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Full Length Research Paper

Semi-Mechanized Brick-Making in Southeast Sulawesi: Feasibility and Constraints for Its Adoption

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This study aimed to assess feasibility of semi-mechanized brick-making enterprises and constraints for their adoption in Southeast Sulawesi. Data about feasibility collected from one unit of semi-mechanized brick enterprise, while information about adoption constraints was collected from 30 traditional small-scale brick making units. Data were collected using interview method based on the questionnaire. Data were analyzed using financial tools of decision making, namely NPV, IRR, BCR, PBP, and sensitivity analysis. The study revealed that the enterprises can generate a positive NPV, IRR higher than the discount rate, BCR higher than 1, and PBP shorter than economic life of the project. These results indicated that semi-mechanized brick making is financially feasible, and the enterprises that received microcredit from local commercial bank could repay fully the loan. However, depsite its higher net profit, producers continued to use traditional brick making. Some factors that cause its non-adoption included financial barriers, lack of knowledge and skills, poor infrastructure, limited support from government and other agencies, labor problem, and non-difference in price. The government and stakeholders need to take measures to solve and eliminate the identified barriers in order to promote the brick industry.

Keywords: Adoption, Brick making, Constraint, Feasibility, Sulawesi

INTRODUCTION

Fired clay brick is one of the most important building materials in Indonesia. Most demand is in urban areas and stems mainly from the construction industry covering residential, commercial, industrial, and public buildings. The increased demand is also due to the growth of economy and population (Maithel *et al*., 2012), and preference of people toward houses made of stone instead of wood. In addition, bricks are more fire-resistant, easy to be used, and economical (Suseno *et al*., 2012). For these reasons, brick making is found in all areas in Indonesia. Widespread operation of brick-making is related to the low investment capital needed, availability of raw clay, and the simple operation of brick making process which anyone can easily learn and master.

Brick-making is one of artisanal businesses which have long been done in Southeast Sulawesi. As found in most areas in Indonesia, brick making in the province is small scale, labor intensive, and employs unskilled and semi-skilled workers. Brick making enterprises are operating in the informal sector with lack of support from the government. Each unit is operated by three persons in average, consisting of two family labors and one paid labor. Bricks are mainly produced through manual processes, sun drying and traditional brick making technologies. Bricks producers generally lacked technical, managerial and marketing skills. They were also generally weak in terms of mentality, education, motivation in exploring opportunities, access to technology and capital (Tarmidi, 2005; Saediman *et al.,* 2006). Even though their operations are feasible as seen from IRR, NPV, NBCR, and PBP, they are marginal business (Saediman *et al*., 2014). In fact, the majority of producers and workers in the brick making industry were in the low economic wellbeing.

Despite its small scale characteristics and marginal business, brick making operations have been done for generations with no technology upgradation. In fact, almost all small-scale brick making operations in the area were done using traditional technology. During pre-survey in three districts, there was only one semi-mechanized brick making in each district. This led to questions about the reasons for brick producers to have remained in such small scale operations for years and for not establishing enterprises with more improved technologies using machineries. As technology upgradation in the sector would open up new sets of employment opportunities in the brick sector and increased profit leading to improved working conditions and livelihoods for both producers and workers, it is important to find out why there was only one semi-mechanized brick making operation in each district. It is in this context that this study was conduted to understand the feasibility of the semi-mechanized brick making and what barriers are there for the adoption of semi-mechanized brick making.

METHODOLOGY

Study Site

The study was conducted as part of a study to establish the lending model for the development of brick making enterprises in the province. The study focused on (i) traditional small-scale brick making operations, whose main results had been reported in Saediman *et al*. (2014), and (ii) semi-mechanized brick making, which is reported in this paper. The survey on traditional brick making was done in three main brick producing subdistricts in three districts. Ten brick producers were selected from each subdistrict, so that there were 30 respondents in total from traditional brick making category. The study on semi-mechanized brick making was done by surveying one available semi-mechanized brick making each in Kendari Municipality, South Konawe District, and Konawe District. However, semi-mechanized brick making in Kendari Municipality was chosen to be further studied due to its close location to the market, available infrastructure, and collaboration from the owner. While information about barriers for adoption of semi-mechanized technology was obtained from all respondents, information about the feasibility aspect was obtained exclusively from one semi-mechanized brick making located in Poasia subdistrict in Kendari municipality.

Kendari municipality is situated between 3°45' and 4°15' south latitude, and 122°15' and 122°45' east longitude. The population was 314,126 in 2013. It has an area of 295.9 km^2 consisting of 10 subdistrict and 64 villages. Temperatures range between 23 and 32°C throughout the year. The number of brick making units is only 11, including one semi-mechanized brick making that is the object in the present study. High demand for brick is met by brick making units in Ranomeeto subdistrict in the neighboring district. The official record of the number of brick-making units in Ranomeeto was 332 in 2013, but the real number is believed to be much higher. At the province level there might be thousands of brick making units, almost all of them are using traditional technologies.

Data Collection

Data and information were collected using interview method based on the questionnaire. One brick-making unit was selected purposively as respondent. The questionnaire was based on earlier questionnaires (Saediman *et al*., 2014) to establish similar data and responses for easy comparison. Data collected included investment, labor, production process, market, government involvement, barriers for adoption of new technology, and issues for brick sector development. Interviews were done with brick producer and workers in the selected brick-making enterprise supported by direct observation of the production process in the shed and brick clamp. For the analysis, a number of assumptions based on data and information obtained were established (Table 1).

Data Analysis

In order to allow the comparison with small-scale traditional brick making, data analysis to determine the investment feasibility on brick making enterprise was done similar to that in Saediman *et al*. (2014). In this regard, four financial tools of decision making, namely Net Present Value (NPV), Benefit-Cost Ratio (BCR), Internal Rate of Return (IRR) and Pay Back Period (PBP) were applied (Asaduzzaman *et al*., 2011; Kadariah, 2001; Husnan and Suwarsono, 2000). Break Even Point (BEP) and sensitivity analysis were also carried out to assess the economic viability of brick production. The calculations were done at 14% discount interest rate.

Table 1. Asumptions Used in the Analysis of Financial Feasibility of Brick-making

No.	Asumption	Unit	Value or Total
1	Length of project life	Year	7
	Length of one production cycle	Day	30 days
	Number of production cycles in a year	Times	12
2	Technical indicator		
	Brick size	cm^3	5 x 10 x 20
	Percentage of breakage	%	1
3	Business scale		
	a. Production capacity per cycle	m^3	30
	b. Number of brick shed	Unit	1
	c. Size of brick shed	m^2	9 x 20
	d. Economic life of brick shed	Year	4
	e. Cost of brick shed construction	US$	567
4	Labor		
	a. Number of workers	Person	5
	b. Family labors	Person	3
	c. Paid labor	Person	2
5	Source of capital		
	a. Proportion of capital from bank credit and own fund	%	70:30
	b. Period of credit for investment capital	Year	2
	c. Period of credit for working capital	Year	1

Table 2. Details of Costs for Investment

No	Item	Cost	
		US$	%
1	Village permits	340.2	3.0
2	Land and brick shed	9,639.4	83.6
3	Machinery and generator	1,474.3	12.8
4	Tools	70.3	0.6
	Total investment	11,524.2	100.0

Information about constraints for adoption, which was obtained through open questions from all respondents, was analyzed qualitatively.

RESULTS AND DISCUSSION

Investment and operational costs

Costs for establishing brick-making enterprise consist of costs for purchasing land, building brick shed, buying tools, buying machinery and electricity generator, and obtaining village governmental permit. Total investment cost is $11,524.2. As Table 2 shows, the greatest proportion in investment cost is for purchasing land, building shed, and purchasing machinery and generator, accounting for 96.4% of the total investment.

Operational costs consist of variable and fixed costs. Variable costs consist of costs for raw material, supporting materials, and labor. There was cost for raw material because clay was obtained from own land which had been purchased at the beginning. At the same time, supporting materials consisted of firewoods and sand. Fixed costs include costs for electricity, telephone, water, moulds, and shovel. The details of start-up working capital can be seen in Table 3. The amount of initial working capital for one production cycle is $850.8. The highest component was variable costs amounting to 97.4% from the total start-up cost.

Source of Capital and Its Repayment

It was assumed that the brick producer would take loans from a local bank to meet the costs required to start and run brick production with the proportion of 70% from bank credit and 30% from own fund. The loans consisted of credit for investment and credit for working capital. Overall, the total cost was $12,375.0 which was obtained from BRI bank $8,662.5 and own capital $3.712.5 (Table 4).

Calculation of interest rate was based on that of KUR credit program at *Bank BRI* in Kendari, namely 14% p.a. flat interest rate. The loan tenor of the investment credit was two years, while that of credit for working capital was one year. Brick producer needed to pay for installments

Table 3. Start-Up Working Capital Needed for One Production Cycle

No	Cost Components	Value (US$)
A	Variable cost	829.0
1	Raw material (clay)	-
2	Supporting materials	284.6
3	Labor cost	544.3
4	Promotional and marketing costs	-
B	Fixed cost	21.8
1	Electricity, telephone and water	16.4
2	Implements consumable in a year	3.4
3	Miscelaneous costs (10%)	2.0
	Total	850.8

Tabel 4. Component and Structure of Brick Production Costs

No	Cost Item	Percentage	Amount (US$)
1	Investment cost		11,524.1
	- From bank credit	70%	8,066.9
	- From own fund	30%	3,457.2
2	Working capital		850.8
	- From bank credit	70%	595.6
	- From own capital	30%	255.2
3	Total cost		
	- From bank credit	70%	8,662.5
	- From own capital	30%	3,712.5
	Total cost		12,375.0

Table 5. Calculation of Credit Repayment ($) Per Year

Year	Principal Repayment	Interest Repayment	Total Repayment	Beginning Balance	Final Balance
Year 0				8.662,5	8.662,5
Year 1	4.629,0	1.001,6	5.630,6	8.662,5	4.033,5
Year 2	4.033,5	305,9	4.339,3	4.033,5	0,0

each month, consisting of principal and interest repayment on flat rate basis. As shown in Table 5, principal repayment was $4,629 in the year 1 and $4,033.5 in the year 2. Along with interest repayment, the total repayment in the year 1 was $5,630.6 and in the year 2 $4,339.3. Both loans were fully repaid at the end of year 2.

Costs, Revenues, and Break Even Point

Table 6 presents production costs, revenues, and BEP each year during the seven-year project period. Brick-making enterprise is profitable in the year 1 with production capacity of 80%. Net profit in the year 1 is $2,224 and profit on sales 20.6%. BEP is obtained at the level of $3,977 or equivalent with 87.7 m^3 of bricks. In the year 2 with production capacity of 100%, profit is $3,664, profit on sales 27.2% and BEP $2,266 (50.0 m^3). From year 3 until year 7, the profit and profit on sales increase and BEP improves because there is no longer credit repayment. In average, for the seven year period, annual profit was $3,644, profit on sales 27.6%, and BEP $1,942 or equivalent to 42.8 m^3 of red bricks.

As shown in Table 6, BEP in dollar sales and in unit sales every year are above their break-even figures and result in profit. This indicates that brick-making enterprise in the study area is profitable.

Feasibility of Brick-Making

The estimated values of various financial tools used to test the feasibility of investment on brick making along with the sensitivity analysis of investment under varying situations are presented in Table 6. It is evident from the

Tabel 6. Estimated Production Cost and Revenue ($) and BEP Each Year

No	Description	Year							Average
		1	2	3	4	5	6	7	
1	Total Revenue	10.778	13.472	13.472	13.472	13.472	13.472	13.472	13.088
2	Total Cost	8.162	9.162	8.856	8.856	8.856	8.856	8.856	8.800
3	Gross Revenue	2.616	4.311	4.617	4.617	4.617	4.617	4.617	4.287
4	Tax (15%)	392	647	693	693	693	693	693	643
5	Income	2.224	3.664	3.924	3.924	3.924	3.924	3.924	3.644
6	Profit On Sale	20,60%	27,20%	29,10%	29,10%	29,10%	29,10%	29,10%	27,60%
7	BEP in US$	3.977	2.266	1.471	1.471	1.471	1.471	1.471	1.942
	BEP in Unit (m^3)	87,7	50	32,4	32,4	32,4	32,4	32,4	42,8

results that under normal cost and returns situation, NPV was positive ($9,981.7) at 14 percent discount rate, IRR higher than the bank interest rate, BCR higher than unity, and PBP shorter than the life of the project. The results of all these investment criteria confirm that brick-making enterprise is financially feasible. Satisfactory financial feasibility means that, if seen from the prospect of brick-making business, producers could fully and timely repay the microcredit taken from commercial banks.

In order to check the changes in the decision criteria due to possible changes in costs and returns, the following three scenarios were applied: (i) decrease in revenue (Scenario 1), (ii) increase in variable cost (Scenario 2), and (iii) simultaneous increase in variable cost and decrease in revenue (Scenario 3). Under scenario 1 and 2, values of NPV, BCR, IRR and PBP satisfied the acceptance rules of investments. Simultaneous 11% decrease in revenue and 11% increase in variable cost result in the investment criteria still being feasible.

Barriers for the adoption of semi-mechanized brick making

Satisfactory results of financial analysis of semi-mechanized brick-making as per findings of this study are in line with that of traditional brick making (Saediman *et al.*, 2014). However, the average annual net profit of semi-mechanized brick making ($3,644) is much higher than that of traditional one ($920.6). Therefore, more traditional brick producers should have shifted to semi-mechanized brick making. However, brick producers still use the century old technologies in the brick production. As mentioned previously, only few semi-mechanized brick making units are present in the province. Given this resistance to change (Heierli and Maithel, 2008), it is important to find out the reasons for them to continuously utilize traditional practices. Based on discussions with respondents the following are identified as the barriers for the adoption of semi-mechanized technology in brick production.

Financial barrier

According to respondents, the main barrier to shift to semi-mechanized brick making is cost. This is line with the study by Asian Institute of Technology (2003) who found out that new technologies are not adopted in developing countries due to lack of resources and high initial cost. Semi-mechanized brick making requires one hundred million rupiahs and brick producers do not have financial capacity to do such changes. Producers need access to credit but banks are reluctant to provide loan to them. In addition to some characteristics of brick making such as not registered as formal entities and absence of book-keeping and business plan, reluctance of bank was related to their lack of knowledge of brick making operation and poor road conditions to brickfields. Brick producers could actually use land certificate as collateral, but banks are reluctant to accept the certificate since land price is low. Low price of brickfields is related to poor basic infrastructure and surface mining practices applied during brick production; the latter will make the soils unsuitable for agriculture and non-agricultural uses. Overall, brick making is not bankable in the eye of financial institutions.

Lack of knowledge and skills

Traditional brick making process has long been applied and brick producers have never seen the use of other technologies. The prevailing traditional technology is well known and easily implemented and hence it remains as the common practice. New and alternative brick making technologies might be available in other provinces but brick producers and workers had never experienced them. In addition, there is lack of information exchanges on the new, existing technologies available in other provinces. Therefore, they lack of knowledge and skills to implement new technologies covering manufacturing process and maintenance of machineries, and as a result, little change in the industry takes place.

Inadequate infrastructure

Basic infrastructure such as electricity, road condition, and water in the brickfield is poor. This makes the land price low, monitoring from banks difficult, and transportation of bricks difficult. Good transportation infrastructure is needed as brick making operation will produce higher volume of bricks every month.

Limited support by government and other agencies

In addition to lack of provision of basic infrastructure and poor dissemination of information regarding suitable credit schemes for brick producers, limited support from the government could be seen from the non-involvement of Research and Development organization in doing researches for the improvement of brick production (Heierli and Maithel, 2008). In view of the dominance of the present traditional brick making production, areas that could be improved through the involvement of the government, Research and Development organizations, and other stakeholders could include firing technologies, mechanization, and diversification and improvement of inputs and outputs.

Labor problem

Brick making is a labour intensive industry and most paid labors come from rural areas in other districts. They usually go back to their villages during the periods of rice planting and harvesting, and during special occasions such as religious and traditional festivals. Their return to the same brick making shed depends upon the financial deals given to them. There were some reported cases where workers were provided with advance money to attract them to come on time in the same shed, but they did not come. Since there is no certainty about the labor coming back to the same clamp next season, labor remains a huge problem in the brick making industry.

Non-difference in price

The construction industry in the province usually uses cement, steel and bricks, and the outer part of the wall is always plastered with various finishes. Since bricks are used for non-load-bearing walls which are not part of the building structure, there is no special demand for high quality bricks. Therefore, bricks produced under semi-mechanized brick making units has the same price with those produced under traditional brick making units. This situation does not provide incentives for entrepreneurs to set up semi-mechanized or modern brick making units.

CONCLUSION

This paper investigates the feasibility of semi-mechanized brick-making enterprise in Southeast Sulawesi Province, Indonesia and find out constraints for its adoption by brick producers. The study assumed that the enterprise would take microcredit from a commercial bank to cover 70% of the total cost needed, consisting of loans for investment and for working capital. With the interest rate of 14% per annum on flat basis, the enterprises can repay fully all principal and interest repayments at the end of the year 2. Cash flow analysis shows that the enterprise could generate net profit $3,644. The results of financial tool analysis show that the enterprise can generate an NPV of $9,981.7, IRR 34.57%, BCR 1.87, and PBP 3.95 years. Since NPV is positive, IRR higher than the discount rate, BCR higher than 1, and PBP shorter than economic life of the project, these results indicate that small-scale brick production is feasible. A sensitivity analysis shows that with the 10% decrease in revenue, or the 10% increase of variable cost, or simultaneous 11% decrease in revenue and 11% increase in variable cost, brick production is still feasible. Results of financial analysis show that semi-mechanized brick making provides higher return than traditional one. Factors that have inhibited the adoption of semi-mechanized technology in brick production include financial barriers, lack of knowledge and skills, poor infrastructure, limited support from government and other agencies, labor problem, and non-difference in price. Banks are recommended to proactively provide loans to help brick producers get funds for their brick-making activities, and the government and stakeholders need to take measures to solve and eliminate the identified barriers in order to promote the brick industry.

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