to its proximity to the sea. High salinity inhibits growth and reduces chili plant production (Karolinoerita & Yusuf, 2020; Aisy & Rachmawati, 2022). Sandy soil requires special treatment to optimize crop yield. The local wisdom of farmers in using organic materials has the potential to enhance agricultural productivity (Hasibuan, 2015).

The utilization of coastal sandy land as productive agricultural land began in the early 1980s (Rusdiyana et al., 2019). In 1985, Sukarman, a 56-year-old farmer, discovered that chili plants could grow on sandy land near his house. This discovery motivated him to

cultivate chili on a 300 m² plot. His success inspired other farmers, leading them to form a farming community. Currently, the land used for chili cultivation has expanded to 30 hectares in Bugel Village, Panjatan District, Kulon Progo Regency (Kusumaningrum et al., 2015). Red chili farmers in Panjatan District can harvest approximately 8 tons of chili per hectare using the Helix variety. On sandy land, farmers can achieve a net profit of up to IDR 41 million per hectare by using superior red chili varieties (Sutardi & Wirasti, 2017). The economic potential of chili farming on sandy land has significantly improved the prosperity of local farmers.

However, farmers often face challenges in marketing chilies due to price fluctuations. At the farmer level, chili prices range from IDR 2,860 to IDR 38,933 per kg (Anwarudin et al., 2015). The production cost of red chilies is approximately IDR 8,580 per kg (Latifa & Sinta, 2022). When prices drop too low, especially below the HPP, farmers suffer financial losses, as they cannot cover production costs. These costs include seeds, fertilizers, labor, and other maintenance expenses (Karyani & Tedy, 2021). Farmers often rely on brokers or intermediaries to sell their products quickly, even at unprofitable prices (Jumiana, 2018). Brokers frequently exploit this situation by purchasing chilies at very low prices, putting farmers at a disadvantage.

One of the main causes of price fluctuations at the farmer level is suspected to be variations in chili production (Pradana, 2021). The lowest prices typically occur in July, while the highest prices are in December (Susanawati et al., 2020). Prices drop during peak harvest periods when supply is abundant and rise when stock is scarce (Anwarudin et al., 2015). The scarcity of chili stock is the primary reason for price increases (Nugroho et al., 2018). Additionally, price instability is suspected to be caused by market mechanisms not functioning properly and unfair distribution among market actors, leading to an unhealthy market system (Sukmawati et al., 2016).

3.2 Chili auction market system for coastal sandy land farmers

The experience of facing low price pressure from brokers has led farmers to develop local wisdom in the form of group marketing through auction markets. Chili farmers in Panjatan District, Kulon Progo, initiated an auction market to control fluctuations in chili prices. The auction market transforms farmer groups into marketing institutions or units that serve as collective marketing platforms for coastal sandy land farmers in Kulon Progo. Through this system, the auction market takes over the role of farmers in marketing their crops. Farmers benefit significantly, including saving energy, time, and resources, making the auction market their preferred method for selling crops (Rusdiyana, 2017). The auction system has been proven to facilitate chili marketing (Oktia & Abubakar, 2022).

The auction market was established in 2004 and continued to grow until 2008 when the government formed the FMA (Syam et al., 2023). The effectiveness of the chili auction market institution is relatively high, reaching 88.3% among the 53 farmers sampled. Factors significantly influencing the effectiveness of the red chili auction market institution include farmers' educational levels, their attitudes toward the auction market institution, and the leadership role within the group (Devi et al., 2015). The group leader plays a crucial role in directing chili sales to the auction market (Asa et al., 2020).

The auction market institution operates effectively due to the presence of structured product flow, financial transactions, and transparent information (Nugroho et al., 2018). The auction market in Kulon Progo is a transparent system characterized by fair, safe, efficient, and competitive pricing mechanisms (Rohman, 2015). A transparent auction process, including setting the initial price and providing information about chili quality, is essential for building trust between buyers and farmers. This system reduces the potential for price manipulation and enhances the attractiveness of auctions (Hanum & Islami, 2023). Currently, at least 24 auction market points have been established along the sandy coast of Kulon Progo, developed through social learning within farmer groups (Asa et al., 2020). The facilities provided by auction management significantly support farmers in marketing their products (Devi et al., 2015). Effective auction market management stabilizes prices,

improves farmer welfare, and ensures a more efficient distribution chain (Supriadi & Sejati, 2018; Aldavi et al., 2023).

The empowerment of farmer groups through the auction market involves collaboration between farmer group management, members, and market traders (Perdana, 2016). The committee, consisting of chili farmers, serves as the management team for the farmer group (Kuntadi & Jamhari, 2012). Developing the auction market requires building a systematic approach, including engaging sellers and buyers, preparing auction mechanisms, establishing auction regulations, socializing with farmers and market players, and training auction managers (Santoso et al., 2016). The auction market plays key roles in facilitating exchanges, physical transactions, and infrastructure functions (Rusdiyana, 2017).

The auction mechanism consists of three stages: pre-auction, auction, and post-auction (Syam et al., 2023). Pre-auction activities include harvesting, weighing, and record-keeping. The committee then seeks auction participants from various regions. During the auction, traders submit price offers, while the auction committee provides information about chili quantity, quality, and harvest conditions in other regions. The bidding process lasts for two days, with each trader having one opportunity to revise their bid (Kuntadi & Jamhari, 2012). The highest bidder wins the auction (Aprilia et al., 2020). Post-auction activities include packaging, transportation, and payment processing.

Prices in the auction market are guaranteed since transactions are conducted through farmer groups, ensuring that farmers' bargaining power remains strong (Rusdiyana, 2017). The auction market was established based on farmers' common interest in standardizing chili prices (Aprilia et al., 2020). Auction activities are carried out by group members or farmers who cultivate and sell chilies (Asa et al., 2020). Farmers participate by delivering their produce to the auction market and awaiting sales results from home, without needing to sort, bargain, or seek buyers (Aprilia et al., 2020).

The auction system uses a closed bidding mechanism to prevent collusion among traders or buyers (Syam et al., 2023). All participants submit their bids without knowing the offers from other participants. The committee invites traders to participate (Kuntadi & Jamhari, 2012). This system allows buyers from various regions to engage, ensuring fair competition. Buyers compete by offering higher bids, while sellers wait for the best offer before finalizing sales.

At the farmer level, chili prices average IDR 8,500 per kg, still below the break-even point (BEP) of IDR 8,580 (Pertapa, 2020; Latifa & Sinta, 2022). However, the auction market has increased selling prices by IDR 2,000–5,000 per kg. From a broker's perspective, purchasing chili through the auction market offers several advantages: (1) large quantities of chili can be obtained (>20 tons per auction point), (2) the auction market ensures chili quality through standardized cleanliness, grading, and varieties, and (3) brokers who win the auction do not need to seek buyers, as the auction market handles marketing (Nugroho et al., 2018). The auction system provides mutual benefits for both farmers and traders.

Auction markets generally benefit farmers both socially and economically (Supriyanto et al., 2012; Devi et al., 2016). They create an environment where individuals and organizations from diverse backgrounds can interact and collaborate, fostering broader economic and social engagement. The chili auction market system established by farmers on the southern coast of the Special Region of Yogyakarta has significantly increased chili sales for local farmers (Rusdiyana et al., 2017) by securing higher selling prices compared to broker-based marketing (Rusdiyana, 2017).

The sustainability of the auction market in Panjatan District has significantly boosted chili farmers' income, with a profit difference of IDR 61,945,009.27 per hectare per season compared to alternative marketing channels (Mulyadi, 2011, in Rusdiyana, 2015). The auction market has encouraged farmers by eliminating the risk of exploitation by traders, collectors, and brokers (Rusdiyana et al., 2017).

Despite its benefits, the auction market faces three key challenges: (1) delayed payment, as local brokers participating in the auction must wait for payments from large traders in Jakarta and Lampung, typically taking 3–5 days; (2) limited participation of large traders, who rely on local brokers due to the distance between Jakarta/Lampung and Kulon

Progo; and (3) a manual auction system that extends the marketing chain, preventing direct transactions with large traders (Purwandani et al., 2016).

The substantial profit difference highlights the auction market's role in increasing farmers' income and bargaining power in Kulon Progo. However, delayed payments have made the system less effective in providing immediate funds for farmers. Since local brokers must sell to large traders in distant regions, the process takes time, forcing farmers to sell at lower prices in local markets to meet urgent financial needs. This situation is concerning and may reduce farmers' interest in participating in the auction system.

Farmers often experience anxiety while waiting for payment, which takes several days. To address this, an immediate payment mechanism should be implemented. If traders lack funds, they should settle payments within five days of winning the auction (Syam et al., 2023). Immediate payment is crucial for farmers to reinvest in the next planting season. However, auction market managers frequently delay payments (Purwandani et al., 2016). To overcome this issue, more effective and efficient marketing innovations are needed to ensure faster transactions and higher selling prices for farmers in Panjatan District, Kulon Progo Regency.

A sustainable solution involves innovating the auction system to shorten the marketing chain, allowing farmers to receive higher prices and immediate sales proceeds while expanding market reach. Increasing farmers' and traders' profits can be achieved by enhancing supply chain efficiency, minimizing costs, and maximizing added value (Nurjannah et al., 2024). A shorter market chain will also attract large traders from outside the region to participate directly in the chili auction market. Key stakeholders in the chili commodity supply chain include farmers, brokers, distributors, retailers, and consumers.

3.3 Semar-Dica apps concept

Semar-Dica Apps is a digital auction market application that connects farmers and buyers to shorten the chili supply chain. The chili supply chain (Figure 1) from farmers to wholesalers follows three different schemes. The first scheme represents the longest supply chain (without an auction market), involving farmers, brokers 1, brokers 2, brokers 3, and wholesalers. The second scheme is a shorter supply chain, facilitated by the presence of an auction market, which connects farmers, brokers, and wholesalers. The third scheme is the shortest, involving only farmers, the auction market, and wholesalers. This third scheme utilizes a digital auction market, allowing wholesalers to participate directly. The digitalization of the auction market provides interactive and transparent pricing access (Ardiansyah, 2022).
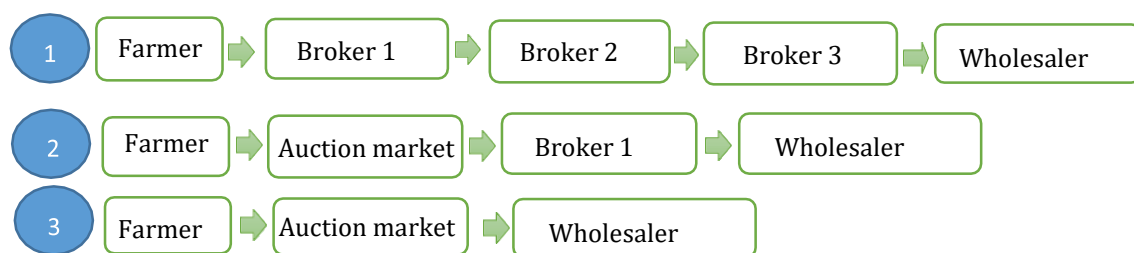

Fig. 1. Chili marketing chain in coastal sandy land: 1) chili marketing chain through broker (collectors); 2) chili marketing chain through auction markets; 3) chili marketing chain through semar-dica apss

The digitalization of the auction market refers to the use of digital technology to facilitate a more efficient, transparent, and accessible auction process for a broader audience. The development of this innovation aligns with the increasing number of coastal sandy land farmers who can access various digital resources related to farming. According to Purnomo (2019), chili farmers, particularly those aged 25–35 years, have high access to agricultural information. They actively seek knowledge on cultivation techniques and chili

agribusiness. Information technology plays a crucial role in marketing chilies in the auction market (Asa et al., 2020), which supports the development of the Semar-Dica Apps digital auction market application. Semar-Dica Apps, as a digital marketing innovation, contributes to achieving the Sustainable Development Goals (SDGs), particularly Goal 10, which focuses on reducing income inequality. Digitalization lowers operational costs by eliminating the need for a physical auction venue. Additionally, the auction process becomes more efficient, as all stages including registration, verification, and payment are conducted online.

Efforts to achieve SDG Goal 10 (reducing income inequality) through the development of Semar-Dica Apps help expand the reach of chili marketing and stabilize fluctuating chili prices over time. This is because the bargaining power of chili farmers in coastal sandy land increases, encouraging consumers and collectors to compete for the best price through Semar-Dica Apps. The urgency of ensuring effective chili marketing for these farmers highlights the immediate need for Semar-Dica Apps. Its development aims to improve marketing effectiveness, reduce marketing costs, and ensure the accurate and timely receipt of marketing funds. The creative concept behind Semar-Dica Apps will be highly beneficial when applied to the chili auction market in Kulon Progo.

Semar-Dica Apps is a location-specific digital auction market application designed for coastal sandy land farmers in Kulon Progo Regency. Digital auctions enable participation from individuals in various locations without requiring physical presence. Semar-Dica Apps will streamline the chili marketing chain through a digital platform available as an Android application.

This application addresses key issues related to delayed payments from sales and expands market access for local traders. Semar-Dica Apps allows farmers to reach a wider network of chili traders and receive payments quickly, as winning bidders must pay immediately before the chili is shipped. The following describes the digital auction market mechanism through Semar-Dica Apps.

The auction market software is easy to use for both buyers and farmers. Prospective buyers and farmers can download the application from the Play Store. Then, they must register by providing their full name, cellphone number, email, place and date of birth, and address. They also need to select their role as either a farmer or a buyer and upload their official identity document.

Once registered, users will receive a verification code via SMS or email to complete the registration process. After logging in, users can access various features within the application, including: Semar-Dica Apps main page, National and regional chili prices, Auction market, which includes auction platforms, opening hours, and available stock, and Auction winners, which displays auction winner records

Farmers and buyers can monitor chili stock in real time. Buyers who wish to place bids can submit their purchase price directly through the Auction Market menu once the auction opens. The auction system uses a closed bidding system, ensuring fair competition among buyers. Buyers will not be able to see other participants' bids, preventing price manipulation. The auction process on Semar-Dica Apps lasts one hour per session and runs in real time. The winning bid will be displayed after the auction ends.

Once the auction winner is determined, the auction manager will issue a sales and purchase contract to make the transaction legally binding. Buyers must then pay for the chilies at the agreed-upon price. A designated payment account is provided, and payments are made to the auction market manager. Farmers who have deposited their chilies into the auction market can immediately withdraw their money after the auction is completed.

In real-time, Semar-Dica Apps can show the price of chili, the buyer's bid price, and the auction winner. This condition increases farmers' motivation to cultivate chili and make sales through the auction market. Through a system that is well recorded, continuously monitored, and paid on time, it can strengthen the trust of farmers and buyers in the auction market manager. Table 1 is a comparison between the conventional auction market and Semar-Dica Apps.

The comparison between conventional auction markets and the Semar-Dica Apps underscores the transformative potential of digital platforms in agricultural marketing. The

reduction of intermediary layers in the marketing chain significantly enhances efficiency, allowing farmers to secure better prices and faster payments. Studies by Reardon et al. (2019) indicate that digital marketplaces improve transparency and reduce transaction costs, benefiting both producers and buyers. Furthermore, the national market reach of Semar-Dica Apps aligns with research by Bellemare & Lim (2020), which highlights the role of e-commerce in expanding rural farmers' access to competitive markets. By eliminating delays in payment processing and ensuring direct transactions between farmers and wholesalers, Semar-Dica Apps exemplifies a progressive shift towards a more equitable and efficient agricultural economy.

Table 1. Comparison between conventional auction market and semar-dica apps.

Num	Distinguishing Aspects	Conventional Auction Market	Semar-Dica Apps
1	Marketing Chain	Farmers-auction market-middlemen 1-trader Large	Farmers-auction market-wholesalers
2	Payment Methods	After being sold to the wholesaler, the middleman 1 pays to the market Auction	Wholesaler wins auction, pays directly to auction market
3	Time of Receipt of Sales Results	Wait 3 - 5 days	On the same day
4	Market coverage	Local	National

3.4 Target analysis in SMART

Semar-Dica Apps application in achieving target recipients through SMART analysis (Specific, Measurable, Acceptable, Realistic, and Time Bound) (Table 2). It is hoped that the implementation of this application can overcome the problems faced by chili farmers in the southern coastal areas of DIY effectively and efficiently.

Table 2. SMART analysis on the semar-dica apps application

Characteristics	Description
Specific	Semar-Dica Apps is a digital auction market application that makes it easy for farmers and buyers to conduct digital auctions in real-time. This can increase the marketing reach of coastal sandy land chili farmers through the auction market system and allow them to receive sales results quickly.
Measurable	Semar-Dica Apps can gather prospective auction participants from all over Indonesia for those who have registered themselves through the application.
Acceptable	Semar-Dica Apps can be accepted by chili farmers on the sandy land of the southern coast of DIY and prospective buyers because they can be easily downloaded via the Playstore and registered in the application to become participants in the auction market.
Realistic	Semar-Dica Apps can effectively and efficiently cut the marketing chain of chili from coastal sandy land farmers to obtain optimal profits.
Time-Bound	Semar-Dica Apps are implemented when farmers have chili stock for auction.

The effectiveness of Semar-Dica Apps in addressing the marketing challenges of coastal sandy land chili farmers aligns with prior research on digital agricultural platforms. According to Wolfert et al. (2017), digital innovations in agriculture enhance supply chain efficiency, improve market transparency, and empower farmers with real-time market information. Furthermore, Smart Farming technologies, as discussed by Klerkx et al. (2019), emphasize the importance of user-friendly applications that facilitate market access and reduce dependency on traditional intermediaries. By integrating SMART criteria into its implementation, Semar-Dica Apps can serve as a model for future agricultural digital transformation, ensuring inclusivity and sustainability in the chili farming sector.

To further strengthen the role of Semar-Dica Apps in digital agricultural transformation, it is essential to consider the socio-economic factors that influence technology adoption among farmers. Research by Rogers (2003) on the Diffusion of

Innovation Theory highlights that the adoption of new agricultural technologies is influenced by perceived advantages, ease of use, and compatibility with existing farming practices. Additionally, studies by Zhang et al. (2020) suggest that mobile-based platforms can bridge the gap between smallholder farmers and potential buyers, thereby reducing transaction costs and increasing profitability. By leveraging these insights, Semar-Dica Apps can be refined to better meet the needs of coastal chili farmers, ensuring its long-term sustainability and widespread adoption.

3.5 Implementing of Semar-Dica apps

The rapid advancement of digital technology has paved the way for innovative solutions in the agricultural sector, addressing long-standing inefficiencies in market access and price transparency. One such breakthrough is the Semar-Dica Apps, a digital auction platform designed to optimize the agricultural supply chain, particularly for chili farmers in the sandy land areas of the southern coast of the Special Region of Yogyakarta. Traditional auction markets in this region, while essential, often present challenges such as delayed transaction processes and limited buyer networks, reducing farmers' bargaining power. By leveraging digital technology, Semar-Dica Apps aims to enhance market efficiency, streamline transactions, and expand the reach of local agricultural products beyond conventional boundaries. The following steps outline the structured implementation of Semar-Dica Apps to ensure its successful adoption and sustainability in the target locations. The Steps to Implement Semar-Dica Apps: first, survey and Analysis of Location Conditions

This step involves identifying potential problems faced by chili farmers on the sandy land of the southern coast of the Special Region of Yogyakarta Province. The target locations include Bugel Village, Pleret Village, Garongan Village, Panjatan District, and Kulon Progo Regency. The survey found that there was an existing auction market in Panjatan District. However, farmers faced challenges such as having to wait 3-5 days for auction sales results, and the buyers were limited to local collectors. Second, socialization of Semar-Dica Apps. the socialization activities aim to introduce the digital auction market innovation through Semar-Dica Apps to beneficiaries and relevant stakeholders. This process ensures that the implementation receives support from various parties. Third, formation of the implementation team, the socialization process raises interest among the target audience in adopting a digital auction market. As a result, an implementation team is formed, consisting of farmer groups, auction market managers, village governments, agricultural extension workers, local governments, and Sebelas Maret University (UNS). Fourth, implementation and mentoring. The implementation and mentoring of Semar-Dica Apps are carried out by the implementation team. This stage focuses on empowering farmers and guiding them through the adoption process using the innovation diffusion model. According to Rogers (1995), innovation diffusion refers to how an innovation is communicated over time through specific channels within a social system. Monitoring and evaluation, monitoring assesses the functionality and performance of Semar-Dica Apps. Evaluation measures the effectiveness and efficiency of Semar-Dica Apps for the Panjatan District auction market in Kulon Progo. Fifth, potential Development of Semar-Dica Apps. The implementation of Semar-Dica Apps has the potential to be expanded to support other agricultural commodities, including watermelon, melon, bitter melon, moringa, peanuts, rice, corn, and more. This expansion aims to ensure the long-term sustainability of the application and further empower farmers through the auction market system.

3.6 Obstacle and alternative solution

The implementation of Semar-Dica Apps is likely to face several obstacles (Table 3). An alternative to reduce the challenges that will occur so that Semar-Dica Apps can run according to the plan that has been set is as follows. To enhance the effectiveness of the proposed alternative solutions, a multi-stakeholder approach should be implemented, involving government agencies, agricultural institutions, and private sector partnerships.

According to Rogers' Diffusion of Innovation Theory (2003), the adoption of new technologies depends on effective communication channels, perceived benefits, and support systems. Therefore, in addition to training and digital socialization, incentive mechanisms such as subsidies for digital tools or reduced transaction fees could encourage farmer participation. Moreover, studies by Van der Burg et al. (2019) emphasize that addressing digital literacy gaps through peer-to-peer learning models can significantly improve technology adoption among farmers. Thus, integrating these strategies will ensure that Semar-Dica Apps become a sustainable and widely accepted platform in the agricultural sector.

Table 3. Analysis of barriers and alternative solutions to the implementation of semar-dica apps

Barriers	Alternative Solution
Understanding and knowledge of technology is still widely found among millennial farmers and has not yet reached all farmers.	Socialization related to the technology used in this digital auction market and conducting training for younger people to access the Semar-Dica Apps for older farmers.
The farmer paradigm regarding the use of technology certainly requires more costs and is complicated to implement	Making video tutorials on using the Semar-Dica Apps application, ongoing assistance, and practicing using the Semar-Dica Apps application.
Conflict with local collectors who usually participate in auction markets because they have to face competition with a whole market through digital technology.	Sharing the auction system directly and digitally for mutual benefit to each other. Local broker may change their position from one of the marketing channels to a wholesale trader.

To further enhance the adoption of Semar-Dica Apps, it is crucial to consider farmers' behavioral intentions towards technology. The Technology Acceptance Model (TAM) proposed by Davis (1989) suggests that perceived ease of use and perceived usefulness significantly influence user acceptance of digital innovations. Implementing a user-friendly interface with localized language support and simplified navigation can enhance farmers' willingness to adopt the application (Venkatesh & Bala, 2008). Additionally, research by FAO (2021) indicates that financial literacy plays a crucial role in the successful adoption of digital agricultural platforms. Providing financial management training alongside technical guidance can empower farmers to make informed decisions regarding their participation in digital markets. By addressing these socio-economic factors, Semar-Dica Apps can establish a more inclusive and sustainable ecosystem for chili farmers in Indonesia.

3.7 Stakeholder roles and implementing organizational structure

The development of Semar-Dica Apps is inseparable from the involvement of various collaborative stakeholders. These stakeholders participate through the Triple Helix Model collaboration, which consists of universities, government, and private sector/third-party Corporate Social Responsibility (CSR). The Triple Helix Model is an innovation framework in which three entities play specific roles and interact with one another (Leydesdorff & Ivanova, 2016). The following are the roles of each stakeholder in the development of Semar-Dica Apps: Universitas Sebelas Maret, Government Entities, Private Sector/Corporate Social Responsibility (CSR) Third Party. UNS plays a crucial role in conducting research and providing assistance for the implementation of Semar-Dica Apps. Additionally, UNS engages in community service activities to further develop the digital auction market. Government support comes from multiple stakeholders, including: 1) the Kulon Progo Regional Government. Through the Department of Agriculture and the Department of Trade, the government provides facilitation in the form of support programs, policies, and funding incentives for the further development of the auction market. 2) agricultural Extension Workers (Panjatan District). These workers assist and train local farmers, ensuring that they consistently sell their agricultural products through the auction market. 3) Bugel Village, Pleret Village, and Garongan Village Governments. These village

governments encourage farmers to utilize the auction market when selling their chili products. They also provide funding incentives to support the development of digital auction market applications.

Bank Indonesia has collaborated with the Panjatan District auction market by providing physical infrastructure support in the form of buildings. Continued cooperation with Bank Indonesia is essential for the development of a digital auction market through Semar-Dica Apps, ensuring the sustainability of the auction market. FMA Karyo Manunggal plays a critical role as a district-level association that oversees 25 chili auction markets in Kulon Progo. FMA fosters and ensures that auction markets in Kulon Progo comply with established standards.

The organizational structure of Semar-Dica Apps implementers consists of several stakeholders and beneficiaries, each with their own roles. The Kulon Progo Regional Government and Sebelas Maret University provide guidance and direction for the digital auction market organization. The Auction Market Association offers assistance and direct supervision to ensure that Semar-Dica Apps operates effectively and that its activities are well-monitored. The application development industry is responsible for maintaining the application, ensuring smooth operation without disruptions. Additionally, the industry also serves as an investor for chili farmers, fostering a more sustainable collaboration. Agricultural extension workers support farmers by providing technical assistance in the field and helping with the monitoring and evaluation process of the program. The key program implementers are the Director of auction market in Kulon Progo. Meanwhile, the beneficiaries, specifically farmer groups from each village, play a direct role in managing the digital auction market by taking on responsibilities as chief excecutive, secretaries, treasurers, and members (Fig 2).
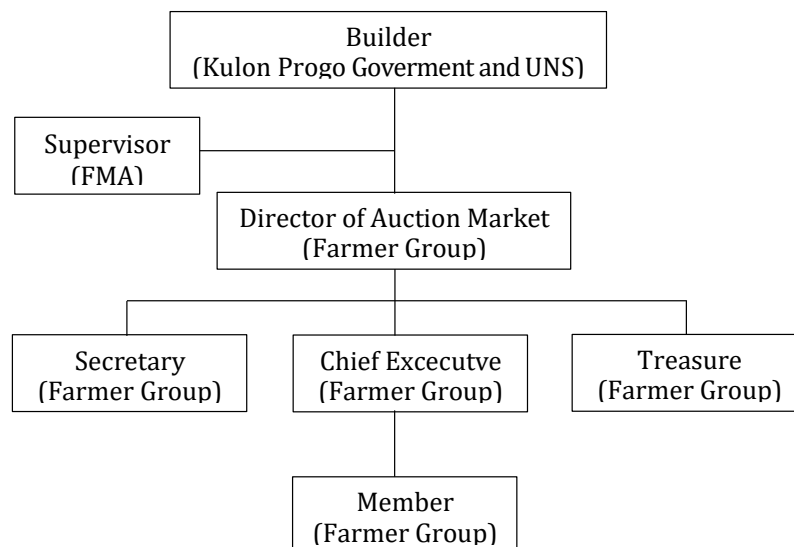
Fig 2. Organizational structure of the digital auction market in Panjatan Sub-district

4. Conclusions

Semar-Dica Apps is a digital chili auction market application designed for chili farmers in the sandy land of Panjatan District. This platform connects farmers, traders, and other stakeholders, making it easier for chili farmers in Panjatan District to increase sales, expand marketing reach, and speed up the receipt of sales proceeds. Semar-Dica Apps improves cost efficiency in chili sales and enhances sales effectiveness by allowing large traders to engage directly through a smartphone-based application.

This initiative is recommended for adoption by the Kulon Progo Regency Government, the Farmers Market Association (Aspartan), and village farmer groups. Farmers involved in auction markets are encouraged to actively participate in this program. Semar-Dica Apps

integrates the local wisdom of sandy land farmers on the southern coast with modern information technology, ultimately boosting local farmers' productivity.

The private sector and third-party CSR must continue to support the development and maintenance of this application while also facilitating investment opportunities through the platform. Agricultural extension workers play a crucial role in monitoring and evaluating its implementation. The Triple Helix collaboration—involving universities, government, and the private sector/third-party CSR—is the key to the successful implementation of Semar-Dica Apps.

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