Production Mechanism Of Environmentally Friendly Brick Small Industry In Kalipucang Kulon Village, Welahan District, Jepara Regency, Central Java, Indonesia

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Abstract
The development of industrial distribution in Indonesia to various regions is so rapid that it is synonymous with the development of a region. One of the famous brick industries in Jepara Regency, Central Java, Indonesia is the brick industry center in Kalipucang Kulon Village, Welahan District. The existence of the industry has an influence on socio-economic life because it is the main livelihood and improves the economy. On the other hand, there has been an increase in the phenomenon of air pollution due to burning, land use change, and former soil excavation pits. This study aims to formulate procedures / mechanisms for the environmentally friendly brick industry in Kalipucang Kulon Village. The method used in this study is a *benchmarking method* to compare environmentally friendly brick practices and the SWOT method (Strenghts, Weakness, Opportunities, Threats) for strategies for handling the impact of the brick industry. The results showed that there was a gap in production procedures between existing conditions and Indonesian National Standard (SNI) 15-2094-2000 concerning Solid Red Brick for Wall Pairs at the dough kneading stage and the baking stage. Thus, a brick production mechanism is needed starting from the selection of raw materials, processing, dough mixing, molding, drying, and proper burning and strategies to increase marketing and promotion to reach a wider market and better known to the general public; (2) improve and maintain the quality of brick business; (3) implement environmentally friendly production practices with quality technology and raw materials, and (4) optimize human resources and the number of tools/machines to support the production of environmentally friendly bricks.

Keywords: bricks, benchmarking, Kalipucang Kulon, SNI, SWOT

1. INTRODUCTION

The industrial world is one of the economic pillars and has a big role so that the development of this industry becomes synonymous with developments in a region (Fonna, 2019). One of the industries that is required to pay attention to environmental issues is the brick industry (Devi &; Primasanti, 2020). Bricks are materials for wall makers consisting of clay soil that is burned until reddish in color (Sukamta et al., 2020). As the population increases, the need for shelter and the need for building raw materials (Prihatin, 2016) increases.

The famous brick industry center in Jepara Regency, Central Java, Indonesia, located in Kalipucang Kulon Village, Welahan District is included in the classification of small industries. The small brick industry became the main livelihood and absorbed labor. Each yard of his house has a pile of bricks and makes an industrial house that involves family members in making it (Wakhidah, 2020).

In contrast to the social and economic impacts, along with the increasing number of industries, there are phenomena that occur from the activities of the brick industry including land use change, brick burning smoke according to the web page (Tomorrow.io, 2023) that Welahan sub-district has an air quality index of 151 means that unhealthy air quality for sensitive groups contains several types of pollutants (dust, CO, SO2, and NO2 gas), ARI disease according to (Badan Pusat Statistik, 2017) in Welahan sub-district which is 169 people (16.3%), and former earthen excavation pits that threaten environmental damage. Not a few business actors do not pay attention to the technical provisions of the manufacturing process according to the established standards, namely SNI 15-2094-2000 on (Badan Standarisasi Nasional, 2000) because the tools used are still simple and labor involves family members.

The production process of the brick industry in Kalipucang Kulon Village still uses conventional methods in contrast to Magelang Regency/City, Sleman Regency, Karanganyar Regency, and Aceh Regency which have used environmentally friendly formulations and procedures. Therefore, alternative brick production processes and strategies for handling social,

economic, environmental, and institutional impacts are needed.

2. RESEARCH OBJECTIVES

The purpose of this study is to formulate procedures / mechanisms for environmentally friendly small brick industry in Kalipucang Kulon Village with the target of (1) formulating a comparison of existing conditions, brick practices of other regions, and Indonesian National Standard (SNI) 15-2094-2000 concerning solid red bricks for wall pairs (2) the development of strategies for handling the impact of environmental, social, economic, and institutional aspects with a SWOT analysis approach (Strenghts, Weakness, Opportunities, Threats).

3. RESEARCH METHODS

a. Location and Time

The research location is the brick industry in Kalipucang Kulon Village, Subdistrict, Welahan, Jepara Regency, Central Java, Indonesia. Kalipucang Kulon Village has an area of 2.35 km^2 and there are 9 RT and 3 RW. The research period will be from May to June 2023. The administrative map of Kalipucang Kulon Village is shown in **Figure 1.**

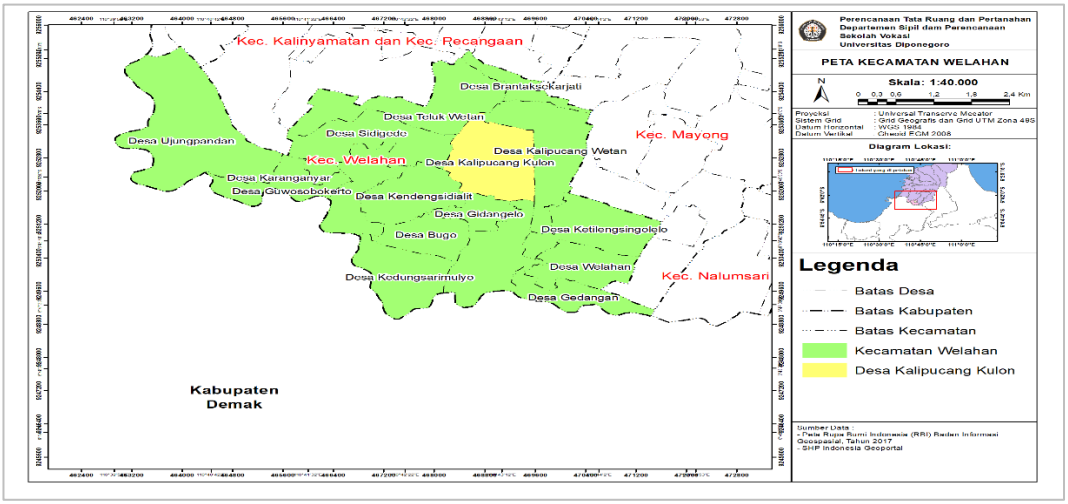


Figure 1. Administration Map of Kalipucang Kulon Village (Source*:* Badan Informasi Geospasial/BIG, 2017)

b. Analytical Materials and Methods

The main material in this study is a small brick industry in Kalipucang Kulon Village. The data used are existing conditions and based on previous research studies. The methods developed are benchmarking analysis and SWOT analysis (Strenghts, Weakness, Opportunities, Threats). The field survey was conducted by reviewing the manufacturing procedures and impact of the brick industry accompanied by interviews of industry owners and residents around the neighborhood.

4. RESULTS AND DISCUSSION

Comparison of existing conditions with standards (SNI 15-2094-2000) and environmentally friendly brick industry practices is an important step to identify gaps and evaluate improvements to improve product quality, protect the environment, maintain work safety, and be able to produce competitive products.

a) Comparison of Existing Conditions and SNI 15-2094-2000

Comparison by identifying criteria variables and benchmarking partners between existing conditions and environmentally friendly brick practices in **Table 1.**

Table 1. Brick Procedure Benchmarking Analysis

Benchmark-ing	Kalipucang Kulon VillageJepara Regency	Regency/ Magelang City	Sleman Regency	Karanganyar Regency	Aceh Regency	SNI 15-2094-2000
Selection of raw materials	Raw materials clay, sand, water, and rice husk ash	Raw materials clay, lime 4%, sand 8% and water a small amount.	Cow dung waste (30%), clay (70%), water.	The main raw material is blotong (sugarcane waste).	Soil raw materials, waste (rice husk ash and oil palm empty bunch ash, cement, sand)	Raw materials clay, sand, water, and rice husk ash
Processing	Clay and sand raw materials are separated from gravel by sifting	Mix loam soil with water a little. The mixture is supplemented with chalk	Mixing cow dung waste materials, clay, and water in a dough container	Mixing blotong, sand, and rice husk ash	Mixing raw materials added water	The clay and sand are then treated and sifted to obtain the right consistency and fineness

Benchmark-ing	Kalipucang Kulon VillageJepara Regency	Regency/ Magelang City	Sleman Regency	Karanganyar Regency	Aceh Regency	SNI 15-2094-2000
Stirring Dough	Mixing soil, sand, and rice husk ash in the ground	Mixing soil, water, lime and sand in a container	Mixing cow dung waste materials, clay, and water in a dough container	Mixing blotong, sand, and rice husk ash.	The quality of the dough is getting bigger rice husk ash (25% and 30% require 700 ml of water	Mixing raw materials in the right proportions in dough containers.
Pressing	Manual pressing using a printing tool with a size of 20x10x5 cm	Manual pressing using a printing tool with a size of 20x10x5 cm	Manual pressing using a printing tool with a size of 20x10x5 cm	The bricks are molded to resemble the letter "Z" so that they have a stronger hook (earthquake resistant)	Pressing with a size of 22.5 x 11 x 5.5 cm	Brick mold size with standard size 20 x 10 x 5 cm.
Drying	Drying with sunlight for 2-7 days	Sun drying	Sun drying	Sun drying	Sun drying for 4 days	Sun/Drying Oven
Burning	Fuel of firewood and rice husks (brambut) is fed into the kiln	Non-burn (addition of lime and sand)	Fuel of firewood and rice husks (brambut) is fed into the kiln	Fuel of firewood and rice husks (brambut) is fed into the kiln	Non-burning	Baking oven
Selection/Selection/Quality testing	Breaking/cracked brick separation	Short production time 2-4 weeks, compressive strength grade 25 or 2.5 N/mm	From the results of the hardness test, it can be seen that the average compressive strength value of 7.2 kg / cm^2 still does not meet the min standard of 25 kg / cm^2	Pemisahan batu bata yang pecah/retak	Highest compressive strength 6.14 Mpa, fracture strength 1.50 MPa, specific gravity 1.60 gr/cm3, porosity 18.65 %, moisture content 7.98 %	Measurement of dimensions, compressive strength, water absorption, and other properties in the standard.

Source: Analysis Results, 2023

The results of the analysis that have been obtained with the company's partners are used to increase the production of environmentally friendly bricks and develop the findings as a competitive advantage. The production of red bricks is carried out in three stages including pre-production, production, and post-production stages. There is a gap at the production stage, namely kneading the dough does not use a machine and conventional combustion so that it has an impact on combustion smoke. Therefore, the strategy to increase the production of environmentally friendly bricks in Kalipucang Kulon Village is as follows:

I. Selection of alternative raw materials using waste materials, environmentally friendly, affordable, and effective.
II. Processing and kneading dough using modern technology with the help of tools / machines.
III. Molding bricks with latest models or stronger "Z" shape is earthquake resistant.
IV. Drying using a drying oven.
V. Selection of combustion alternatives using reverse furnaces or combustion ovens and non-combustion alternatives by adding a mixture of materials for hardening at certain proportions such as the addition of sand, rice husk ash, and other alternatives.
VI. Selection and quality testing adjusted SNI 15-2094-2000.

Thus, in the industrial production of environmentally friendly bricks it is necessary to improve, repair and adapt to maintain quality and create competitive advantages.

b) Procedure/Mechanism of Industrial Production of Eco-Friendly Bricks

The eco-friendly red brick production procedure consists of three stages as follows:

1. Pre-Production Stage

The stage of selection of raw materials according to SNI is clay, sand, rice husk ash and water. For environmentally friendly brick making with alternative waste materials available such as cow dung, *blotong* (sugarcane waste), agricultural waste, recycled plastic and so on.

2. Production Stage

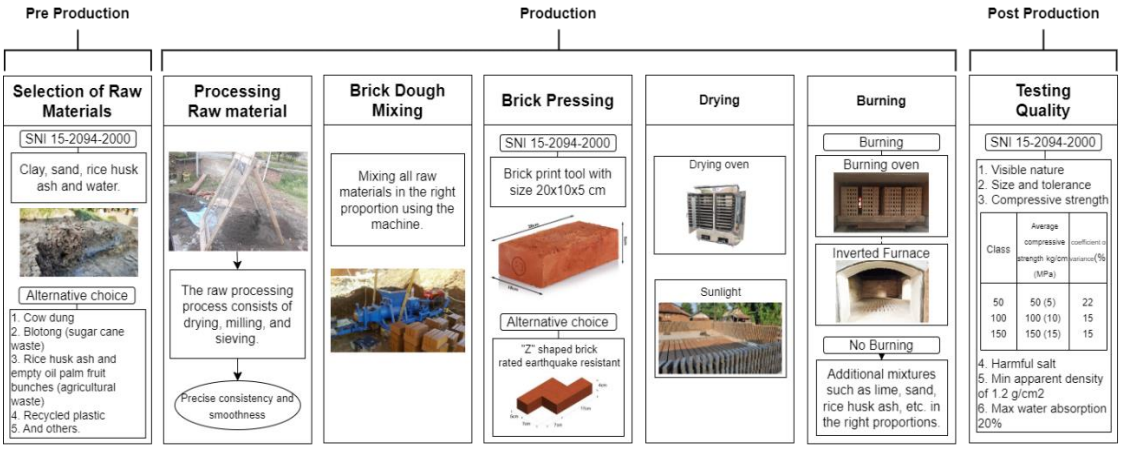
The production stage is divided into several manufacturing steps as follows.

a- Processing of raw materials, sorting gravel from clay and sand by sieving process.
b- Stirring raw materials, using machine technology.

c- Pressing, using a printing tool size 20 x 10 x 5 cm.
d- Drying, using faster using a drying oven so that the temperature is evenly distributed compared to sunlight depending on the weather.
e- Combustion, using a combustion oven and an inverted furnace to ensure the temperature is evenly distributed and does not pollute the environment.

3. Post-Production Stage

The quality testing stage of red bricks to be ready for distribution needs to be carried out quality tests based on visible properties, size, compressive strength, harmful salts, apparent density, and water absorption.



Picture 2. Environmentally Friendly Red Brick Production Mechanism (Source: Analysis Results, 2023)

c) Strategies For Handling the Impact of Small Brick Industry

The existence of a small brick industrial center in Kalipucang Kulon Village has a positive impact on the socio-economic community but on the other hand causes environmental pollution. In addition, over time some brick industries have decreased in number after the Covid-19 pandemic due to expensive raw materials and competition with various other types of industries.

The survival of the brick industry business in Kalipucang Kulon Village is certainly influenced by the strategy in maintaining its business to be able to compete in the midst of economic and cultural developments. As for analyzing strategies for handling social, economic, environmental, and institutional impacts using SWOT analysis. SWOT analysis is one of the research methods used to evaluate internal factors including *strengths and* weaknesses, as *well as external factors including opportunities and threats*. SWOT analysis is a strategic planning instrument that provides a simple way to estimate the best way to determine a strategy (Fatimah, 2020). The steps in conducting a SWOT analysis are as follows:

1. Analysis of Internal and External Strategis Factors

Internal Strategic Factor Analysis (IFAS) and External Strategic Factor (EFAS) determine the weighted value, score value by generating the sum of the total internal factor values and the total value of external factors. The scores of weights and scores were obtained from interviews with the Welahan Sub-District Apparatus and Kalipucang Kulon Village Government.

Weight criteria and scores according to (Purwasanti, 2015), that weights determine the importance of factors on a scale of 0.0 (not important) to 1.0 (very important). Meanwhile, the score determines the level of influence of the factor, namely the score value of 1-4. Strength and opportunity factor scores of 1 (weak), 2 (medium), 3 (strong), and 4 (very strong) support planning. Inversely proportional to the description of the score of weakness and threat factors of 1 (very strong), 2 (strong), 3 (medium), and 4 (weak) hindered planning.

Internal factor analysis consists of strengths and weaknesses by determining the value of weights, score values, and average weights in **Table 2**. From the calculation results above, the total average value of the strength factor is 1.85. Meanwhile, the total average value of the consideration of *weakness factors* is 0.73 so that the total value of internal strategic factors (IFAS) is the sum of strength factors and weakness factors obtained a value of 2.58.

In the analysis of external factors consists of opportunities and challenges by determining the value of weights, score values, and average weights in **Table 3.** The total average value of the opportunity factor is 1.43. Meanwhile, the total average *value of threat factor consideration* is 0.86 so that the total value of external strategic factors (EFAS) is the sum of opportunity factors and threat factors obtained a value of 2.29.

Table 2. Internal Factor Strategy (IFAS) for Handling the Impact of the Brick Industry

Key Internal Factors	Weight	Score	Average Weight
Strengths			
1. Job creation	0,23	4,00	0,92
2. Local economic contribution	0,08	3,00	0,23
3. High grade brick quality	0,15	3,00	0,46
4. Skills development	0,08	3,00	0,23
Sub Total			**1,85**
Weaknesses			
5. Air pollution	0,23	1,00	0,23
6. Respiratory Disease	0,15	2,00	0,31
7. Damage to public infrastructure	0,08	2,50	0,19
Sub Total			**0,73**
Total	**1**		**2,58**

Source: Analysis Results, 2023

Table 3. External Factors Strategy (EFAS) for Handling the Impact of the Brick Industry

Key External Factors	Weight	Score	Average Weight
Opportunities			
1. Some Industries Are Starting to Use Machines	0,14	4,00	0,57
2. Cooperative Formation	0,21	2,00	0,43
3. Reforestation (Greening)	0,14	3,00	0,43
Sub Total			**1,43**
Threats			
4. Competition with Other Types of Industries	0,14	2,50	0,36
5. Expensive Raw Materials	0,21	1,00	0,21
6. There has been no action from the relevant institutions	0,14	2,00	0,29
Sub Total			**0,86**
Total	**1**		**2,29**

Source: Analysis Results, 2023

2. Analysis of the Matrix of Internal and External Strategis Factors

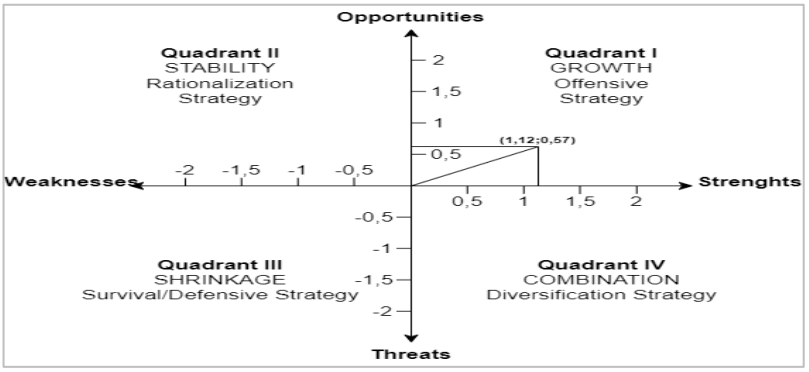
The results of the calculation of weights with the internal strategic factor score (IFAS) and external strategic factor (EFAS) of the brick industry are used for the SWOT matrix by determining the x and y values. The internal factor (X) by subtracting the strength and weakness factors produces the value of X. Meanwhile, the external factor (Y) by subtracting the opportunity and threat factors resulted in the value of Y. shown in **Table 4.** Calculation of Internal Value and External Value.

Table 4. Internal and External Value Calculation

Internal Factors	Internal Factors
X = Strengths - Weaknesses	Y = Opportunities- Threats
X = 1,85 - 0,73	Y = 1,43 - 0,86
X = 1,12	Y = 0,57

Source: Analysis Results, 2023

The results of the calculation of internal and external values in **Table 4.** obtained X value which is 1.12 and Y value which is 0.57. The results of this calculation are used to determine the position of the impact management strategy in **Figure 3.**



Picture 3. SWOT Quadrant *(***Source:** Analysis Results, 2023)

The positioning of the strategy for handling the impact of the brick industry based on the results of internal and external calculations is at the point (1.12; 0.57), this point is in quadrant I, namely the growth of the offensive strategy. This position is a favorable condition where you can take advantage of internal potential by utilizing existing external opportunities.

3. Develop Alternative SWOT Strategies

In determining the chosen strategy adjusted to the results of the analysis on the SWOT diagram, the quadrant obtained in **Figure 3.** showing quadrant 1 means the growth of an offensive strategy that utilizes strengths and *opportunities* or a SO (*Strenght-Opportunity*) strategy. Alternative strategies for addressing environmental, social, economic, and institutional impacts formulated from a combination of strength (S) and opportunity (O) factors are shown in **Table 5.**

Table 5. Alternative Strategies for Handling the Impact of the Brick Industry

Internal Factor / **External Factor**	**STRENGTH (S)**
	1. Job creation
	2. Local economic contribution
	3. High grade brick quality
	4. Skills development
OPPORTUNITY (O)	**STRATEGI SO**
1. Some Industries Are Starting to Use Machines	**1. Improve marketing and promotion to reach a wider market and better known to the general public (S1-S2-O2)**
2. Cooperative Formation	**2. Improve and maintain the quality of brick business (S2-S3-S4-O4)**
3. Reforestation (Greening)	**3. Implementing environmentally friendly production practices with quality technology and raw materials (S3-S4-O1)**
	4. Optimizing human resources (HR) and the number of tools/machines to support the production of environmentally friendly bricks (S4-O1)

Source*:* Analysis Results, 2023

5. CONCLUSION

(i). Comparison of existing conditions, brick practices, and SNI 15-2094-2000 red brick production is carried out in three stages including pre-production, production, and post-production stages. There are gaps at the production stage, namely dough mixing and burning

(ii). The impact management strategy is located in quadrant 1 with the value (x,y) which is (1.12; 0.57), meaning SO (Strenght-Opportunity). Thus, the strategies needed for the brick industry of Kalipucang Kulon Village are (1) increasing marketing and promotion to reach a wider market and better known to the general public; (2) improve and maintain the quality of brick business; (3) implement environmentally friendly production practices with quality technology and raw materials, and (4) optimize human resources (HR) and the number of tools/machines to support the production of environmentally friendly bricks.

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