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Building “Porang” processing industry using supply chain management method

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Abstract. Wonogiri Regency is one of the leading porang producing regions in Indonesia, but the potential of its industry is still largely unexplored. Currently, business actors market corms and chips in East Java Province, resulting in a multiplier effect. This is because these actors cover only a small portion of the region. Therefore, the purpose of this study was to develop porang processing industry model through Supply Chain Management method. The study employed both quantitative and qualitative methods with Interpretive Structural Modelling (ISM) analysis. The triangulation method was used to cross-examine data at the respondents' level. Based on the results, processed product demand, supplier engagement in the production process, and glucomannan production technology were the sub-criteria with the greatest effect on supply chain management. Furthermore, market access was identified as the major factor influenced by other sub-criteria. The strategies for establishing processing industry based on the 18 sub-criteria were in the linkage quadrant, showing the presence of high effect and interconnection. Variables in this sector must be investigated carefully because the relationship between variables is unstable. Every action on this variable will affect others and the feedback effect can magnify the impact. The strategy implemented must undergo various reviews to obtain best results. The findings of this study can be used as a reference for stakeholders to strengthen competitive advantage and implementing effective strategies

Keywords: sub-criteria; glucomannan; chips; monopsony; oxalic acid

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INTRODUCTION

Food is an essential need in the human life cycle, with agriculture as a sector offering various alternative sources. In Indonesia, rice serves as a primary carbohydrate source for the majority of the population, constituting 90% of the overall nutritional content. With technological advance and information development, lifestyle choices, including energy sources, are significantly influenced. This contributes to the interest of the community in more nutritionally dense food. Excessive consumption of white rice can pose a risk of diabetes mellitus. This is attributed to the low nutritional content and high glycaemic index of white rice. One proactive strategy to minimise this risk includes substituting or reducing rice consumption with other food sources (Embling *et al.*, 2020).

Porang (*Amorphophallus muelleri* Blume) is an agricultural commodity sought-after by the export market due to its nutritional content. This plant is categorised as a corm in the *Araceae* family and has been cultivated as export commodities over the past 3 years. In Indonesia, the export demand has significantly increased from 11,721 t in 2019 to 20,476 t in 2020 (Naufali & Putri, 2023). Due to this high demand, the cultivated area for porang has increased from 19,950 ha in 2020 to 47,461 ha in 2021. Indonesian porang has successfully entered markets in China, Japan, South Korea, Australia, Thailand, Malaysia, and Vietnam. Wonogiri Regency is one of the porang producing regions in Indonesia. This plant flourishes in Wonogiri thanks to its favourable geographical conditions. However, porang corms cannot be consumed directly due to their calcium oxalate content which causes throat irritation and large consumption can lead to the formation of stones or crystals in the kidneys (Subagiana *et al.*, 2022; El Habbani *et al.*, 2023).

Porang farming is affected by the National Porang Farmers Association (P3N) community which serves as a platform for farmers to exchange vital information. In practice, this information is still difficult to obtain, specifically during the peak harvest season, since porang market operates as a monopsony (Farhana *et al.*, 2022). A lack of information flow exists within the product supply chain, beginning from farmers, collectors, suppliers, and processing plants, to export readiness. Farmers may not always be aware of the market demands and standards for corms (Shegelman *et al.*, 2020). Frequently, the quality of the product falls short of collectors' expectations in terms of weight, defects, or diseases. This lack of information impacts farmers' understanding of the financial flow, spanning from importers to the payments they receive.

The increasing demand for porang exports each year emphasises the need for robust supply chain management (SCM) planning. X. Zhao *et al.* (2021) uses SCM to determine critical factors in improving product quality. Other research also proves that supply chain

management can be improved by considering the priority of attributes or factors that influence it, as in the study conducted by A. Jokandan *et al.* (2020) on the increase of exports of livestock products. SCM is widely used to determine the most suitable strategy for increasing exports, whether caused by internal or external production factors. The Interpretive Structural Model (ISM) method was chosen in several SCM-related studies, e.g., by H. Amintahmasbi and Y. Zahedan (2022) to identify the best performance factors in the apparel industry and by E. Kusriani *et al.* (2019) to find the key factors that influence the success of MSMEs. S. Kumar *et al.* (2021) aimed to identify barriers to the implementation of Industry 4.0 and the circular economy in the agricultural supply chain. N. Samadi-Foroushani *et al.* (2022) developed models for sustainable entrepreneurial development in Iranian agriculture. N. Durge *et al.* (2021) analysed the factors affecting marketing performance in the fresh mango supply chain.

Bulbotuber supply is exclusively reliant on farmers, but the dependence on intermediaries limits the profit-fulfilling ability. On the other hand, this predicament is exacerbated by the disadvantaged bargaining position of small-scale farmers. According to A. Bidarti *et al.* (2021), farmers with small land holdings may face financial constraints that affect their decision-making process, especially when it comes to prioritising their needs. This dynamic substantially contributes to inefficiencies in the SCM system, specifically in the upstream sector. Farmers readily part with their harvest once a predetermined price offers some semblance of profit, even when it is nominal. Importers, exporters, and large-scale processing industry do not provide price guarantees for each harvest cycle. In the past two years, bulbotuber prices at the farmer level have seen a decline as porang supply from diverse regions inundates processing industry in East Java Province (Naseer *et al.*, 2019). The current situation underscores the motivation behind this study – to develop strategies that will advance the porang processing industry in Wonogiri Regency, enhancing added value and improving the welfare of farmers. The SCM system should focus on simplifying the involvement of intermediaries and enabling farmers to directly engage with the processing industry. In this regard, the purpose of this study was to foster the porang processing industry using the SCM method, thereby strengthening competitive advantage and implementing effective strategies.

MATERIALS AND METHODS

This study was conducted in Wonogiri Regency, a prominent porang producing region in Central Java. It was conducted in May 2023 under the auspices of the Agriculture and Food Department Office. Wonogiri Regency, however, has yet to develop into a central hub for porang processing or trading industry. The study employed an

incorporating Interpretive Structural Modelling (ISM) analysis. This process started by identifying variables relevant to the issues or problems at hand, which were subsequently grouped accordingly (Attri *et al.*, 2013). The discussed issues were divided into criteria and sub-criteria to gain a more profound understanding. The next step was to establish contextual relationships between criteria and sub-criteria with experts through focus group discussions. The results served as data to generate a digraph model illustrating the interconnections between criteria and sub-criteria within the supply chain (Arsiwi & Adi, 2020). Additionally, the triangulation method was applied to cross-examine data across various respondent levels (Fawcett *et al.*, 2008; Mangla *et al.*, 2018).

The steps in developing the ISM model are explained as follows:

1. Determination of Criteria and Sub-criteria. The criteria and sub-criteria were determined through brainstorming, discussions with experts, and a review of relevant literature from earlier studies, such as M. Lim *et al.* (2017), X. Zhao *et al.* (2021), H. Putri *et al.* (2023). The experts were 18 individuals selected based on their insights into the conditions and issues related to the problem under study. These included policymakers (3 people), processing industry actors (7 people), large-scale traders (4 people), the National Porang Farmers Association (P3N) (3 people), and experts from universities (1 person). Sub-criteria functioned as explanatory variables for the established criteria. The criteria and sub-criteria (Table 1) were identified based on the needs and challenges of developing the porang processing industry in Wonogiri Regency. These criteria formed the basis of the questionnaire presented to the experts (Diabat *et al.*, 2014).

Table 1. ISM Criteria and Sub-criteria

Criteria	Sub-criteria
Market	Information access
	Market access
	Processed product demand
	Direct access to processing industry
	Direct access to exporters
Production	Role of suppliers in the production process
	Seedling availability
	Raw material quality
Technology	Oxalic acid removal technology
	Glucomannan production technology
	Postharvest technology (drying)
	Limitations of derivative product technology
HR	Institution
	Partnership network
	Capital access
Partnership	Ease of obtaining buyers for porang chips/flour
Government policies	Policies not yet leading to increasing the added value of porang
Competitive environment	Categorised as a monopsony market

Source: developed by the authors of this study based on E. Riptanti *et al.* (2023)

2. Questionnaire Completion. The questionnaire comprised questions concerning the relationships between sub-criteria. It was administered by an enumerator through interviews and discussions with experts or direct responses. The questions asked how the sub-criteria influence each other, whether one influences the other, or if there is no influence between them.

3. Structural Self-Interaction Matrix (SSIM). The results of the questionnaire completed by the experts, showing the relationships between criteria and sub-criteria, were transformed into the V, A, X, and O filling rules within a matrix (Watson, 1978). Each row (i) and column (j) represent a relationship, and when a sub-criterion in row (i) affects the one in column (j), it is denoted by the letter V. Conversely, when a sub-criterion

in column (j) affects the one in row (i), it is denoted by the letter A. In cases where the sub-criteria in both row (i) and column (j) affect each other, it is denoted by the letter X. The letter O denotes the absence of relationship between the sub-criteria in the respective rows and columns (Raut *et al.*, 2019).

4. Reachability Matrix. The reachability matrix was created based on the output from the SSIM by converting the notations V, A, X, and O in the SSIM into binary symbols 1 and 0 (Lim *et al.*, 2017). When the notation V on the effect of i on j (i, j) is present, it is assigned a value of 1, while in cases where j affects i (j, i), it is assigned a value of 0. The presence of the notation A on the effect of i on j (i, j) is given a value of 0. Meanwhile, the effect of j on i (j, i) is valued to be 1. In cases where

the notation X is present in (i, j) and (j, i) , both are assigned a value of 1. When the notation O is present in the relationship between i and j (i, j) , it is given a value of 0. Finally, the relationship between j and i (j, i) , is valued to be 0.

5. Level Partitioning. Having obtained the reachability results for SSIM, the levels were divided by considering three aspects, namely reachability, antecedent, and intersection set (Kannan & Haq, 2007). The reachability and intersection sets consist of sub-criteria with a relationship value of 1 for i to j (i, j) and j to i (j, i) , respectively. The intersection set consists of sub-criteria contained in both reachability and antecedent (Pfohl *et al.*, 2011). The intersecting sub-criteria become

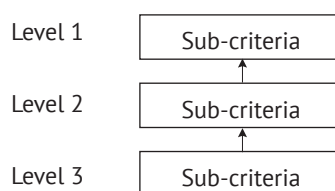


Figure 1. Structure Diagram of the SCM Model

Note: the graphs were created using Exsimpro

Source: W. Rohmah *et al.* (2019)

7. Creating Driver Power and Dependence Diagram. Driver power refers to the aggregate of values from the same row in the matrix, while dependence is the cumulative sum of values from the same column. Both serve as coordinates in constructing a diagram. The driver power value was indicative of the ordinate point on the vertical axis, while the dependence value serves as the abscissa point on the horizontal axis. This diagram was composed of 4 quadrants, each representing distinct clusters, namely autonomous, dependent, linkage, and independent. In quadrant 1, autonomous showed that the elements within it have an effect, albeit with weak dependence. Quadrant 2, labelled as dependent, signifies the elements have a weak effect but high dependence. Quadrant 3, referred to as linkage, implies that the elements have both strong effect and dependence. Finally, quadrant 4, designated as independent, signifies that the elements have a strong effect but weak dependence (Diabat *et al.*, 2014).

RESULTS AND DISCUSSION

1. SCM Model for Establishing Porang Processing Industry. SCM is a coordinated system that integrates activities such as coordination, scheduling, and control from suppliers to consumers. The primary objective is to attain cost efficiency across the entire distribution process until the final delivery to the consumer is achieved. Notably, supply chain does not only connect one party to another or business to business. According to M. Chiu and C. Lin (2022), the mechanisms in the supply chain create relationships across a broader network of multiple businesses. The risk of deviation from the

the top elements in the ISM hierarchy. Having identified these top elements, they were separated from other sub-criteria. The same process was repeated to determine the sub-criteria at the next level, continuing until they were all ascertained. These levels help in constructing the ISM diagram and model.

6. ISM Model. The final result from the reachability matrix formed a structural or ISM model. The relationships between two criteria or sub-criteria from i and j were shown by arrows. Furthermore, the hierarchy in the model was divided into 3 categories, namely lower, middle, and upper levels. To obtain the final result of the ISM diagram, transitivity from the initial model was eliminated (Lim *et al.*, 2017).

planned course increases when dealing with a company that manages more than one business entity. SCM is an effort to synchronise activities within and outside the company while maintaining interrelated relationships with the various stakeholders.

The successful implementation of the SCM into business operations is expected to enhance good relationships between upstream and downstream actors, elevate customer satisfaction, and instil trust in the performance of the company. The Global Supply Chain Forum identified 8 core processes that form the essence of the SCM, and they included customer relationship management, customer service management, demand management, demand satisfaction, manufacturing flow management, procurement, product development and marketing, as well as returns (Hazen *et al.*, 2019). Each of these processes forms a strategic plan that can be effectively executed by the company.

The study has yielded an SCM model for porang processing industry as presented in Figure 1 and Table 1. Through level partitioning and subsequent ranking, the relationships within each sub-element were symbolised by arrows. In this case, those at the beginning and end of the arrow represent the causing and resulting events, respectively. Processed product demand (E3), role of suppliers in the production process (E6), and glucomannan production technology (E10) are factors that mostly affect other sub-criteria in each criterion. They are key determinants that initiate events at various levels. Specifically, the level of processed product demand significantly affects the availability of raw materials held by the producers

(Dermoredjo *et al.*, 2021). Therefore, collaboration between producers and raw material suppliers is crucial.

This is because processed product and raw material demands are directly proportional.

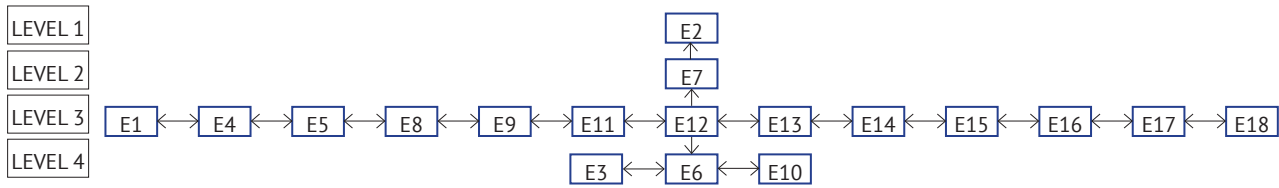


Figure 2. Structure Diagram of SCM Model for porang Processing Industry

Source: data processing results from Exsimpro (2023)

E1:	Information Access	E10:	Glucomannan Production Technology
E2:	Market Access	E11:	Postharvest Technology (Drying)
E3:	Processed Product Demand	E12:	Limitations of Derivative Product Technology
E4:	Direct Access to processing Industry	E13:	Institution
E5:	Direct Access to Exporters	E14:	Partnership Network
E6:	Role of suppliers in the Production Process	E15:	Capital Access
E7:	Seedling Availability	E16:	Ease of Obtaining Buyers for Porang Chips/Flour
E8:	Raw Material Quality	E17:	Policies Not Yet Leading to Increasing the Added Value of Porang
E9:	Oxalic Acid Removal Technology	E18:	Classified as Monopsony Market

Source: compiled by the authors of this study

According to K. Kodrat *et al.* (2019), the cooperative relationship between raw material suppliers and processing industry is a crucial issue to be addressed, as their interests often diverge, with each party seeking to maximise its profit. Raw material suppliers aim for the highest possible price to ensure profitability, while processing industry aim for cost maximisation to avoid overbudgeting. In the processed porang production, suppliers play a vital role in providing the desired quality and quantity of raw materials for producers. Conversely, raw material suppliers stand to gain significant profits when demand from producers increases. Effective collaboration establishes a conducive product flow to satisfy market demand, and positive perceptions of consumers are formed when the desired products fulfil expectations in terms of timing, location, quantity, and quality (Milusheva, 2022). These raw materials can be either in their raw or semi-finished state. Porang corms are used as raw materials for other industries once the oxalate acid content, which causes throat irritation and kidney stones in humans, has been eliminated (Chen *et al.*, 2020). Due to its complex and expensive technological requirements, glucomannan production process is typically conducted by major industries.

The demand for processed product (E3), role of supplies in the production process (E6), and glucomannan production technology (E10) are factors that need to be planned before the product flow begins. This underpins the establishment of a sustainable porang processing industry. The fundamental challenge in

this industry was glucomannan production technology (Riptanti *et al.*, 2022; 2023). Therefore, collaboration between the government and study institutions in developing low-cost technology to produce glucomannan is crucial. Government support is needed to facilitate and connect the domestic market for processed porang products. Information flow regarding needs and demand is essential and should be provided by stakeholders. This has a multiplier effect in driving other processing industries. The sustainability of the production process needs to be supported by the continuous availability of raw materials and the role of suppliers. These sub-criteria provide information for business actors.

Business actors require information access (E1) to determine product distribution channels, locate processing industry facilities (E4), and establish direct access to exporters (E5). After the producers have determined the market destination of the product, they proceed to ascertain the raw material quality (E8) and the type of product to be manufactured. Raw materials such as porang corms can only be used after oxalic acid removal, necessitating the corresponding oxalic acid removal technology (E9). Before the removal of this acid, corms are subjected to sun-drying (E11). Not all farmers have the expertise to process porang well due to the limitations in derivative product technology (E12). Furthermore, a structured institution (E13), partnership network (E14), and capital access (E15) are needed to develop processing businesses. Apart from technical considerations, business actors also require ease in

locating buyers for porang chips/flour (E16) to ensure that their products find traction in processed or derivative form. However, this situation is not accompanied by policies geared towards enhancing the value-added aspects of porang (E17). The number of processing industry is still limited, with distribution primarily confined to a select few buyers, resulting in a tendency towards a monopsony market (E18), as observed in

Figures 2 and 3. The conditions and challenges in the porang supply chain, from production to consumption, affect each business actor's assessment and efforts to improve both the quantity and quality of their products. According to W. Zhang and Q. Su (2020), the information required to support quantity and quality pertains not only to product attributes but also comprises processes, operations, and factors influencing the final products.

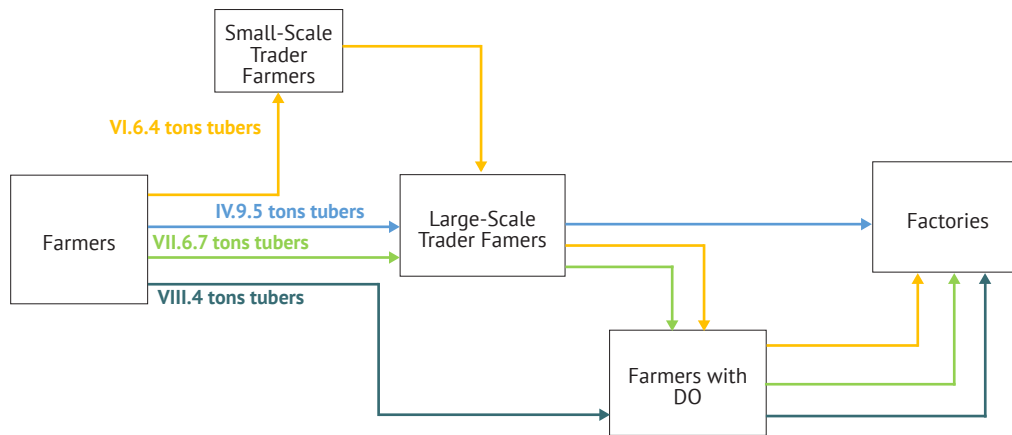


Figure 3. Porang Corms Marketing Channels in the Wonogiri Regency

Source: compiled by the authors of this study

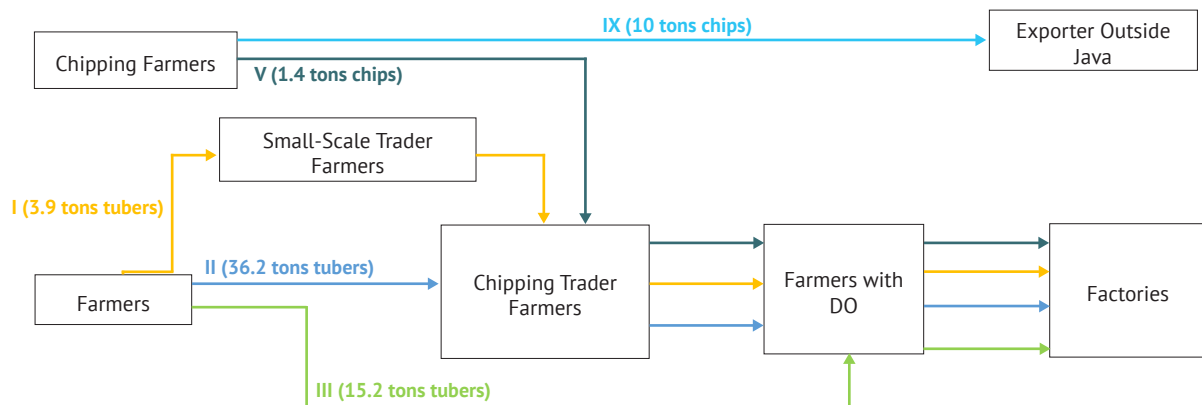


Figure 4. Porang Chips Marketing Channels in the Wonogiri Regency

Source: compiled by the authors of this study

The seedling availability (E7) at level 2 is conditioned by sub-criteria at level 3. Seedlings, sourced from bulbils and corms weighing less than 0.25 kg, play a crucial role in the cultivation process of porang. These seedlings may originate from harvesters, traders, or the National Porang Farmers Association (Riptanti *et al.*, 2022; 2023). A dormancy period can lead to specific planting intervals, as stated by (Harijati & Widoretno, 2019). Farmers strategically plan for the required quantity and source of seedlings in the subsequent year to avert shortages during planting. The last sub-criterion at level 1 is market access, which is the result affected by the preceding sub-criteria. Farmers should have access to information concerning prices, the quantity demanded by processing industry, and the down orders (DO) from processing

industry. The relatively weak bargaining position of farmers needs to be enhanced, and this could be achieved by optimising the function of their institution.

The journey of processed porang products begins with the farmers who cultivate them on owned or leased land, while some may operate as permanent labourers. The best harvest age for porang is in the second or third year after planting (Gusmalawati *et al.*, 2022). Harvest timing hinges not only on the maturity of corms but also on market price conditions. When the price is favourable or high, farmers harvest and sell to small-scale traders (Fig. 2 and 3). Most farmers directly sell the corms, and only a small portion engages in chipping (slicing porang thinly and then drying it). Chipping farmers supply their products directly to

small-scale trader farmers. These small-scale traders distribute them to larger-scale counterparts. Corms then move from these larger-scale traders and chipping traders to individuals or traders with DO from processing industry (Fig. 3). However, information regarding prices and required quantities for processing industry is limited. Major industries use oxalic acid removal technology to process corms into glucomannan flour, a critical raw material for various domestic and export industry in China, Japan, and Korea. The results show that not all major industry have this technology. Processing industry exports porang in the form of “krepes”, namely dried and crushed chips.

Supply chain for porang corms, from cultivation to consumption, is quite extensive. The elongated marketing chain allows for the accumulation of significant price transmission biases. Furthermore, it can be attributed to some factors such as distance and monopsony market. According to P. D’Odorico *et al.* (2019), the extended marketing distance can be a result of commodity production being concentrated in specific regions, while consumer areas are relatively scattered within a broader geographical scope. Farmers, as cultivation business actors, face limitations in accessing the market on a wider scale due to the prohibitive costs of processing and the lack of product absorption assurance in the market. A monopoly market limits access to information regarding price, quantity, and the entry of corms into processing industry.

The resolve of farmers in cultivating porang fluctuates in response to uncertainties in market price and demand. According to D. Darmawan *et al.* (2023), a crucial way to build trust and optimism among farmers is to ensure the absorption of the entire product output, either through government policies or by establishing cooperative relationships with various partners. Furthermore, farmers were confronted with the reality that the processed porang products command significantly

higher prices compared to fresh corms. The length of supply chain, technological, and knowledge limitations in corm processing, as well as a lack of market information, create income disparities between farmers acting on farms and processing industry, along with exporters. Therefore, strategic measures are needed to address the challenges inherent in establishing an effective SCM for porang processing industry.

2. Strategies for Establishing Porang Processing Industry. As Figure 5 suggests, market access (E2) has low driver power compared to other sub-criteria and high dependence power. Furthermore, seedling availability (E7) has the same dependence power as market access but higher driver power. These findings are consistent with H. Irianto *et al.* (2021) in the development of “jarak towo” cassava as a raw material for processing industry. Meanwhile, the strongest driving powers were processed product demand (E3), role of supplies in the production process (E6), glucomannan production technology (E10), information access (E1), direct access to processing industry (E4), direct access to exporters (E5), raw material quality (E8), oxalic acid removal technology (E9), post-harvesting technology (E11), limitations of derivative product technology (E12), institution (E13), partnership network (E14), capital access (E15), ease of obtaining buyers for porang chips/flour (E16), policies still not increasing the added value of porang (E17), and categorisation as a monopsony market (E18). All sub-criteria were in the linkage quadrant and have significant strength in affecting and controlling the situation, but they also show strong dependence. Sub-criteria E3, E6, and E10 directly affected E1, E4, E5, E8, E9, E11, E12, E13, E14, E15, E16, E17, and E18. Variables in this quadrant must be investigated carefully because the relationship between variables is unstable. Every action on this variable will have an impact on others and the feedback effect can magnify the impact.

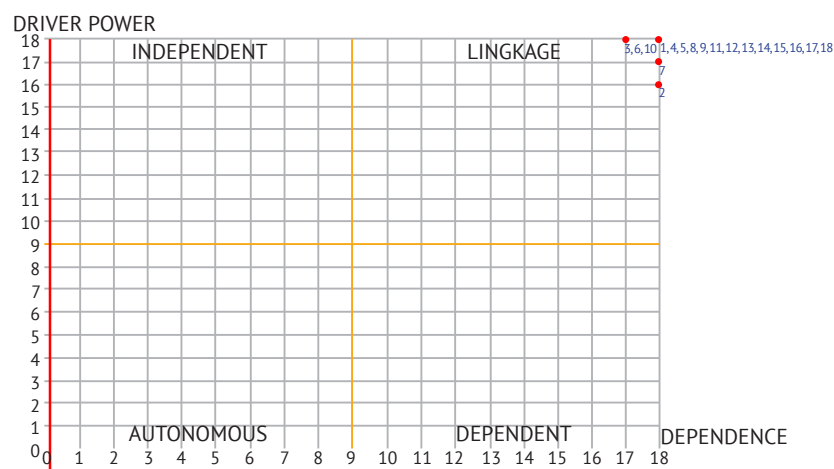


Figure 5. Driver and Dependence Power Diagram (Power Matrix)

Note: all sub-criteria are in the linkage position, sub-criteria with the same position are represented by one red dot

Source: data processing results from Exsimpro (2023)

Barriers and opportunities obtained from these sub-criteria will affect information access (E1), direct access to processing industry (E4), direct access to exporters (E5), raw material quality (E8), oxalic acid removal technology (E9), post-harvest technology (E11), limitations of derivative product technology (E12), institution (E13), partnership network (E14), capital access (E15), ease of obtaining buyers for porang chips/flour (E16), policies still not increasing the added value of porang (E17), and classification as monopsony market (E18). These barriers and opportunities are consistent with the findings of E. Riptanti *et al.* (2023).

Factors in porang distribution process that influence its final product affect input availability at the farmer level. Seedlings also serve as commodities traded at this level. When there is a high demand for seedlings, the price increases. However, when it is produced by the farmers, the price becomes lower. An oversupply of seedlings occurs, as various regions also produce bulbils. The quality of the seedlings declines when they are not used immediately after the dormant period, thereby exhibiting reduced germination and growth rates (Sianturi *et al.*, 2022). With the porang supply chain situation in Wonogiri Regency, market access became the sub-criteria with the lowest driving power but had very strong dependence power. Interactions among these sub-criteria can generate effects and feedback within the SCM system. Each sub-criterion influences the others, and the feedback provided can enhance the effect (Kusrini *et al.*, 2019).

The demand for processed porang products is growing, specifically in the food industry, due to the increasing human awareness of a healthy lifestyle. Glucoman content in porang is excellent for diets, preventing liver and diabetes diseases, lowering cholesterol, and preventing hypertension. Apart from being used as a raw material in the food industry, porang corms are used in cosmetics, adhesives, laboratory raw materials, and pharmaceuticals (Dwiyono & Djauhari, 2021). Therefore, this product has become a sought-after commodity in the export market due to high demand, as it is not cultivated by all countries. Despite being a major producer, Indonesia has not been able to control prices, leading to uncertainties and fluctuations. E. Riptanti *et al.* (2022) attribute this to the absence of sales contracts with exporters or processing industry. Regulatory frameworks surrounding porang are still unclear, leaving farmers in a weak bargaining position. Formalising contracts for bulbotuber procurement with processing industry would benefit both parties, ensuring price stability, quality, and consistent quantities. Such contracts can also address challenges related to raw material procurement and price fluctuations during harvest seasons.

Farmers producing fresh porang corms often complain about price instability set by traders, which tends to decline over time (Arumsari *et al.*, 2023). The long

supply chain results in wider price margins, thereby driving down prices at the farmer level. The findings suggest that porang marketing in the Wonogiri Regency consists of 10 channels that lead to processing industry in East Java and only 1 exporter outside Java (Fig. 2 and 3). Processing industry in East Java and the exporter partner with farmers or traders whom supplier warrants known as DO. According to X. Zhao *et al.* (2021), direct partnership makes it easier for companies to ensure product quality and safety as well as respond quickly to market needs. From the farmers' perspective, partnering directly with exporters provides greater benefits due to the assurance of porang corm distribution. For this export commodity, information about price conditions and demand trends in the global market is crucial for farmers, traders, processing industry, and exporters. The limitation in technology and the prohibitive processing costs have led to a limited number of processors in Indonesia, resulting in a tendency towards monopolistic practices.

Traders, acting as intermediaries between farmers and the processing industry, were relatively few. The monopolistic influence held by farmers or traders with Delivery Order (DO) gives them the flexibility to control purchase prices (Nathan, 2021). Price hikes at processing industry/exporter level did not immediately translate into equivalent increases. This was clear among farmers in the Wonogiri Regency, where a significant price differential exists. Monopolistic power can be established through various means, such as traders collaborating to set purchase prices from farmers, creating barriers to deter other traders from entering the market for particular commodities, and establishing dependence among farmers on marketing their produce exclusively to particular traders. Additionally, there should be a harmonious relationship between farmers and processing industry to establish a more focused and sustainable business framework. Therefore, a suitable SCM model shows that demand for processed products, supplier involvement in the production process, and glucoman production technology are sub-criteria with the greatest potential to influence SCM of porang processing industry. Collaboration among stakeholders, including processing industry, traders, exporters, government entities, the National Porang Farmers Association, and study institutions, is crucial in advancing the processing industry.

CONCLUSIONS

Processing industry typically relies on a steady supply of raw materials from the surrounding areas. However, despite being a significant porang production region, the Wonogiri Regency lacks processing industry. Even though Wonogiri is a major hub for porang bulbotuber production, this is not in line with the number of industries in it. Farmers in the Wonogiri Regency also lack the supplies to carry out processing, since processing costs are prohibitive and require a complex

technology. Factors such as the length of supply chain, technological and knowledge constraints in bulbotuber processing, and a lack of market information contribute to income disparities between farmers operating at the on-farm level and processing industry, as well as exporters. The proposed porang processing industry model based on the SCM method, hinges on factors such as processed product demand, role of suppliers in the production process, and the application of glucomannan production technology. These sub-criteria are expected to have the greatest impact on the SCM of the porang processing industry. Strategies for implementing this model necessitate close collaboration among the relevant stakeholders, allowing for vital access to essential information. The strategy must ensure that all sub-criteria stay in the linkage quadrant. Variables in this sector must be investigated carefully because the relationship between variables is unstable. Every

action on this variable will have an impact on others and the feedback effect can magnify the impact. This study can be a reference for further research on determining strategies based on the problem characteristics approach using the ISM method.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Побудова переробної промисловості «Поранг» з використанням методу управління ланцюгами поставок

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Анотація. Регіон Воногірі є одним з провідних регіонів-виробників порангу в Індонезії, але потенціал його галузі залишається значною мірою недослідженим. В даний час бульбоцибулини та чіпси продаються в провінцію Східна Ява, що призводить до мультиплікативного ефекту, оскільки лише невелика частина регіону отримується бізнес-агентами. Тому метою цього дослідження було побудувати модель галузі переробки порангу за допомогою методу управління ланцюгами поставок. Процедури дослідження використовували як кількісні, так і якісні методи з аналізом інтерпретаційного структурного моделювання (ISM). Метод триангуляції використовувався для перехресної перевірки даних на рівнях респондентів. Згідно з результатами, попит на перероблений продукт, залучення постачальників до виробничого процесу та технологія виробництва глюкоманнану були підкритеріями, що мали найбільший вплив на управління ланцюгами поставок. Крім того, доступ до ринку був визначений як основний фактор, на який впливають інші підкритерії. Стратегії створення переробної промисловості на основі 18 підкритеріїв опинилися у квадранті зв'язку, що свідчить про наявність високого ефекту та взаємозв'язку. Змінні в цьому секторі необхідно ретельно вивчати, оскільки взаємозв'язок між змінними є нестабільним. Кожна дія на одну змінну матиме вплив на інші, а ефект зворотного зв'язку може посилити цей вплив. Впроваджувана стратегія повинна проходити різні перевірки, щоб отримати оптимальні результати. Результати цього дослідження можуть бути використані зацікавленими сторонами як орієнтир для зміцнення конкурентних переваг та впровадження ефективних стратегій.

Ключові слова: підкритерії; глюкоманнан; чіпси; монопсонія; щавлева кислота
