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Exploring The Rice Supply Chain in Semarang City : An Educational Game Concept

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Abstract: This study introduces an educational game designed to enhance students' understanding of the rice supply chain in Semarang City. The primary research objective is to provide an interactive learning tool that immerses players in the complexities of the supply chain, from rice cultivation to consumer delivery, while highlighting the roles of various stakeholders and the impact of government interventions. The study employs a qualitative approach, using interactive model to integrate case study analysis and educational game development. Data collection involves semi-structured interviews with key stakeholders and field visits, while thematic and comparative analyses are used to evaluate supply chain dynamics. By incorporating real-world examples of supply chain optimization, the game provides students with hands-on experience in analyzing market dynamics, resource allocation, and technological advancements in agribusiness. This approach not only deepens engagement with complex economic structures but also prepares students for careers in logistics, policy-making, and sustainable enterprise development.

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Introduction

The study of supply chains, particularly in agricultural contexts, offers valuable educational opportunities for students across various disciplines. Semarang City's reliance on external rice supplies presents an insightful case for understanding economic dependencies, logistics, and sustainability. This study adapts supply chain optimization findings for educational purposes, illustrating how real-world business models, such as the Farmer-Owned Enterprise (BUMP), can be integrated into curricula to teach students about market efficiencies, economic resilience, and sustainable food systems.

Rice is the staple food for nearly all Indonesians, including the residents of Semarang City. However, since Semarang is not a major rice-producing region, it depends heavily on supplies from agricultural areas in Central Java, such as Demak, Kebumen, Kendal, Blora, Grobogan, Rembang, Cilacap, Sukoharjo, Jepara, and Temanggung. Compared to these regions, Semarang's rice production is relatively low, reaching only 8.74 thousand tons in 2022—a 25.07% decline from the previous year (BPS, 2022). This figure is significantly lower than that of neighboring districts like Demak, which produced 355,303 tons in the same period (BPS, 2022). The dependence of urban areas on external food sources is a common global phenomenon, observed in cities across various countries (Badami & Ramankutty, 2015; Crush et al., 2020; Langemeyer et al., 2021). Urban centers typically rely on complex and extended supply chains (Khan et al., 2022) that transport food from rural regions or even international sources to ensure a steady supply. This reliance stems from several factors,

including the limited availability of arable land within cities, the prioritization of land use for housing and infrastructure, and the economic challenges associated with large-scale food production in urban environments (Wang, 2022). Consequently, urban food systems remain highly dependent on external sources, making them vulnerable to disruptions caused by market fluctuations, climate variability, and geopolitical instability.

Semarang City's food system is deeply interconnected with distant agricultural regions, relying on extensive networks to secure rice supplies. These networks facilitate the flow of food, capital, knowledge, and information (Liu et al., 2013; Seto & Ramankutty, 2016). Rice, as a staple food, requires a well-coordinated supply chain to meet urban demand. The rice supply chain for Semarang involves multiple stages: production in surrounding agricultural areas, distribution through wholesalers, and sales in both traditional and modern markets within the city. Large traders typically manage this distribution process, sourcing rice from these agricultural regions and transporting it to Semarang's markets. This lengthy supply chain contributes to higher rice prices and supply instability. Therefore, innovations are needed to streamline Semarang's rice supply chain and improve its efficiency.

This study introduces an innovative educational game concept that leverages the complexities of Semarang City's rice supply chain, offering a novel approach distinct from traditional research. While previous studies have focused on individual company performance (Itang et al., 2022; Nattassha et al., 2020; Thorlakson et al., 2018) or broader industry trends within Indonesia's agricultural sector (Dania et al., 2022; Guritno, 2018; Yadav et al., 2022), this research uniquely blends theoretical insights with practical applications. By immersing players in the intricacies of the supply chain—from rice cultivation to consumer delivery—the game enhances understanding of stakeholder roles and the effects of government interventions while addressing inefficiencies caused by multiple intermediaries. Additionally, it underscores the crucial role of Farmer-Owned Enterprises (BUMP) in overcoming these challenges, providing an engaging and interactive educational tool. This approach not only enriches academic discourse but also equips students with critical insights into logistics, economic resilience, and sustainable practices.

Serious games have increasingly been utilized as educational tools to simulate complex systems, including supply chains, to enhance learning outcomes and decision-making skills (De la Torre et al., 2021). In the context of supply chain resilience and risk management, games provide an interactive environment where players can experiment with different strategies to mitigate disruptions and optimize logistics (Salvini et al., 2022). These games enable learners to understand the interplay between supply chain components, risk factors, and resilience strategies in a controlled setting that mimics real-world challenges. Gamification is an effective pedagogical tool (Luo, 2022). In the context of supply chain management, it helps players grasp the dynamic nature of supply chain risks, such as those caused by natural disasters, pandemics, and geopolitical tensions. In particular, supply chain simulation games help players develop decision-making skills by introducing them to real-world constraints, such as inventory shortages, transportation disruptions, and supplier failures (Zaefarian et al., 2024). By engaging in role-playing scenarios, participants can experience how supply chain resilience strategies, including redundancy and flexibility (Zaefarian et al., 2024), play a crucial role in maintaining operational stability. One example of such a simulation is the "Beer Distribution Game," originally developed at MIT, which demonstrates how minor changes in demand can cause significant fluctuations in the supply chain, known as the bullwhip effect (Kandanaarachchi & Perera, 2021). More recently, digital supply chain simulation games have been designed to incorporate risk management

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principles, allowing players to explore the impact of disruptions and test strategies to enhance resilience (Brauner & Ziefle, 2022).

As research suggests, shortening supply chains can enhance resilience by minimizing dependencies on distant suppliers and reducing the risks associated with extended logistics networks (Maryniak & Kliber, 2023b). Educational games that incorporate supply chain shortening strategies, such as local sourcing and decentralized distribution, can help players understand the benefits of reducing intermediaries (Agi et al., 2021). These games provide hands-on experience with concepts like just-in-time inventory, regional food hubs, and direct producer-to-consumer networks. By exploring the advantages of reducing intermediaries and shortening supply chains, players can identify strategies that enhance supply chain resilience, reduce costs, and ensure food security.

This study introduces an educational game designed to enhance students' understanding of the rice supply chain in Semarang City. The primary research objective is to provide an interactive learning tool that immerses players in the complexities of the supply chain, from rice cultivation to consumer delivery, while highlighting the roles of various stakeholders and the impact of government interventions

Research Method

This study employs a qualitative research approach, guided by Miles, Huberman and Saldana's interactive model of data analysis (Miles et al., 2018) to integrate case study analysis and educational game development to explore the rice supply chain in Semarang City. The research is designed to analyze the inefficiencies in the current rice supply chain and develop an educational game concept that simulates real-world supply chain dynamics. The objective is to enhance students' understanding of economic dependencies, logistics, and sustainability through an interactive learning experience. This research is limited to the development of the game concept and does not extend to the testing or pilot project phase.

The study utilizes both primary and secondary data sources to comprehensively analyze the rice supply chain in Semarang. Primary data collection involves conducting semi-structured interviews with key stakeholders, including farmers originated from Semarang City (3 persons), the manager of BUMP, the representative of suppliers for each subdistrict (16 persons), and the representative of consumers (10 persons). These interviews will explore the participants' lived experiences, operational challenges, and perceptions of the benefits and obstacles associated with BUMP Lumpang Semar Sejahtera initiatives. Additionally, case studies of successful farmer-owned enterprises from similar agricultural regions will be analyzed to identify transferable best practices and strategies. Additionally, field visits will be conducted to agricultural areas that supply rice to Semarang, such as Demak, Kebumen, and Kendal, allowing for direct observation of the production processes and logistical operations involved in the supply chain. This multifaceted approach ensures a thorough understanding of the complexities and dynamics at play in the local rice market.

The research incorporates game-based learning principles to create an educational simulation reflecting the complexities of Semarang's rice supply chain. The game development process consists of the following phases:

1) Conceptualization: Defining the learning objectives and key supply chain challenges to be incorporated.
2) Design & Prototyping: Developing game mechanics, rules, and scenarios based on real-world supply chain structures.
3) Data Analysis Methods

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The study employs qualitative data analysis techniques, including:

a) Thematic Analysis: Identifying recurring themes and patterns from interviews, FGDs, and observations to understand supply chain challenges.
b) Comparative Analysis: Evaluating the efficiency of traditional supply chain models versus shorter, optimized supply chains within the game.

Results and Discussion

The Rice Supply Chain in Semarang City

The rice supply chain in Semarang City involves multiple stages, from production in surrounding agricultural regions to final sales in urban markets. Semarang relies on external sources for rice, with key suppliers located in areas like Demak, Kebumen, and Grobogan. PT Lumpang Semar Sejahtera, a Farmer-Owned Enterprise (BUMP), plays a crucial role in stabilizing rice prices and availability, serving as a model for inflation control through food supply management. In 2024, PT Lumpang Semar Sejahtera sourced rice from various partners, with significant contributions from UD. Sumber Rizky (30.63%) and several other BUMPs and farmer groups across Central Java. This collaborative network helps mitigate supply fluctuations, though Semarang's local production remains minimal compared to its consumption needs.

Consumer purchases are influenced by rice quality, price, household income, and promotional activities (Choerunnisa et al., 2024). Government interventions, through agencies like Bulog and programs like the Cheap Market for Food Commodities - *Pasar Pangan Rakyat Murah dan Aman* (Pak Rahman) and Safe Food Kiosks - *Pangan Aman Tersedia untuk Warga Kita* (Pandawa Kita), help regulate prices and ensure accessibility. BUMP PT Lumpang Semar Sejahtera acts as a key mechanism for inflation control, offering rice at lower prices and enhancing supply chain resilience. This interconnected system highlights the complexity of urban food supply chains and the importance of innovations like BUMP in sustaining food security and stabilizing markets. Based on the description, there are two rice supply chain models in Semarang City. First, the rice supply chain without BUMP intervention illustrated in Figure 2.

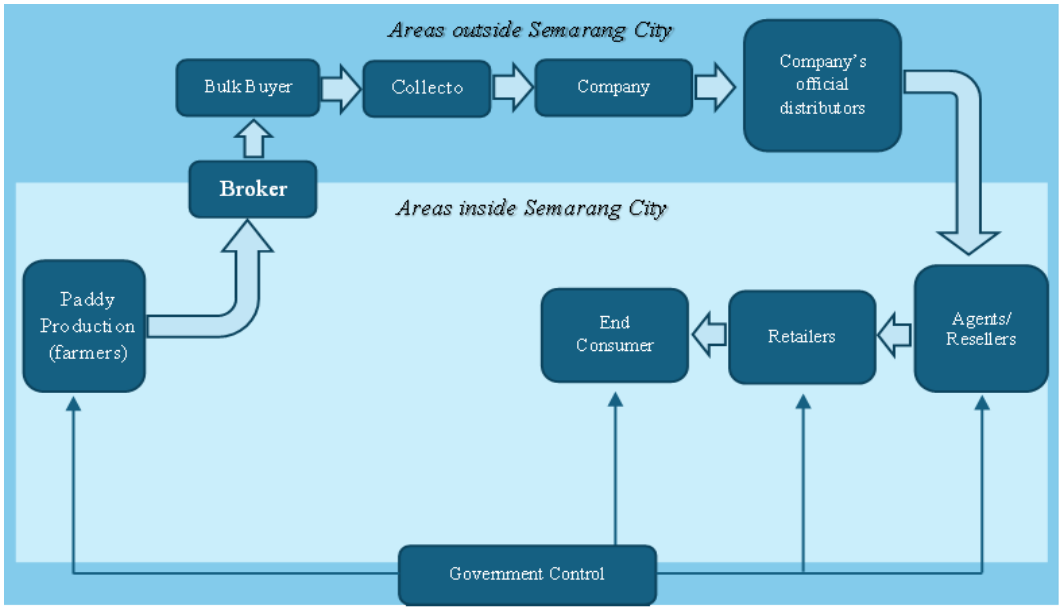

Figure 2. The Pattern in the Rice Supply Chain in Semarang City without BUMP Intervention

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The rice distribution pattern in Semarang City reveals significant disparities, with some districts serving as key hubs due to local production, while others rely heavily on external supplies. At least seven supply chain links exist between farmers and consumers, adding processing and distribution costs, as rice must be processed outside the city. This extended supply chain drives up consumer prices unnecessarily. Emmanuel (2017) highlighted the crucial role of middlemen in the local rice trade, noting their impact on costs, revenues, and overall business performance. While they facilitate market connections, inefficiencies in transportation and pricing mechanisms reduce farmer profitability. Similarly, Nainabasti & Bai (2009) observed that small-scale farmers, often in urgent need of cash, are forced to sell rice at low prices immediately after harvest, reinforcing price inflation as middlemen compete and increase costs.

The "Badan Usaha Milik Petani" (BUMP) Lumpang Semar Sejahtera, launched in early 2023 by the Semarang city government, aims to streamline the local food supply chain for key commodities like rice, shallots, and chili by reducing intermediaries (Kariada et al., 2024). Partnering with local farmer groups from areas like Kendal, Demak, and Grobogan, BUMP uses an online platform (https://lumpangsemar.semarangkota.go.id/) to connect farmers or first-tier distributors directly with consumers, stabilizing prices and enhancing food security. Shortening supply chains increases resilience and reduces risks associated with complex networks (Katsaliaki et al., 2022). By cutting out middlemen, BUMP stabilizes rice prices and helps manage inflation, while farmers retain a larger share of revenue, boosting their economic stability. The model also emphasizes supply chain transparency and traceability, addressing urban food system challenges like price volatility and supply inconsistencies (Scholten et al., 2020). This approach highlights how farmer-owned enterprises can leverage digital tools to create shorter, more efficient food supply chains, as illustrated in Figure 3, which presents the second rice supply chain model in Semarang City.

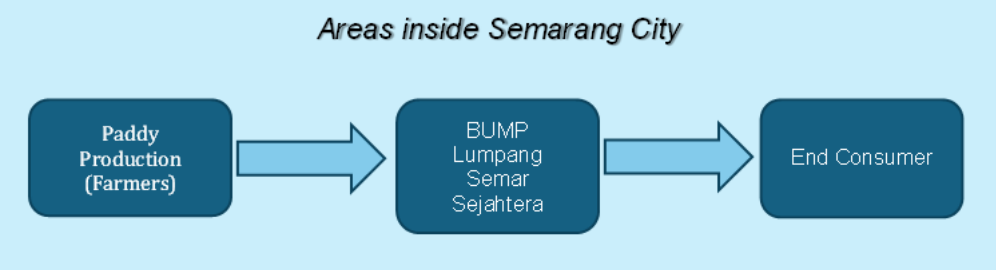

Figure 3. The Pattern in the Rice Supply Chain in Semarang City with BUMP Intervention

Based on the results of in-depth interviews and field observations at BUMP Lumpang Semar Sejahtera, it was found that with BUMP intervention, rice prices can decrease by around IDR 1,000.00 – IDR 1,500.00 per kilogram, as it successfully cuts off at least five supply chain points that the rice previously had to pass through before reaching consumers. This can be achieved because BUMP Lumpang Semar Sejahtera already has a sufficiently representative rice storage warehouse and processing machines for rice husks, with the number of machines continuously increasing. It is hoped that the production scale of BUMP Lumpang Semar Sejahtera will become larger, allowing it to serve more farmers and reach a wider marketing area in Semarang City.

The rice supply chain in Semarang City faces inefficiencies due to multiple intermediaries, leading to higher consumer prices. Without intervention, rice costs IDR 13,000/kg, but supply chain complexities add IDR 1,500/kg, raising the price to IDR 14,500/kg. Logistics costs, mainly from material handling (65.8%), add another IDR

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1,541.18/kg, pushing the final price to IDR 16,041.18/kg. The calculation is presented in Table 1.

Table 1. Analysis of Rice Supply Chain Costs and the Impact of BUMP Intervention

Parameter (IDR/Kg)	Without BUMP Intervention	With BUMP Intervention	Reduction
Initial Rice Price	13,000	13,000	No change
Added cost due to supply chain	1,500	0	
Logistics Cost	1,541.18	1,232.94	20%
Final Consumer Price	16,041.18	14,232.94	11.28%

BUMP Lumpang Semar Sejahtera helps address these issues by removing at least five intermediaries, cutting logistics costs by 20% to IDR 1,232.94/kg. This reduces the final consumer price to IDR 14,232.94/kg — an 11.28% decrease. BUMP's streamlined system, efficient storage, and rice husk processing lower costs, stabilize prices, and increase farmers' earnings.

Studies suggest further improvements through blockchain technology, which can reduce intermediaries, enhance transparency, and lower transaction costs (Vashishth et al., 2024; Sharma et al., 2024). Real-time data tracking and smart contracts could enable direct farmer-to-buyer sales, ensuring fair payments and price reductions. Additionally, policies like subsidies, antitrust enforcement, and diversified production can strengthen supply chain resilience, though their success depends on market conditions (Hadachek et al., 2024). Scaling the BUMP model and integrating technologies like blockchain could make supply chains more efficient, promoting fair trade, improving food security, and fostering agricultural sustainability.

Educational Implications of Supply Chain Resilience and Risk Management

Incorporating case studies like Semarang's rice supply chain into business and economics courses allows students to analyze risk management strategies and the impact of supply chain resilience (Johnson & Helms, 2008). Shortening supply chains, as demonstrated by BUMP, reduces dependency on intermediaries, ensuring stable food prices and fostering local economic growth. By studying these models, students gain insight into real-world economic applications, which can be valuable in entrepreneurship, business planning, and public policy courses.

BUMP as a Learning Model in Business and Economics Education

The BUMP model serves as an effective educational tool across multiple disciplines. In economics, it allows students to explore market structures, price formation, and economic sustainability by analyzing real-world applications of supply chain efficiency. Business management courses benefit from examining BUMP's operational efficiencies, digital marketing strategies, and entrepreneurship models, offering students insight into how businesses optimize logistics and costs. Sustainability studies leverage the BUMP model to teach about food security, environmental impact, and ethical business practices, demonstrating the importance of sustainable supply chain operations. Additionally, in technology and business courses, students can investigate how blockchain technology is implemented in supply chains to enhance transparency and efficiency. By incorporating BUMP as a case study, students can engage in problem-solving exercises, policy development discussions, and business model simulations, which enhance their critical thinking and decision-making skills while preparing them for real-world challenges in economic and business environments (Farashahi & Tajeddin, 2018).

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Educational Game Concept: "Rice Supply Chain Challenge"

Overview

"Rice Supply Chain Challenge" is an interactive educational game designed to teach players about the complexities of the rice supply chain in Semarang City. Players will take on the roles of different actors in the supply chain, from farmers to consumers, and navigate the challenges and opportunities within each stage. The game aims to enhance understanding of agricultural economics, supply chain management, and the impact of government interventions. Research indicates that educational games can significantly improve learning outcomes in complex subjects like supply chain management and agricultural economics. For instance, Peng et al. (2022) explored the use of blockchain technology in enhancing supply chain supervision, which can be applied to the rice supply chain context. Additionally, Wang, et al. (2022) emphasizes sustainable practices in rice production, which aligns with the game's objectives. The importance of pricing strategies in agricultural supply chains is highlighted by Wang, et al. (2022), while Lee, et al. (2024) discuss the effects of simulation games on understanding agricultural practices, reinforcing the educational value of this game concept.

Target Audience:

1) Middle and high school students
2) Agricultural students
3) General public interested in supply chain management and economics

Game Objectives

1) Understand the Stages of the Rice Supply Chain: Players will learn about rice production, processing, distribution, market sales, and the role of government.
2) Identify Key Actors: Players will recognize the roles of farmers, millers, wholesalers, retailers, and consumers.
3) Analyze Economic Factors: Players will explore how pricing, quality, and consumer behavior affect the supply chain.
4) Evaluate Government Interventions: Players will assess the impact of government programs like BUMP on rice prices and supply stability.

Game Mechanics

1. Role Selection

Players can choose to play as one of the following roles:

a) Farmer: Cultivates rice and sells it to millers.
b) Miller: Processes harvested rice into consumable products.
c) Wholesaler: Distributes rice to retailers and markets.
d) Retailer: Sells rice to consumers in traditional or modern markets.
e) Consumer: Purchases rice for household or business use.

2. Game Stages

The game consists of several stages, each representing a key part of the rice supply chain:

a. Rice Production
   1) Players as farmers must manage resources, choose the right crops, and deal with weather conditions.
   2) Players can earn points by maximizing yield and minimizing costs.

b. Processing (Rice Milling)
   1) Players as millers must decide on the scale of operations and manage milling costs.
   2) Players can upgrade their facilities to improve efficiency and quality.

c. Rice Distribution

1) Players as wholesalers must navigate transportation logistics and negotiate prices with retailers.
2) Players can choose between BUMP and independent distribution channels, affecting their profit margins.

d. Market Sales
1) Players as retailers must set prices based on supply and demand, manage inventory, and respond to consumer preferences.
2) Players can run promotions to attract more customers.

e. End Consumers
1) Players as consumers must make purchasing decisions based on quality, price, and household needs.
2) Players can influence market trends through their buying choices.

3. Challenges and Events

Throughout the game, players will encounter various challenges and events, such as:

a) Price fluctuations due to market demand.
b) Natural disasters affecting crop yields.
c) Government interventions that can either help or hinder their operations.
d) Competition from other players or AI-controlled entities.

4. Scoring and Progression

Players earn points based on their performance in each role, including:

a) Profit margins achieved.
b) Efficiency in production and distribution.
c) Consumer satisfaction ratings.
d) Successful navigation of government policies.

Players can progress through levels, unlocking new regions, technologies, and market opportunities as they gain experience.

5) Educational Outcomes

a) Players will gain a comprehensive understanding of the rice supply chain in Semarang City.
b) Players will develop critical thinking and problem-solving skills as they navigate economic challenges.
c) Players will learn the importance of collaboration among different actors in the supply chain.

The "Rice Supply Chain Challenge" serves as an engaging and educational tool for players to explore the complexities of rice distribution in Semarang City. By simulating real-world supply chain dynamics, the game offers valuable insights into the roles of various stakeholders, economic decision-making, and the impact of external factors such as government policies and market fluctuations. Through interactive gameplay, players will not only enhance their understanding of agricultural economics and logistics but also develop strategic thinking and problem-solving skills. Ultimately, this game fosters a deeper appreciation of the challenges and opportunities within the rice supply chain, equipping learners with knowledge applicable to real-world scenarios in supply chain management and sustainable food systems.

Conclusion

The findings emphasize the significance of studying supply chain inefficiencies through educational simulations, demonstrating how lengthy and intermediary-heavy networks contribute to increased costs and reduced economic sustainability. The development of an

educational game concept based on Semarang City's rice supply chain provides an innovative approach to teaching students about logistics, market dependencies, and sustainability. By engaging with supply chain challenges in a simulated environment, students can better understand the impact of inefficiencies and explore potential solutions. However, this research is limited to the conceptualization of the game and does not include the implementation or pilot testing phase. Additionally, the study focuses solely on the rice supply chain in Semarang City, which may limit the applicability of the findings to other contexts.

Recommendation

Future research should expand the scope to include different urban and rural supply chains, allowing for a broader understanding of how educational games can be used to model supply chain resilience and efficiency. Incorporating stakeholder perspectives, such as those of farmers, traders, and policymakers, could provide richer qualitative insights to enhance the learning experience. Educators and policymakers should consider integrating supply chain simulation games into academic curricula to enhance students' grasp of logistical complexities and economic sustainability. Additionally, leveraging digital tools such as blockchain or AI-driven analytics could further refine game-based learning approaches, making them more interactive and reflective of real-world challenges. Expanding research into digital learning platforms and gamification in vocational education can further bridge the gap between theoretical knowledge and practical applications, preparing students for careers in logistics, economics, and sustainable business development.

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