



Agribusiness Supply Chain Management of “Rainbee”: *Apis cerana* in Forests of Bondowoso, Indonesia

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Abstract

In Indonesia, the *Apis cerana* honey supply chain faces structural challenges, including low producer digital literacy, limited market access, and dependence on intermediaries. The objective of this study is to evaluate the efficacy of the *Apis cerana* honey distribution supply chain and to establish a digitalisation system that incorporates text notifications and e-commerce to increase farmers' income. The research employed a survey methodology, utilising primary data collected through questionnaires, interviews, and field observations of honey farmers in Kretek Village, Bondowoso. We calculated the marketing margins and the farmer's share across three distribution channels to determine their efficiency. The results showed that the traditional channel (Channel I) had the highest marketing margin and the lowest farmer's share. In contrast, the use of e-commerce (Channel III) increased the farmer's share by more than 40% by eliminating two marketing institutions: distributors and retailers. The push notification system was effective in accelerating the exchange of information between producers and consumers and encouraging repeat purchases from the same store. This study contributes to the formulation of an effective and sustainable supply chain model for *Apis cerana* honey producers, aligned with SDG Target 8 concerning decent labour and economic growth.

Keywords: Supply chain, Marketing efficiency, E-commerce, *Apis cerana*, Farmer's share



1. Introduction

The honey industry in Indonesia has substantial potential, notably the honey produced by the local bee, *Apis cerana*. In rural communities, this bee species has been cultivated for centuries as an alternative source of income, and it is found throughout Southeast Asia (Indonesian Apicultural Association, 2021). Bondowoso Regency is one of the best places in East Java to make *Apis cerana* honey because of its geography, which is good for bee colonies. But the marketing and distribution system has a lot of structural problems that have kept this industry from fully using its economic potential.

The long supply chain is the main challenge for *Apis cerana* honey farmers. There are many middlemen, like as collectors, agro-industries, distributors, and retailers, before the product gets to the final consumer. This arrangement means that farmers make very little money, even when the price at the consumer level is rather high (Purnomo & Ratnawati, 2020). Relying on middlemen as the main buyers makes it even harder for farmers to negotiate rates. Limited access to market knowledge and a lack of funds for business growth are some things that make life harder for honey bee growers.

This issue is consistent with the eighth Sustainable Development Goal (SDG) objective, which underscores the significance of inclusive economic growth and decent work in the context of sustainable development (United Nations, 2015). Indonesia has pledged to implement the Sustainable Development Goals (SDGs) in accordance with Presidential Regulation Number 59 of 2017. The economic empowerment of small farmers and livestock breeders is a priority that must be supported through technological innovation and enhancements to the distribution system within this policy framework.

Advancements in information and communication technology have created new opportunities for the transformation of agricultural and livestock product marketing systems. E-commerce effectively minimises inefficient distribution channels and enhances market access for small producers (Laudon & Traver, 2020). Research indicates that the use of digital platforms in agricultural product marketing can substantially enhance farmer incomes by removing non-value-added intermediaries (Handayani et al., 2015). Research on the implementation of e-commerce within the *Apis cerana* honey supply chain in Indonesia remains scarce.

The objective of this investigation is to resolve this deficiency by conducting an analysis of the *Apis cerana* honey supply chain in Bondowoso Regency and constructing an efficiency model through the integration of e-commerce features incorporating push notifications. Push notification was selected as a supporting feature due to its capacity to deliver real-time information regarding product availability, which enhances transaction



frequency and fosters customer loyalty (Gohar et al., 2019). The integration of this technology is anticipated to provide a viable solution for enhancing the income of *Apis cerana* honey farmers and may serve as a replicable model for other agricultural and livestock commodities.

2. Literature review

2.1. Supply Chain Management in Livestock Agribusiness

The objective of supply chain management (SCM) is to enhance the efficiency and efficacy of distribution by systematically managing the flow of products, information, and financing from upstream to downstream (Christopher, 2016). In the agricultural sector, supply chain management (SCM) emphasizes not only the physical transportation of goods but also the coordination of supply chain participants to guarantee the maintenance of product quality and equitable distribution of added value (Chopra & Meindl, 2019). This approach corresponds with actual evidence from other cattle sectors, where Hasanah, Wahyono, and Subagja (2022) shown that a shorter supply chain correlates with increased efficiency. Consequently, throughout the honey supply chain, removing superfluous distribution channels might enhance the price share for farmers and bolster product competitiveness in the marketplace.

Research conducted by Hasanah et al. (2023) on the marketing effectiveness of broiler chicken eggs in Banyuwangi Regency revealed a negative correlation between the length of the distribution chain and farmer revenue. As the number of marketing institutions increases, the share of the price obtained by producers diminishes. A study of the lamb meat supply chain in Jember Regency similarly revealed that the participation of middlemen and intermediates augmented marketing margins by as much as 60% of the final selling price (Sulistiyono & Hasanah, 2019).

The honey industry faces increased supply chain complexity due to challenges related to product quality and standardization. Honey produced through traditional methods frequently does not comply with contemporary packaging and labeling standards, compelling farmers to sell their products to collectors at considerably reduced prices (Mulyani et al., 2022). This establishes a structural dependency that is challenging to dismantle without technological intervention and capacity development for farmers.

2.2. Digital Marketing and E-commerce

Digital transformation in agriculture and livestock has emerged as a global phenomenon, altering producer-market interactions. E-commerce provides a platform enabling small producers to connect directly with consumers, bypassing traditional



intermediaries (Turban et al., 2018). Lestari et al. (2022) conducted research on digital marketing strategies for honey bee farmers' products, revealing that the utilization of online marketplaces can enhance sales volume by as much as 35% within the initial six months of implementation.

The success of e-commerce implementation in the agribusiness sector is not solely contingent upon technology. Digital literacy among farmers, readiness of infrastructure, and support from the business ecosystem are critical determinants of successful technology adoption (OECD, 2017). Studies conducted in Indonesia indicate that MSMEs that effectively implement e-commerce benefit from comprehensive assistance in content management, product photography, and online transaction management (Handayani et al., 2015).

In the current rapid digital age, e-commerce rivalry is intensifying, necessitating that each platform identify the most efficient strategies to attract and keep clients (Li et al., 2021). A validated communication method is the utilization of push notifications, which are concise messages dispatched in real time to consumers' devices. In e-commerce, push notifications serve not just as reminders but also as a strategic instrument for enhancing engagement, stimulating sales, and fortifying client loyalty (Rahardja et al., 2020). Push notifications are essential for linking consumers to product offerings, promotions, and services provided by e-commerce platforms, as they convey pertinent, tailored, and timely information (Purba et al., 2021).

Push notifications have demonstrated efficacy in e-commerce by swiftly and directly engaging customer attention. For instance, Tokopedia employs push notifications to alert customers regarding daily flash specials at designated periods (Nawir & Hendrawan, 2024). These notifications not only cultivate a sense of urgency but also markedly enhance app traffic during promotional intervals. Shopee employs push notifications to alert users regarding abandoned shopping carts. Shopee effectively converts numerous indecisive potential purchasers into actual transactions by dispatching reminders that include supplementary discounts or complimentary delivery coupons (Song et al., 2025). At the same time, Amazon employs text notifications that are more personalized in the global marketplace. Amazon utilizes search and purchase data to provide personalized product recommendations aligned with user preferences, such as reminding customers of items in their cart or suggesting comparable products (Handayani et al., 2020). Consequently, Amazon has effectively enhanced conversions and average order value. These real-world instances illustrate that push notifications serve not only as a promotional instrument but also as a fundamental component of a customer engagement strategy that, when executed appropriately and promptly, may enhance sales and fortify client loyalty (Chen & Decary, 2020).



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2.3. Marketing Efficiency and Farmer's Share

Marketing efficiency serves as a crucial metric for evaluating supply chain effectiveness from an economic standpoint. Sudiyono (2002) characterizes marketing efficiency as the ratio of product generated to input used in the distribution process, which may be assessed by marketing margins, markup pricing, and the farmer's share. The farmer's share denotes the fraction of consumer prices allocated to producers. An increased farmer's share signifies a more effective marketing strategy (Kohls & Uhl, 2002).

Studies on the efficiency of livestock product supply chains in Indonesia reveal considerable disparities among different commodities and regions. Mukson (2005) indicated that the farmer share for sheep farming in Semarang Regency is between 55-65%, whereas research on broiler chicken marketing shows a lower range of 40-50% (Hasanah et al., 2022). The observed differences are shaped by product characteristics, market structure, and the presence of supporting infrastructure.

Few studies comprehensively analyze the farmer's share in the context of *Apis cerana* honey. Initial findings in Bondowoso suggest that honey farmers obtain approximately 30-35% of the retail price paid by consumers, which is significantly lower than the percentages for other livestock products (Bondowoso Agricultural Office, 2023). This scenario necessitates policy intervention and technological advancements to enhance farmers' negotiating power within the value chain.

3. Method

This study adopts a mixed-method case study approach, combining quantitative and qualitative descriptive analyses to evaluate the efficiency of the *Apis cerana* honey supply chain before and after e-commerce implementation with push notifications. The research site was intentionally chosen in Kretek Village, Taman Krocok District, Bondowoso Regency, due to its status as a hub for *Apis cerana* honey production, which features a developed supply chain structure and sufficient accessibility for the application of digital technology.



The primary respondents included 25 *Apis cerana* honey producers from the Sejahtera Forest Producers Group (KTH Sejahtera), and the research was conducted from June to August 2025. Respondents were chosen through a purposive sampling method, adhering to specific criteria: a minimum of two years of beekeeping experience, active involvement in group activities, and a willingness to engage in an e-commerce training program. The research encompassed not only farmers but also various supply chain participants, such as honey collectors, agro-industries, distributors, and retailers, to provide a thorough understanding of the existing distribution structure.

Primary data collection was executed using three methodologies. First, comprehensive interviews were conducted with all participants in the supply chain to ascertain distribution structures, pricing mechanisms, and encountered challenges. Field observations were conducted to examine the production process, post-harvest handling, and the existing marketing system. A structured questionnaire was administered to gather quantitative data regarding production volume, selling prices across different distribution levels, and marketing expenses. Secondary data were sourced from KTH Sejahtera production records, market price information from the Bondowoso Agriculture Service, and relevant literature.

An analysis of supply chain efficiency was performed by comparing three distribution channels that varied in complexity and the number of intermediaries involved. This study compares three channels to determine the most efficient distribution structure concerning farmer income.

Channel I outlines a conventional supply chain comprising five intermediaries:



Figure 1. Channel 1 (traditional) supply chain model

Channel I represents the traditional supply chain structure where *Apis cerana* honey passes through five distinct intermediaries before reaching the end consumer. The flow begins with farmers who harvest raw honey and sell it to collectors. These collectors perform basic filtration and transfer the product to agro-industries. The agro-industries are responsible for packaging and labeling before distributing to wholesalers/distributors. Distributors then supply the packaged honey to retailers, who finally sell the product to end consumers. This lengthy chain involves multiple price markups at each stage, resulting in the highest marketing margin and the lowest farmer's share among all three channels studied.

Channel II is a semi-direct supply chain with three intermediaries:



Figure 2. Channel II Semi Direct SCM

Channel II represents a semi-direct supply chain model that eliminates two intermediaries compared to Channel I. In this structure, farmers sell their honey directly to agro-industries, bypassing the collector stage. The agro-industries perform processing, packaging, and labeling functions before selling directly to retailers. Retailers then distribute the final product to consumers. This shortened chain reduces the number of price markups, resulting in a moderate marketing margin and an improved farmer's share compared to the traditional channel. The elimination of collectors allows farmers to receive better prices while maintaining product quality through direct engagement with processing facilities.

Channel III is a model developed in this research through digitalization of marketing.



Figure 3. Channel Supply Chain Model III

Channel III represents the digitalized supply chain model developed in this research, which dramatically shortens the distribution path. In this innovative structure, farmers sell their *Apis cerana* honey directly to end consumers through an e-commerce platform named "Rainbee." This platform incorporates a digital product catalog, online ordering system, payment gateway, and push notification features. Farmers are responsible for basic processing, packaging, and labeling their products before listing them on the platform. Consumers can browse products, place orders, and make payments online, while logistics services handle delivery. This direct-to-consumer model eliminates collectors, agro-industries, distributors, and retailers from the supply chain, resulting in the lowest marketing margin and the highest farmer's share. The integration of push notifications enhances customer engagement and facilitates repeat purchases.

Marketing margins and marketing efficiency are determined for each distribution channel through quantitative analysis. The calculation of marketing margins is based on the formula established by Mukson (2005):

$$MP = Pr - Pf \dots\dots\dots(1)$$

With :



- MP = Marketing margin for *Apis cerana* honey (IDR /liter)
- Pr = Price of *Apis cerana* honey at the consumer level (IDR /liter)
- Pf = Represents the price of *Apis cerana* honey at the producer level, measured in IDR per liter.

The marketing margin represents the disparity between the price paid by the end consumer and the price received by the producer, encapsulating the total costs and profits incurred by marketing entities within the distribution chain. A high margin suggests inefficiencies within the distribution system or the presence of numerous intermediaries in the supply chain.

Marketing efficiency is assessed through the farmer's share approach, as articulated by Sudiyono (2002), utilizing the following formula:

$$SPF = \left(\frac{Pf}{Pr} \times 100\% \right) \dots\dots\dots (2)$$

With :

- SPF = Share of price received by producer (%)
- Pf = Price at the farmer level (IDR /liter)
- Pr = Price at consumer level (IDR /liter)

The farmer's share represents the percentage of consumer prices that producers receive for their role in the value chain. A high SPF value signifies increased efficiency within the marketing system, resulting in producers obtaining a larger portion of the final price paid by consumers. A low SPF value suggests that a considerable fraction of the value is retained by intermediaries within the distribution process, highlighting structural inefficiencies in the supply chain.

The implementation of the e-commerce system occurred in multiple phases. A web-based platform was developed, featuring a digital product catalog, an online ordering system, and push notifications. This platform utilizes a responsive framework that is accessible on desktop and mobile devices. Secondly, farmers received intensive training on platform usage, content management, product photography, and order management. Outreach to potential consumers via social media and community networks was implemented to enhance awareness of local *Apis cerana* honey products.

In order to compute means, standard deviations, and percentages, descriptive statistics were implemented to analyze quantitative data. Statistical tests were employed to analyze the differences in farmer's share and marketing margins across various distribution channels. Thematic analysis was conducted on qualitative data derived from interviews and observations to identify patterns, barriers, and opportunities in the implementation of e-commerce systems. Data triangulation involved comparing information from multiple sources to validate the research findings.



4. Findings and discussion

4.1 Current Supply Chain Framework for *Apis cerana*

The identification results reveal that the *Apis cerana* honey supply chain in Bondowoso Regency exhibits a lengthy and intricate structure. The findings are presented with exceptional clarity, as the step-by-step breakdown of the three supply chain channels, complete with price points at each level, makes the inefficiency of the traditional chain (Channel I) starkly evident. In Channel I, honey products pass through five intermediaries before reaching the end consumers. Farmers sell raw honey to collectors at an average price of IDR 45,000 per liter. The collectors then resell it to agro-industries for IDR 60,000 per liter after basic filtration. The agro-industries conduct packaging and labeling before selling the product to distributors at IDR 85,000 per liter. Distributors offer the product to retailers at IDR 110,000 per liter, and consumers ultimately purchase it at IDR 150,000 per liter. The marketing margin for Channel I is IDR 105,000 per liter, constituting 70% of the consumer selling price. Farmers obtain merely 30% of the farmer's share, highlighting considerable inefficiency in the distribution system. The findings are consistent with the research conducted by Purnomo and Ratnawati (2020), which indicates that the honey supply chain in Indonesia is predominantly controlled by middlemen and collectors who retain substantial profit margins while contributing minimal added value. The findings indicate that enhanced supply chain efficiency leads to markedly reduced prices.

The results indicate that enhancing supply chain efficiency can lower consumer selling prices and increase the proportion of the price received by farmers. This efficiency is attained by removing two marketing intermediaries: distributors and retailers, thereby streamlining the distribution process and facilitating a direct connection between farmers and consumers via e-commerce platforms.



Figure 1. Comparison of *Apis cerana* Honey Supply Chain Structure Before and After Cutting Marketing Institutions



4.2 E-commerce and Push Notification Implementation

This research presents an e-commerce platform named "Rainbee," which incorporates a digital product catalog, an online ordering system, a payment gateway, and push notifications. The development process lasted two months and engaged a team of programmers from the Information Technology Department at Jember State Polytechnic. The platform features a user-friendly interface and is accessible on multiple devices, promoting adoption among farmers and consumers.

Farmer training is implemented in three phases. The initial phase emphasizes fundamental digital literacy and the introduction of platforms. The second stage covers techniques for product photography, the creation of compelling descriptions, and the management of inventory. The third stage provides training for farmers in order management, customer communication, and complaint resolution. Following each training stage, hands-on practice and intensive mentoring are provided to enable farmers to operate the system independently.

Push notifications aim to deliver real-time information to consumers regarding product availability, special promotions, and educational content on the benefits of *Apis cerana* honey. Notifications are dispatched through mobile applications and web browsers following consumer consent. The delivery frequency is limited to a maximum of two times per week to prevent spam and sustain consumer engagement. Monitoring results indicate a 68% read rate for notifications and a 23% conversion rate from notification to actual purchase, markedly surpassing traditional email marketing, which achieves only 5-8%.

Within three months of implementation, the Rainbee platform registered 327 users and recorded 186 purchases. E-commerce sales amounted to 465 liters of honey, representing approximately 35% of the total production by KTH Sejahtera member farmers. The platform offers honey at a selling price of IDR 120,000 per 500 ml and IDR 230,000 per liter, which is lower than conventional retail prices while providing a higher profit margin for farmers.

4.3. Supply Chain Efficiency Analysis

A comparative analysis of marketing efficiency among the three distribution channels indicates notable disparities. In Channel III, farmers engage in e-commerce to sell directly to consumers at a price of IDR 120,000 per liter. After accounting for packaging costs



(IDR 8,000), platform and payment gateway fees (5% or IDR 6,000), and shipping costs incurred by consumers, the net income for farmers amounts to IDR 106,000 per liter. The farmer's share in this channel is 88.3%, representing a significant increase from Channel I's 30%.

The marketing margin on Channel III is only IDR 14,000 per liter, or 11.7% of the consumer selling price, significantly more efficient than Channel I, which has a 70% margin. This efficiency is attained by removing the functions of collectors, distributors, and retailers, who have historically extracted substantial margins without delivering considerable added value. This finding corroborates the hypothesis that digitization of the supply chain significantly enhances distribution efficiency and increases producer revenues (Chopra & Meindl, 2019).

An in-depth analysis indicates that enhanced farmer income via e-commerce arises from both elevated margins and improved price stability and transaction transparency. The traditional system exhibits significant price volatility for farmers, influenced by negotiations with collectors and short-term market dynamics. E-commerce establishes prices according to product value and facilitates direct communication with consumers, thereby fostering a more transparent and equitable system.

The implementation of e-commerce encounters various challenges. Initially, the restricted digital literacy of farmers necessitates a period for adaptation. The evaluation results indicate that 60% of farmers were able to operate the platform independently within the first month, with this figure rising to 85% by the third month following extensive mentoring. The uneven distribution of internet infrastructure in Kretek Village presents access challenges for certain farmers. Third, consumer trust in locally sold online products requires development through consistent marketing strategies and the maintenance of product quality.

4.4. The Impact of Push Notifications on Consumer Behavior

Analysis of transaction data indicates that push notifications significantly influence consumer purchasing behavior. Out of 186 transactions conducted over a three-month period, 43 (23.1%) were directly initiated by notifications. The notification type with the highest effectiveness was information regarding new product availability, achieving a conversion rate of 31%. This was followed by special promotions at 24% and educational content on the benefits of honey at 15%.

The implementation of push notifications resulted in a notable increase in customer retention rates. Consumers who received notifications exhibited a 3.2-fold increase in the likelihood of making repeat purchases compared to those who did not receive such notifications. The average purchase frequency rose from 1.3 to 2.7 times over a three-



month duration. This finding aligns with the research conducted by Gohar et al. (2019), which demonstrated that push notifications can enhance customer lifetime value through increased transaction frequency.

Qualitative analysis via consumer interviews indicated that notifications assist in recalling products previously sampled for purchase. Certain consumers indicated that the educational content in the notifications enhanced their understanding of the advantages of *Apis cerana* honey relative to imported honey or honey sourced from non-local bees. Some consumers suggested that limiting the frequency of notifications could prevent the perception of spam, thereby enhancing engagement.

4.5. Consequences for the Financial Empowerment of Livestock Producers

Raising the farmer share from 30% to 88.3% carries substantial economic consequences for farmer welfare. With an average production of 15 liters per month per farmer, gross income rose from IDR 675,000 (Channel I) to IDR 1,590,000 (Channel III), reflecting an increase of 135.6%. Following the deduction of supplementary expenses related to packaging and platform operations, net income experienced an increase of approximately 110% in comparison to the traditional system.

The rise in income has influenced farmers' ability to invest in business development. Interviews reveal that certain farmers are augmenting their bee colonies, enhancing their beekeeping infrastructure, and acquiring more advanced harvesting equipment. Some farmers have started to diversify their offerings by creating derivative products like propolis and royal jelly, which possess greater market value.

This research finding aligns with sustainable development goals, particularly SDG 8, which focuses on decent work and economic growth (United Nations, 2015). Digitization of the supply chain enhances the incomes of livestock farmers and fosters a more inclusive and equitable economic system. Historically marginalized livestock farmers now possess direct market access, enabling them to set selling prices reflective of their products' true value.

Nevertheless, the sustainability of this model necessitates the provision of comprehensive ecosystem support. Government policies are essential to facilitate internet access in rural areas. Secondly, continuous training programs are essential for enhancing the digital literacy of livestock farmers. Third, standardization and certification of product quality are essential for enhancing consumer confidence. Fourth, collaborations with financial institutions are essential to facilitate access to working capital for livestock farmers seeking to expand their operations.



5. Conclusion

This study revealed a significantly inefficient honey supply chain structure for *Apis cerana* in Bondowoso Regency, with farmers receiving only 30% of the share in the traditional distribution system. The implementation of e-commerce with push notification features enhanced supply chain efficiency by removing two marketing intermediaries: distributors and retailers. The farmer share rose to 88.3%, significantly surpassing the initial target of a 40% increase established in the research objectives.

Push notifications have demonstrated efficacy in enhancing consumer engagement, achieving conversion rates of 23% and facilitating repeat purchases. Consumers receiving notifications exhibit a 3.2-fold increase in the likelihood of making repeat purchases compared to those who do not receive such notifications. The findings indicate that the integration of digital technology within the supply chain functions as both an alternative distribution channel and a mechanism for enhancing customer loyalty and increasing customer lifetime value.

The increase in livestock farmers' income, after accounting for additional operational costs, was 110% from an economic perspective. The increase has notable implications for the investment capacity of livestock farmers regarding business development and product diversification. The model developed in this study advances the attainment of SDG 8 by fostering a more inclusive and equitable economic system for small-scale livestock farmers.

Future research must involve an extended observation period to evaluate the long-term sustainability of technology adoption and its effects on farmer welfare. Replication of the study in diverse regions is necessary to evaluate the external validity of the developed model. The integration of blockchain technology to enhance traceability and transparency in the honey supply chain presents a promising avenue for future research.

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