

Feasibility of Establishing Small and Medium Agro-industries in Kabawetan Subdistrict, Indonesia, based on Economic and Spatial Analyses

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インドネシア・カバウェタン地区における小規模農産業施設の設置に対する 経済的、空間的な検討

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Abstract: Economic feasibility analyses and optimal site selection are necessary for the effective establishment of new agro-industries. In this study, we applied economic (feasibility and sustainability) and spatial analyses to select optimal locations for new industries based on environmental characteristics and raw-material availability. We combined the economic and spatial analyses to assess the feasibility of establishing small and medium agro industries for the production of three value-added products (dried banana, dried vegetable, and coffee powder) in Kabawetan Subdistrict, Indonesia. The economic feasibility analysis showed that dried vegetable production was the most feasible, as indicated by a net present value of 481 million Indonesian Rupiah (IDR) and a benefit–cost ratio of 3.49. After 7 years, production would provide 481 million IDR after subtracting the costs of machinery and interest. The sensitivity analysis showed that dried vegetable production would remain feasible regardless of increases in the number of workers, worker salaries, and raw material prices, and a decrease in the sale price. The sustainability analysis showed that dried vegetable production had the shortest payback period, the highest sale price, and the smallest break-even point; further, a change in the sale price would not affect demand. We identified two candidate sites based on their distance from settlements, water sources, slope, and distance from markets. The best site was 2.85 ha and was located a moderate distance from the central market (8.7 km). Our results can improve the economic situation of local farmers in the study area by increasing the product shelf life and stabilizing the sale price of agricultural produce. Finally, the method can be applied to other small and medium industries.

キーワード：農産業、経済的実現可能性、経済的持続可能性、適地選定

Keywords: Agro-industry, economic feasibility, economic sustainability, site selection

1. Introduction

Small and medium enterprises (SMEs) are the principal drivers of economic activity in Indonesia. Based on a 2017 survey, there were 4.46 million such businesses throughout Indonesia¹⁾. There is an important relationship between SMEs and economic growth in developing countries²⁾, because such businesses employ a large number of workers³⁾. The SME workforce in Indonesia is centered on Java Island. However, other islands, such as Sumatra, also have good prospects for industrial development because of their extensive agricultural land. In 2015, shifting cultivation in Indonesia comprised 5.1 million ha, 93.79% (4.85 million ha) of which was outside Java Island⁴⁾. However, beyond Java Island, agro-industrial growth is slow. A report from Medan, North Sumatra, suggested that the obstacle to SME growth in North Sumatra was weak competitiveness of business actors and business activities in terms of raw material, capital, marketing, and information technology⁵⁾. Of these, raw-material availability is the most important factor for the sustainability and feasibility of industry.

Sumatera Island can supply abundant raw agricultural materials. Therefore, production of industrial goods from agricultural materials would enable farming communities to improve economic and industrial development in Sumatra. Despite this agricultural abundance, the economic status of Sumatran farmers is low. Based on an in-depth survey by the author in eight villages in Kabawetan Subdistrict, farmers are forced to dispose of surplus agricultural produce when sale prices drop, because vegetables are not commodities that can be stored until prices rise. The establishment of agro-industries is an alternative to extending the shelf life of agricultural products, and would increase sale prices, absorb labor, and increase the industrial potential of Sumatra.

Determining the feasibility of an industry is the first step in planning an industrial estate. Economic analysis is commonly used in industrial feasibility studies^{6, 7)}. Economic analysis comprises feasibility and sustainability analyses, with the aim of evaluating investment feasibility based on financial calculations and market sustainability projection. For instance, an economic analysis of the coffee bean industry in Bener Meriah District, Aceh Province, Indonesia, was performed by combining financial (economic) and technical analyses⁸⁾.

In addition, site selection is essential for the effective establishment of agro-industries, such as milk⁹⁾, sorghum¹⁰⁾, microalgae farming¹¹⁾, and banana distribution¹²⁾. Establishing an industry without considering feasibility factors causes various problems, particularly environmental issues¹³⁾. Spatial analysis assesses the feasibility of potential sites using map-based data, and site selection methods generally rely on geographic information systems, such as ArcGIS¹⁴⁻¹⁶⁾. Moreover, spatial analysis can be combined with other methods, such as analytic hierarchy process, as was applied in a study of the selection of sorghum-processing industries in Lamongan Regency, East Java, Indonesia¹⁰⁾.

In this study, we assessed the feasibility of the establishment of new small and medium agro-industries in Kabawetan Subdistrict, Bengkulu, Indonesia, using economic and spatial analyses. The economic analysis comprised feasibility and sustainability analyses, and the spatial analysis was used to identify suitable locations considering environmental factors, raw-material availability, and distance to markets. The target products were dried banana, dried vegetable (cabbage, tomato, and welsh onion), and coffee powder. Our method can be applied to other agricultural areas in Indonesia to support the growth of agriculture-based SMEs and absorb labor in areas such as Sumatra Island.

2. Study area

The study area was located in Kabawetan Subdistrict, Kepahiang Regency, Bengkulu Province, Sumatra, Indonesia (Fig. 1). The study area is located on a gentle slope at the foot of Bukit Hitam Mountain, has an altitude of 600–1200 m a.s.l., and has an area of 6,331 ha, representing 9.51% of the total area of Kepahiang Regency¹⁷⁾. Of this area, 1,173 ha is used as dry fields, unirrigated agricultural fields, and shifting cultivation (Statistics Indonesia 2017c). Kabawetan Subdistrict produces large volume of vegetables (*e.g.*, red pepper, cabbage, Chinese cabbage, scallion, and potato), with a cultivation area of 242 ha¹⁸⁾.

In 2017, Kabawetan Subdistrict had 15 villages and a population of 11,578. Most workers are horticultural or plantation

farmers (90.2%). Kabawetan produces 134 tons of banana, 559 tons of cabbage, 624 tons of welsh onion, and 640 tons of coffee¹⁹⁾. In Kabawetan there are 11 food-processing businesses, 4 handicraft businesses, and 6 restaurants²⁰⁾. SMEs in Kabawetan are predominantly food-related (e.g., milk, civet coffee, and sweet-salty corn), which sell their products within Bengkulu Province and experience discontinuous production.

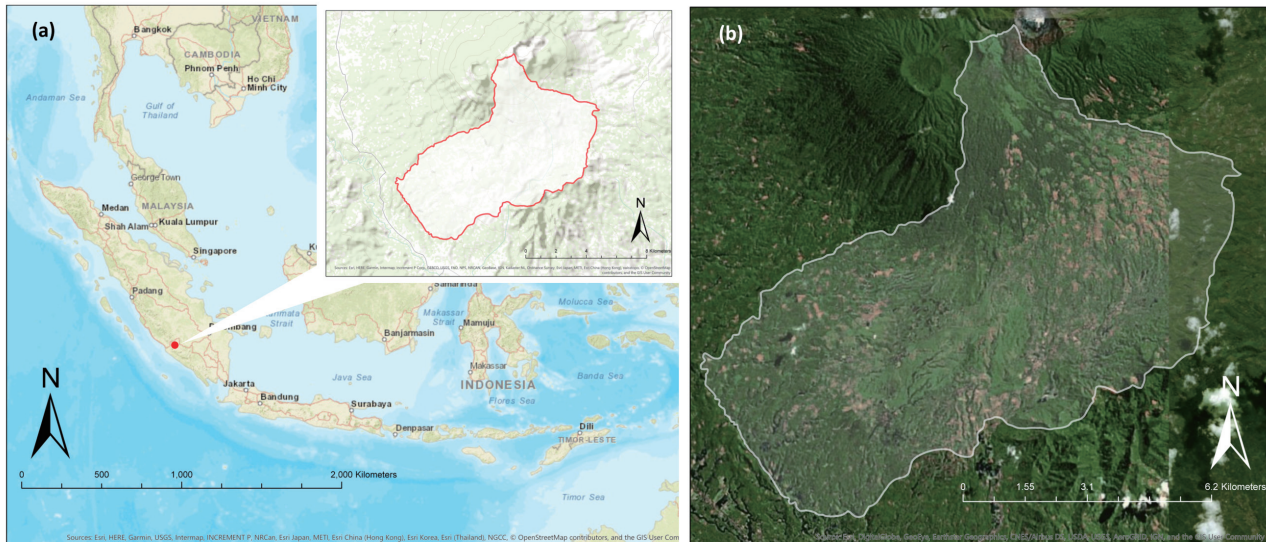


Fig. 1. Study Area: (a) Bengkulu Province and (b) Kabawetan Subdistrict (background map provided by ArcGIS).

3. Materials

Table 1 summarized the economic and spatial data. The economic data were the prices of materials and the costs associated with the establishment and operation of the industry. The spatial data (elevation map, rivers, settlements, roads, and land use) are shown in Fig. 2.

Table 1. Input data used in this study

	Input data	Source
Economic	Cost of machinery and equipment, transportation unit, equipment attribute, and packaging	Based on an internet survey performed by Alibaba, Alibaba Indonesia, Toko Mesin, Toko Mesin Yogyakarta, Rumah Mesin, <i>etc.</i>
	Cost of the building, ground rent, fuel, electricity, and water	Assumptions based on the survey results
	Labor wages	Provincial Minimum Wage per Year and Average National Wages
	Raw-material production	Statistics of Annual Fruit and Vegetable Plants and Statistics of Seasonal Vegetable and Fruit Plants
	Producer price of raw material	Agricultural Producer Price Statistics: Foodcrops, Horticulture, and Smallholder Estate Crops Subsectors
	Costumer prices of raw materials	Consumer Price of Selected Goods for Food Groups of 82 Cities in Indonesia
Spatial	Market selling price and market consumption	Indonesia Foreign Trade Statistics
	Conservation area	Utilisation Direction 2014 ²¹⁾
	Digital Elevation Model	ASTER GDEM ²²⁾
	River, Roads	The Shape of the Indonesian Earth ²³⁾
	Land Use	Visual interpretation of Google Earth

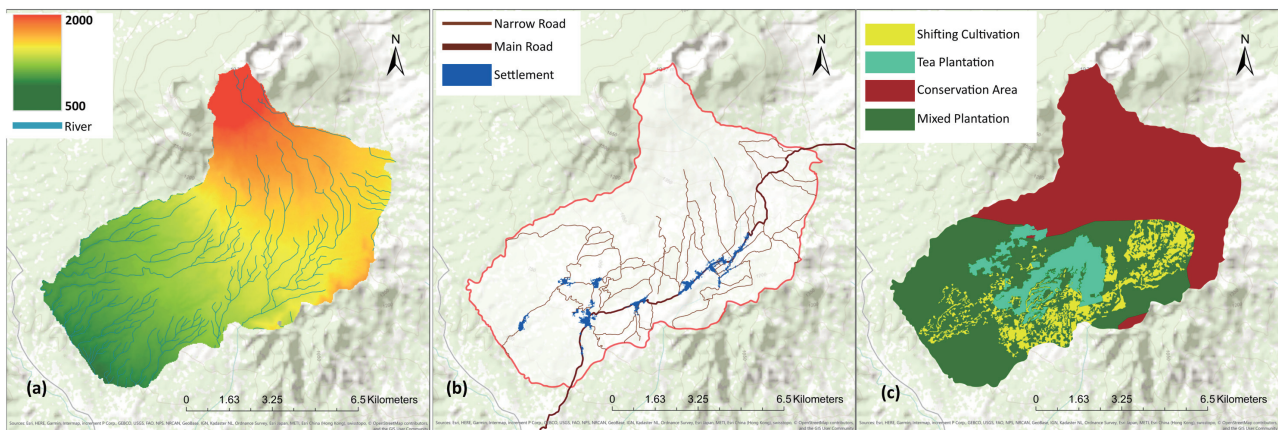


Fig. 2. Spatial data: (a) elevation and rivers; (b) settlements and roads; and (c) land use (background map provided by ArcGIS).

4. Methods

4.1 Outline

We performed economic and spatial analyses of three small and medium agro-industries: dried banana, dried vegetable, and coffee powder. The economic analysis evaluated the feasibility and sustainability of these industries. The feasibility analysis was based on calculations of financing, periodic profits, returns on capital, price, and investment. The sustainability analysis was based on raw-material availability forecasts and elasticity. Locations were evaluated based on the standard environmental criteria of the Ministry of Industry of Indonesia²⁴. Fig. 3 shows an outline of the study.

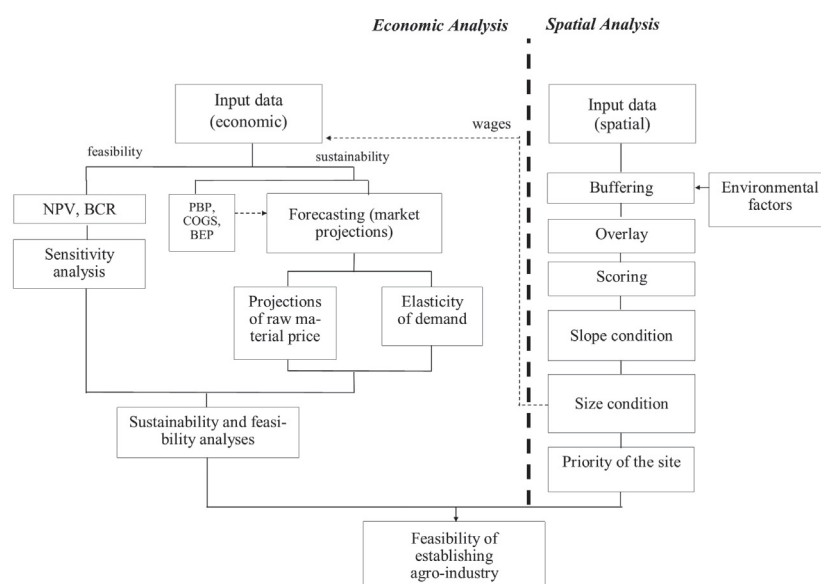


Fig. 3. Outline of the methodology.

4.2 Economic analysis

The economic analysis evaluated feasibility using the net present value (NPV) and benefit–cost ratio (BCR) and sustainability based on the payback period (PBP), cost of goods sold (COGS), break-even point (BEP), and elasticity. These six indicators were calculated using Microsoft Excel.

4.2.1 Feasibility

The NPV is the difference between the present benefits and costs and is used in capital budgeting and investment planning to

forecast revenue and make decisions. This method uses monetary values as inputs representing various factors to perform quantitative analyses that can facilitate measurement of a company's wealth²⁵⁾. The formula is as follows:

$$NPV = \sum_{t=0}^n \frac{B_t - C_t}{(1+i)^t} \quad (1)$$

where NPV is the net present value, B_t is benefit in year t , C_t is cost in year t , i is the annual interest rate, and n is the number of years. A higher NPV indicates greater feasibility²⁵⁾. The data used to calculate benefits and costs (operational and investment) are listed in Table 2.

Table 2. Input data for the economic analysis

Cost/benefit		Industrial Unit (million IDR)		
		Dried Banana	Dried Vegetable	Coffee Powder
Operational Cost	Resources	57.3	149.3	192.0
	Packaging	109.9	109.9	0.6
	Fuel	1.9	1.9	1.9
	Ground rent	12.0	12.0	12.0
	Overhead	4.8	4.8	4.8
	Employees	237.6	237.6	237.6
	Administration	30.0	30.0	30.0
Investment Cost	Machinery and equipment	75.2	75.2	75.7
	Transportation (unit)	8.1	8.1	8.1
	Equipment/attribute	80.0	80.0	80.0
	Buildings	30.0	30.0	30.0
Benefit		432	720	480

The following conditions were assumed in the analysis:

- 1) Of the total cost, 70% was bank credit with 12% tax; the remaining 30% was direct costs,
- 2) The project duration was 7 years,
- 3) There were 20 working days/month,
- 4) The annual frequency of equipment repair was 2%, and
- 5) The minimum salvage value was 300,000 Indonesian Rupiah (IDR).

The purchasing costs of raw materials were the producer selling prices for banana, coffee, cabbage, tomato, and welsh onion, taken from the 2017 Agricultural Statistics of Indonesia²⁶⁾. The prices of machinery and equipment were those in May 2018 as stated on the manufacturers' websites. Employee salary was the minimum wage in Bengkulu Province in 2016, and it was assumed that all workers received the same salary. The number of workers was 11, comprising 2 operators, 2 marketing staff, 1 administrator, and 6 technicians.

Economic feasibility was also assessed based on the BCR. The BCR is the ratio of the total current benefit divided by the total current cost²⁷⁾. The BCR is an indicator of the cost-benefit relationship in monetary or qualitative terms. This method is frequently used in capital budgeting, but for large projects can be difficult because there are many assumptions and uncertainties to quantify. The formula is as follows:

$$BCR = \frac{(PV)B}{(PV)C} \quad (2)$$

where (PV)B is the current benefit and (PV)C is the current cost. If the BCR is > 1 , the project proposal can be accepted. The data used to calculate the BCR were identical to those used for the NPV (Table 2).

The NPV and BCR calculations were based on a simulation of the financial feasibility of SMEs for salted eggs and coffee powder^{8, 28)}. The calculation is based on the costs, including the investment and operational costs and benefit of the project, in a particular period. Next, income is projected by determining the selling price via a survey, projecting the installments of bank-loan principal and interest, and making projections on profit and loss and cash flow.

The sensitivity of the NPV was analyzed in relation to four factors: worker quantity, worker salary, sale price, and raw-material price. The sensitivity to changes in raw-material prices over 7 years was assessed to determine the potential raw-material availability during this time frame. The results of the analyses of sensitivity to changes in sale price, daily production, worker salaries, and quantity of workers were compared to determine the potential NPV under various scenarios. Overall, the analysis results helped clarify the potential sustainability of the investigated agro-industries.

4.2.2 Sustainability

Sustainability was evaluated using three indices (PBP, COGS, and BEP) and elasticity. PBP is the period required to recover the investment in the project. If the PBP is shorter than a predetermined value, investment is more likely. The PBP is calculated as:

$$PBP = \frac{I}{T} \quad (3-1)$$

where:

$$T = \frac{P + D}{I} \quad (3-2)$$

T is the annual capital return rate, P is annual net profit, D is annual depreciation, and I is investment.

The COGS is the direct cost of production. It includes the cost of the materials and direct labor but excludes indirect expenses. The formula for COGS is:

$$COGS = \frac{C_f + C_v}{12 \cdot P_d \cdot W_d} \quad (4)$$

where C_f is the fixed cost, C_v is the variable cost per unit, P_d is daily production, and W_d is the number of working days per month.

The BEP is the point at which cost and income are equal: there is no loss or profit. The formula for the BEP is:

$$BEP = \frac{C_f}{r - C_v} \quad (5)$$

where r is the sale price per unit, and C_f and C_v are as in Eq. 4.

The data used to calculate the PBP, COGS, and BEP were identical to those used for the NPV and BCR (Table 2). The

calculation followed that in simulations of the industrial feasibility of salted egg and coffee powder^{8,28}.

Market forecasting is the concept of predicting future values based on past trends. In this study, forecasting was used to evaluate the possibility of industry sustainability based on future trends of raw-material availability and prices. Although accurate prediction is difficult, forecasting assists decision making, particularly as related to predicting the prospects of a project.

In a preliminary analysis using four statistical functions (arithmetic straight line, arithmetic-geometric curve, statistical straight line, and statistical parabolic curve), the statistical parabolic curve showed the lowest deviation. The formula is:

$$Y_c = a + bx + cx^2 \quad (6-1)$$

where

$$a = \frac{(\sum X^2)(\sum Y) - (\sum X)(\sum XY)}{n(\sum X^2) - (\sum X)^2} \quad (6-2)$$

$$b = \frac{\sum XY}{\sum X^2} \quad (6-3)$$

$$c = \frac{n(\sum X^2 Y) - (\sum X^2)(\sum Y)}{n(\sum X^4) - (\sum X^2)^2} \quad (6-4)$$

where Y_c is the projected value; a , b , and c are regression coefficients; X is past years and x is future years; Y is past value; and n is number of years.

The input data for market forecasting were the raw-material prices and production of cabbage, welsh onion, tomato, banana, and coffee, as well as the sale price and consumption of dried banana, dried vegetables, and coffee powder. The data were obtained from Agriculture Producer Price Statistics of Food Crops, Horticulture, and Smallholder Estate Crops Subsector from 2010–2017.

The forecasting method followed the simulation and market forecasting methods used by FLORES²⁹ and The Center for Academic Innovation and Studies Gadjah Mada University³⁰. Forecasting enables prediction of supply elasticity, raw-material supply, and raw-material prices. The projection of raw-material prices is subjected to sensitivity analysis to predict the likelihood of raw-material prices affecting production cost. The prediction of raw-material availability is important for stable operation of the project.

The elasticity of demand is a measure of the sensitivity of demand to changes in sale price. A higher elasticity of demand indicates that consumers are more responsive to changes in this variable. The elasticity of demand is calculated as the percentage of the change in the number of requested commodities divided by the percentage change in commodity prices²⁵.

$$E_d = \frac{\% \Delta Q_d}{\% \Delta P} \quad (7)$$

where $\% \Delta Q$ is the percentage change in quantity, d is demand, and $\% \Delta P$ is the percentage change in price. An E_d value > 1 indicates elasticity.

4.3 Spatial analysis

The spatial analysis comprised distance from features (river, road, and settlement), land use, land slope, and area. Input data expressed as a vector (river, road, settlement, and land use) and raster (slope) were input as layers in ArcGIS Pro 2.0.0. These data were overlaid and analyzed using the ModelBuilder feature in ArcGIS. ModelBuilder assigns processing steps for manufacturing of a product of analysis³¹.

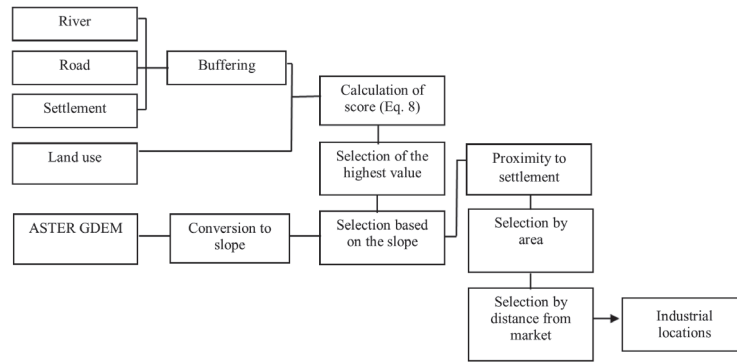


Fig. 4. Input, process, and outcome of the spatial analysis.

Distance is important for transportation, environmental protection, and influence on residents. Here, it was evaluated using the buffering function in GIS. Distance from a river was ranked from 1 to 5 (farther was higher) in 100-m increments, from the viewpoint of protecting water quality. Distance from a road was ranked from 1 to 3 (closer was higher) in 1-km increments. Distance from a settlement was ranked from 1 to 3 (farther was higher) in 1-km increments. Land use was assessed to identify areas that could be used for industrial purposes based on the Technical Guidelines for Industrial Zone Development²⁴⁾. Land use was categorized as conservation area, tea plantation, mixed garden, and shifting cultivation. Conservation areas were assigned a score of zero because industry is not permitted in these areas to support biodiversity and ecosystem conservation. Tea plantations were also assigned a score of zero because they are owned by the government or private parties. Areas of mixed plantations and shifting cultivation were assigned a score of five because these are suitable for industry due to community ownership and proximity to raw materials.

The distance and land-use scores were summed using the overlay function of GIS. The total score was calculated by:

$$Pa = \sum_{l=1}^n S_l \quad (8)$$

where Pa is the priority score, l is layer, S is the score of the l th layer about the distance or land use based on priority area.

Industry requires flat land to reduce the work required for land maturation (cut and fill), increase the efficiency of land use, simplify construction, and reduce construction costs. Areas with a slope of $< 15\%$ were selected based on the regulations of the Ministry of Industry of Indonesia²⁴⁾. The slope was calculated using ASTER GDEM at a 30-m spatial resolution using a threshold of 15%. The data were converted from raster to vector. Slope areas were eliminated using the masking function in GIS.

Areas less than 500 m from a settlement were excluded. There are no standard rules regarding the distance between SMEs and settlements. However, the likelihood of industrial pollution impacting a settlement decreases with distance. In contrast, a smaller distance from settlements facilitates travel by workers, reduces traffic congestion around industrial estates, and reduces the impact of pollutants and waste on health²⁴⁾.

In addition, sites with a minimum area of 1.3 ha were selected according to the relevant regulations²⁴⁾. We prioritized sites closer to the central market, which would decrease transportation costs and increase product availability.

5. Results and discussion

5.1 Economic feasibility

The NPV and BCR values differed among banana, dried vegetable, and coffee powder (Table 3). Projects may be accepted if the NPV is positive and the BCR is > 1 . The dried vegetable industry had the highest NPV of 481 million IDR, as well as the highest

BCR. For comparison, the Luwak coffee agro-industry at Balik Bukit District, Lampung, had an NPV of 2,856 million IDR and a net BCR of 5.81³²⁾ and the banana chip agro-industry in Metro City, Lampung, had an NPV of 633–817 million IDR and a net BCR of 6.16³³⁾. The sale price of dried vegetable supported a BCR score > 1 because the product is intended for industrial use, *e.g.*, instant noodles and export.

Table 3. Overview of the feasibility analysis

Industry	NPV (million IDR)	BCR	Plan
Dried banana	-122	0.00	Rejected
Dried vegetable	664	62.0	Accepted
Coffee powder	-73	0.19	Rejected

* IDR: Indonesian Rupiah

The sensitivity of the NPV to $\pm 20\%$ changes in worker quantity, worker salary, sale price, and raw-material price is shown in Fig. 5. Worker quantity had the greatest impact because it affected the variable costs. Raw-material price showed the least impact because raw materials are cheap and available.

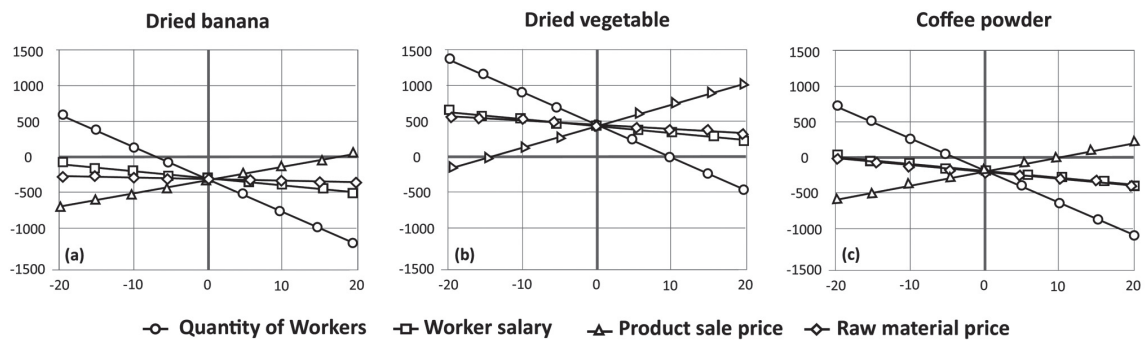


Fig. 5. Sensitivity of the NPV of (a) dried banana, (b) dried vegetable, and (c) coffee powder production. Horizontal axis, change (%); vertical axis, NPV (million IDR).

Dried vegetable retained a positive NPV even with an increase of five workers, a 20% increase in worker salary, or an 18% reduction in sale price and a 20% decline in raw-material price. Coffee powder had a positive NPV after a decrease of three workers or a 2% increase in the sale price. However, the NPV remained negative even when worker salary and raw material price decreased by 20%.

5.2 Economic sustainability

Dried vegetable had a PBP of 1.41 years because of the higher sale price (Table 4). This showed that annual income would be higher than annual expenditure from the beginning of production. The COGS can be used as an indicator of the minimum sale price depending on the production cost. A COGS value lower than the sale price indicates that production cost has been covered. If the sale price of coffee powder were higher than the COGS, coffee powder would have the most efficient production cost. Dried vegetable showed the largest difference between the sale price and COGS value; therefore, it had the greatest potential profit. Dried vegetable had the lowest BEP, indicating that fewer units would need to be sold to recuperate costs. The elasticity showed that a change in the sale price of dried banana affected its demand, suggesting that consumers are more interested in dried bananas than coffee powder or dried vegetables.

Table 4. Overview of the sustainability analysis

Industry	PBP (year)	COGS (IDR)	Selling Price (IDR)	BEP (unit)	Elasticity
Dried banana	8.00	15753	15000	34129	Elastic
Dried vegetable	0.08	22736	30000	16340	Inelastic
Coffee powder	8.00	7983	8000	69419	Inelastic

* IDR: Indonesian Rupiah

Overall, dried vegetable had the highest sustainability value because of a shorter PBP, higher potential revenue (with a COGS value less than the sale price), smaller number of units required to break even, and stable demand. Vegetable cultivation is a dominant economic activity in Kabawetan Subdistrict. Therefore, dried vegetable production would provide a market for vegetable produce, even when sales prices are low, support local resource development, and improve the local economy. This could change the economic practices of the farming community, where farmers base production on sales prices that fluctuate, by providing a consistent market for raw materials.

Raw materials are important for agro-industry because they affect production costs. Projection of raw material production and raw material prices will facilitate decision making and prediction of industrial sustainability. Forecasts of raw material production and the prices of the three investigated value-added products are shown in Fig. 6.

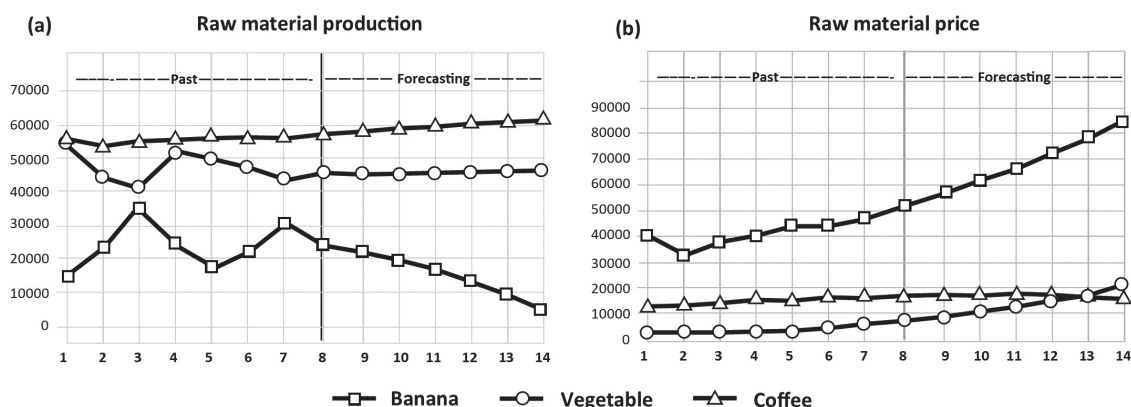


Fig. 6. Forecasting of (a) raw-material production and (b) price. Horizontal axis, period (years), vertical axis, quantity in tons (a) and price/kg (b) of raw materials (IDR).

The availability of raw materials for dried banana were projected to decline over the long term, while those of the other products remained stable. In addition, the prices of the raw materials for dried banana and dried vegetable were projected to increase, while that of coffee powder remained stable. Therefore, both dried vegetable and coffee powder production are likely to be sustainable industries, although coffee powder may have the advantage of more stable raw-material availability. In Kabawetan Subdistrict, farmers allocate fields for both vegetable and coffee production. Therefore, the availability of raw materials for dried vegetables and coffee powder is likely to be greater than that for bananas, because farmers grow the latter only for local consumption.

5.3 Spatial analysis

Fig. 7 shows the results of the spatial analysis. The color gradient in Fig. 7a indicates the total scores. Fig. 7b shows the areas selected based on slope. The highest value of image a multiplied by a score based on slope. Areas within 500 m of the settlement were excluded to prevent potential detrimental effects on the settlement (Fig. 7c).

Location selection should consider the distance to the market, particularly for businesses located near raw materials. Area P1 in Fig. 7d was closer to the central market (8.7 km) than P2 (13.2 km). Location selection must balance the need for obtaining raw

materials with the ease of transportation of the product to the market. If heavy raw materials are needed, the industry should be located close to their source. If the product is heavy, the industry should be located closer to the market²⁵⁾. Because the raw materials are readily available, the optimum location in this study was determined to be roughly equidistant between the raw materials and the market, *i.e.*, location P1.

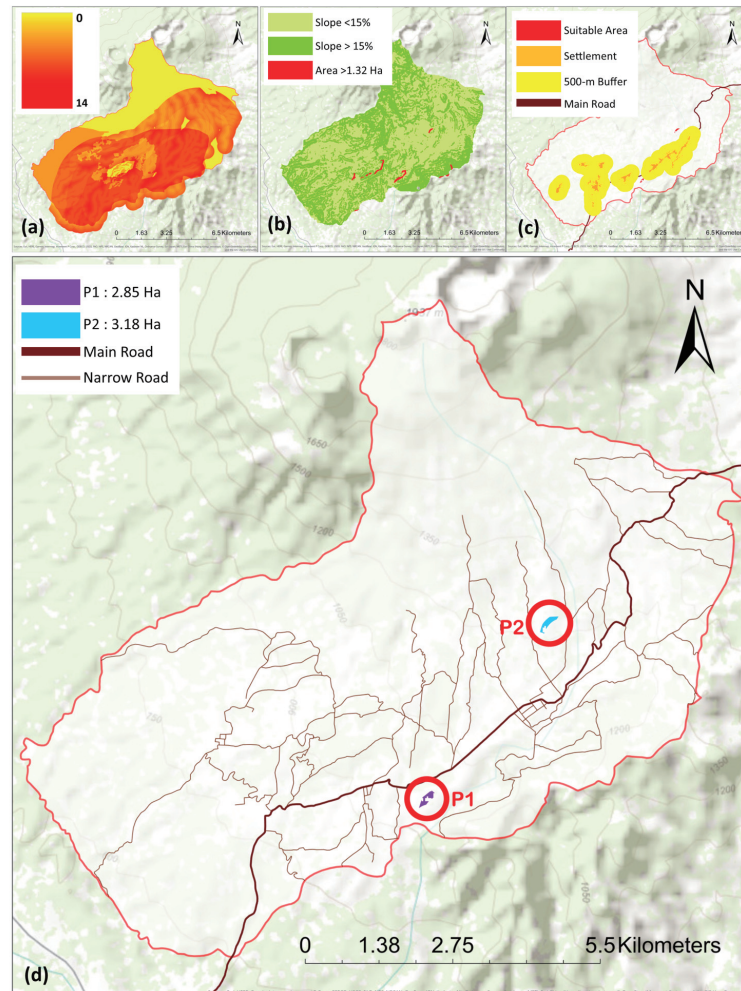


Fig. 7. Location selection: (a) sum of the location selection scores, shown as a color gradient; (b) areas by slope threshold; (c) areas 500 m from the settlement; and (d) two candidate sites ranked by distance from the central market.

5.4 General discussion

Economic analysis of the feasibility and sustainability of SMEs should be based on sensitivity and forecasting assessments to be confident in the success of such enterprises. In addition, site selection is vital and is related to social and environmental factors such as regulations, land use, and conservation. GIS enables the mapping and selection of suitable locations.

In this study, we focused on economic and spatial analyses, which provide important data for decision making, but have not been applied to small-scale agro-industries in the study area; therefore, our results will facilitate the successful establishment of food production. Analysis of feasibility allows assessment of resilience to unexpected changes in transportation^{34,35)} and the availability of raw materials^{36,37)}.

Kabawetan Subdistrict has considerable agricultural production but low community income. Farmers plant vegetables with a high sale price; the resulting increase in product availability leads to a decrease in the sale price. When this occurs, farmers cannot cover the production cost and the produce may be discarded or used as animal feed.

Instability in the sale price is caused by fluctuations in product availability while demand is stable. If product availability

decreases, the sale price increases. Changes in sale price cannot be predicted by farmers, which reduces their economic status. Over many years, this has become a serious issue for farming communities in Kabawetan Subdistrict.

A shift from selling raw materials (vegetable, banana, and coffee) to selling value-added products (dried vegetable, dried banana, and coffee powder) will alter this poverty cycle. Small and medium agro-industries offer an alternative to processing of agricultural products in Kabawetan Subdistrict, and could stabilize sales prices by preserving the costs of raw materials and equipment. As additional advantages, the products are durable and use of local resources improves the quality of life of the residents. Finally, agro-industrial products can be selected based on local objectives and needs, which can affect the availability of raw materials and the social involvement that will support the success of the industry³⁸⁾.

Assessment of the economic feasibility and selection of locations suitable for agro-industry in Kabawetan Subdistrict will support pre-establishment proposals and formulation of regional development plans, which should take into account local resources. This is essential for industrial sustainability³⁹⁾.

6. Conclusion

We performed a feasibility analysis, combining economic and spatial factors, of the establishment of small and medium agro-industries in Kabawetan Subdistrict, Indonesia. Dried vegetable had a positive NPV and was resistant to changes in raw-material prices, sale price, and the number and salary of workers. Therefore, the dried vegetable agro-industry could create value-added products using local produce as a solution to the disposal of surplus produce, representing an alternative to extending the shelf life of vegetables. As the next step toward creating a dried vegetable agro-industry in Kabawetan Subdistrict, a detailed operation plan should be developed.

The method presented herein can be applied to other regions in Indonesia, although a simpler site selection and profitability calculation framework should be developed to facilitate its application.

Acknowledgement

This study was carried out at Kochi University under the framework of The Six University Initiative Japan–Indonesia.

References

- 1) Statistics Indonesia, Micro and Small Manufacturing Industry Profile 2017. National Statistics (2017).
- 2) Obi, J., I. A. Stephen, A. Tolulope, O. M. Ayodele, A. A. Bosede, T. B. Tairat and P. Fred, Contribution of small and medium enterprises to economic development: Evidence from a transiting economy. *Data in Brief*, 18, 835–839 (2018).
- 3) Tambunan, T., Entrepreneurship development: SMEs in Indonesia. *Journal of Developmental Entrepreneurship*, 12, 95–118,(2007).
- 4) Statistics Indonesia, Land Area by Utilization 2015. National Statistics (2015).
- 5) Manurung, S. and M. Baiquni, Dinamika Usaha Kecil Menengah (UKM) di Pusat Industri Kecil (PIK) Menteng di Kota Medan. *Jurnal Bumi Indonesia*, 5, 1-10 (2016).
- 6) Foster, R., Economic and quality of life factors in industrial location decisions. *Social Indicators Research*, 4, 247–265 (1977).
- 7) Chen, L., J. Olhager and O. Tang, Manufacturing facility location and sustainability: A literature review and research agenda. *International Journal of Production Economics*, 149, 154–163 (2014).
- 8) Herdyanti, K., Preliminary design and feasibility analysis of processing coffee been plant in the District Bener Meriah, Aceh Province (2013). [online; cited May 2018] Available from URL: <https://repository.ipb.ac.id/bitstream/handle/123456789/68131/F13khe.pdf>
- 9) Hendrawati, T. Y. and S. Utomo, S., 2015, Pemilihan Prioritas Lokasi Industri Susu Sterilisasi di Jawa Tengah dengan Metode Analytical Hierarkhi Process (AHP). *Jurnal Teknologi Universitas Muhamadiyah Jakarta*, 7, 65-71 (2015).

- 10) Gayuk, N. C. and A. Pamungkas, Penentuan Alternatif Lokasi Industri Pengolahan Sorgum di Kabupaten Lamongan. *Jurnal Teknik Pomits*, 2, c211-c214 (2013).
- 11) Bravo-Fritz, P. C., A. C. Sáez-Navarrete, Z. A. L. Herrera and C. R. Ginocchio, Location selection for microalgae farming on an industrial scale in Chile. *Algal Research*, 11, 343–349, (2015).
- 12) García, J. L., A. Alvarado, J. Blanco, E. Jiménez, A. A. Maldonado and G. Cortés, Multi-Attribute evaluation and location selections for agricultural product warehouses based on an analytic hierarchy process. *Computers and Electronics in Agriculture*, 100, 60–69, (2014).
- 13) Rita, I. G. D. and A. F. F. Ferreira, Meidutė-Kavaliauskienė, I., Govindan, K.: Proposal of a green index for small and medium-sized enterprises: A multiple criteria group decision-making approach. *Journal of Cleaner Production*, 196, 985–996 (2018).
- 14) Church, R. L., Geographical information systems and location science. *Computers & Operations Research*, 29, 541–562 (2002).
- 15) Eldrandaly, K., A COM-based spatial decision support system for industrial location selection (in Indonesian). *Journal of Geographic Information and Decision Analysis*, 7, 72–92 (2003).
- 16) Rikalovic, A., I. Cosic and D. Lazarevic, GIS-Based multi-criteria analysis for industrial location selection. *Procedia Engineering*, 69, 1054–1063 (2014).
- 17) Statistics Indonesia, Luas Wilayah Menurut Kecamatan di Kabupaten Kepahiang Tahun 2015, (2017) [online; cited October 2018] Available from URL: <https://kepahiangkab.StatisticsIndonesia.go.id/dynamictable/2017/01/18/19/luas-wilayah-menurut-kecamatan-di-kabupaten-kepahiang-tahun-2015.html>
- 18) Statistics Indonesia, Kepahiang Regency in Figures 2017. Statistics Indonesia Kepahiang (2017).
- 19) Statistics Indonesia, Kabawetan Subdistricts in Figures 2017. Statistics Indonesia Kepahiang (2017).
- 20) Statistics Indonesia, Kabawetan Subdistricts in Figures 2013. Statistics Indonesia Kepahiang (2013).
- 21) Ministry of Environment and Forestry of Indonesia, Utilisation direction 2014 (chapter Bengkulu) (2014). [online; cited May 2018] Available from URL: http://appgis.dephut.go.id/appgis/Arahan_pemanfaatan_2014/
- 22) U. S. Geological Survey, Advanced Spaceborne Thermal Emission and Reflection Radiometer Global Digital Elevation Model (ASTER GDEM) (2011). [online; cited May 2018] Available from URL: <https://earthexplorer.usgs.gov/>
- 23) Center for Management and Dissemination of Geospatial Information Geospatial Information Agency of Indonesia. The shape of the Indonesian earth (region) (2018) [online; cited May 2018] Available from URL: <http://tanahair.indonesia.go.id/portal-web/download/perwilayah#>
- 24) Ministry of Industry of Indonesia, Technical Guidelines for Industrial Zone Development. Regulation of the Minister of Industry of the Republic of Indonesia Number 40/M-IND/PER/6/2016. Kemetrian Perindustrian RI, Jakarta (2016).
- 25) Soeharto, I., Studi Kelayakan Proyek Industri. Penerbit Erlangga, Jakarta, Indonesia (2001).
- 26) Statistics Indonesia, Agriculture Producer Price Statistics of Food Crops, Horticulture, and Smallholder Estate Crops Subsector 2017. National Statistics (2017).
- 27) Sowe, S., N. Ketjoy, P. Thanarak and T. Suriwong, Technical and economic viability assessment of pv power plants for rural electrification in The Gambia. *Energy Procedia*, 52, 389–398 (2014).
- 28) Bank Indonesia, Pola Pembiayaan Industri Telur Asin (Konvensional) (2019) [online; cited May 2018] Available from URL: https://www.bi.go.id/id/umkm/kelayakan/pola-pembiayaan/industri/Pages/telurasin_konvensional.aspx
- 29) Flores, R., Market projection (2013). [online; cited June 2018] Available from URL: <https://www.slideshare.net/RudyFlores1/3-market-projections>
- 30) The Center for Academic Innovation and Studies Gadjah Mada University, Metode Pengukuran dan Peramalan. Universitas Gadjah Mada. (2001)
- 31) Smith, D., N. Strout, C. Harder, S. Moore, T. Ormsby and S. Balstrom, Understanding GIS: An ArcGIS Pro Workbook Third

Edition. Esri Press, California (2017).

- 32) Pahlevi, R., W. A. Zakaria, U. Kalsum, The financial feasibility analysis of Luwak coffee agroindustry at Balik Bukit District of West Lampung Regency. *Journal of Agribusiness Science*, 2, 48-55 (2014).
- 33) Febriyanti, M. I. Affandi, and U. Kalsum, Financial and added value analysis of micro and small-scale banana chip agroindustries in metro city (in Indonesian). *Journal of Agribusiness Science Lampung University*, 5, 48-56 (2017).
- 34) Behrens, K., C. Gaigné and J. F. Thisse, Industry location and welfare when transport costs are endogenous. *Journal of Urban Economics*, 65, 195–208 (2009).
- 35) Ishikawa, J. and N. Tarui, Backfiring with backhaul problems trade and industrial policies with endogenous transport costs. *Journal of International Economics*, 111, 81–98 (2018).
- 36) Bhatnagar, R. and S. A. Sohal, Supply chain competitiveness: measuring the impact of location factors, uncertainty and manufacturing practices. *Technovation*, 25, 443–456 (2005).
- 37) Amorim, P., E. Curcio, B. Almada-Lobo, A. P. Barbosa-Póvoa and I. E. Grossmann, Supplier selection in the processed food industry under uncertainty. *European Journal of Operational Research*, 252, 801–814 (2016).
- 38) Indrawati, S., SME Product investment priority and selection based on local competencies. *Procedia Economics and Finance*, 4, 59–67 (2012).
- 39) Anggadwita, G. and M. Q. Yuuha, Identification of factors influencing the performance of small-medium enterprises (SMEs). *Procedia Social and Behavioral Science*, 115, 415–423 (2014).

令和元年 (2019) 11月11日受理

令和元年 (2019) 12月31日発行