Increasing productivity in SMEs Samiler crackers by implementing appropriate technology

A D Witjaksono¹*, A Susanti² and A Frianto¹

¹ Department of Management, Faculty of Economics, Universitas Negeri Surabaya, Ketintang, Surabaya, 60231, Indonesia
² Department of Civil Engineering, Faculty of Engineering, Universitas Negeri Surabaya, Ketintang, Surabaya, 60231, Indonesia

*andredwijanto@unesa.ac.id

Abstract. This study was conducted on Small and Medium Enterprise (SMEs) Samiler crackers in Indonesia and aims creating designs of hygienic steamer and a scraper as well as testing the tools in order to ensure their performance, determine standard time, standard output, and piece work rate as the basis for designing incentive-giving policies. By using tools designed with appropriate technology such as stainless steel based material and using gas as production fuel, production capacity as well as the hygiene in production process can be optimized. The increase in productivity occurred at a decrease in processing time for scraping machines by 75%, increased production capacity by 300%, decreased fuel consumption costs by up to 43%, decreased processing time for steam engines up to 60%. The calculation results also indicate if the operator produces more than five products, it will get wages plus incentives of 1,049 IDR per additional product produced. Communication in designing the tools to meet the needs and function in the use becomes the key to secure the success in increasing productivity of SMEs. More broadly, the synergy between the government, universities and other stakeholders is believed to strengthen the position of SMEs at the national and even international level.

1. Introduction

Undeniably, SMEs have proven their ability to survive in economy crises by showing the growth both in management and numbers [1]. It is understandable as the low diversification levels of products and few downsizing options, so the effects will be relatively homogeneity compared to dependency of overall world economy in global market [2]. Similarly in Indonesia, during the economic crisis of 1998, the productivity of SMEs had increased and had better resilience than big companies. This was because SMEs were more independent especially in the both formal markets and credit, so the response in facing sudden changing was more quickly and flexibly than bigger companies [3]. However, it did not mean that SMEs did not have any weaknesses. Some of the main obstacles faced by SMEs in Indonesia are competition barriers, financial access, price of energy, technology, inefficient production cost, economic factors, management skills, process, limitation of sales, and raw materials [4]. Due to this condition, in the production, SMEs give also less concerned in the environmental aspects [5–7].

Based on the Law of the Republic of Indonesia Number 20 Year 2008 article 6 mentioned that SMEs have criteria as below.
Table 1. Criteria of Small Medium Enterprises.

| No | Type of business | Net Capital (excluding land and building of business premises) (IDR) | Annual Sales (IDR) |
|----|-----------------|---------------------------------------------------------------|-------------------|
| 1  | Micro           | ≤ 50,000,000,-                                                | ≤ 300,000,000,-   |
| 2  | Small           | 50,000,000 to 500,000,000,-                                  | 300,000,000,- to 2,500,000,000,- |
| 3  | Medium          | 500,000,000,- to 10,000,000,000,-                            | 2,500,000,000,- to 50,000,000,000,- |

Source: [8]

From the table above, it can be concluded that micro business has net capital less than 50,000,000 IDR with annual sales less than 300,000,000 IDR; small business with net capital between 50,000,000 to 500,000,000, - IDR and annual sales between 300,000,000 to 2,500,000,000, - IDR; and medium-sized businesses with net capital of 500,000,000 to 10,000,000,000 and annual sales of 2,500,000,000, - to 50,000,000,000, - IDR. All net capital does not include land and building of business premises.

Many studies showed that the increase in business activity of SMEs is directly influenced by technology innovation [9–12]. Technology innovation enables the increase in product quality as well as production time which affect to overall organization performance.

Until 2013, the number of SMEs in Indonesia had reached 57.89 million units (99.99%), while the number of big companies had been 5.066 units (0.01%). SMEs contribution in creating employment was equal to 97.16% and to national GDP was equal to 58.65% [13]. It proved that SMEs have a significant role in Indonesian economy.

A number of SMEs raise a high competition level in the market, in which encouraging the SMEs actors to improve the quality and value of their products, so as they possibly compete both in national and in global markets. Appropriate technology has an important role to produce competitive products. The role of appropriate technology is also important to improve the SMEs performance and to solve the issues involved in producing qualified products [14]. Introducing appropriate technology supported by adequate human resources is expected to be able to produce qualified products and to strengthen the market as well as gain better profits.

Appropriate technology introduced to SMEs is applicable technology which is easily operated and is low maintenance cost. Availability of appropriate technology should be designed with focusing on environmental, cultural, social, and economic aspects of society. Considering to those conditions, appropriate technology needs low sources, maintainable, low production cost, and labor intensives, as well as utilizes local sources and labors and also more environmental friendly than sophisticated technology in modern industries [15]. Thus, appropriate technology refers as better and more efficient way to solve issues in productivity considering developmental growth and absorption of society.

Developing appropriate technology-based equipment, has better to use stainless steel material as it is capable solve corrosion problem which is as main concern in food industries as well as in many other industries [16]. Furthermore, there are six main reasons in using stainless steel for the food and dairy industry, including corrosion resistance, durability; fabrication easiness; heat resistant; ability to keep taste and color; as well as cleanliness.

In developing countries, especially in rural areas, 2.5 billion people rely on biomass, such as fuelwood, charcoal, agricultural waste and animal waste, to meet their energy needs for cooking. These resources account for more than 90% of the energy consumption coming from households [17]. In the end, the goal of appropriate technology is to improve living standards for developing countries without causing environmental damage.
In Indonesia, rural community empowerment is conducted by implementing and developing appropriate technology to encourage, to grow, to improve, and to develop economy, to level upstate development, as well as to alleviate poverty [18]. Based on those notions, SMEs need a hygienic, effective, and efficient equipment innovation which possibly increase its productivity as well as considers the environmental aspect. The presence of innovations in more hygienic equipment through appropriate technology, also requires further analysis in relation to the resulting productivity including the most ideal worker wage setting. An approach that can be used to analyze and improve productivity is a work study technique [19,20]. Work study in general can be distinguished from two aspects; if reviewed from how to improve methods of productions, then this becomes part of the method study. When it comes to aspects of human effectiveness assessment, it is part of the work measurement (time study) [19]. Work measurement is concerned with determining the length of time that should be take to complete the job [21]. Further states that standard time is the amount of time that qualified workers should take specific tasks, working on a sustainable level, using certain methods, tools, and equipment, raw material input, and workplace settings.

The study conducted in SMEs that produce Samiler crackers in Indonesia showed that the SMEs need production efficiency and how to improve productivity, the proper technology in production process, especially the steamer because they use traditional tools which use firewood as fuel. In addition, scrapping process also has issue due to the unstable electricity. This study aims 1) creating designs of hygienic steamer and a scraper using fuel for limited electrical power; 2) testing the tools in order to ensure their performance as well as to assess their productivity improvements; 3) determine standard time, standard output, and piece work rate.

2. Methodology

This study is applied research conducted on SMEs Samiler crackers in Pasuruan, East Java, Indonesia. Applied study aims to provide information which can be directly applied/implemented in the real world [22]. Research design is action research, due to systematical procedure conducted by researchers to collect data both quantitative and/or qualitative to aid their control [23]. Further, this study can be identified by involving practitioners as researchers, and focusing on real issues locally. This study is a practical action research because it aims to examine specific professional situations by looking towards the improvement of existing practices, involving small-scale research projects, narrowly focusing on a particular issue, and being conducted by practitioner or team in a certain setting. We also use time study technique to analyze standard time, output time and piece work rate for dough molding production process.

2.1. Equipment development

Data obtained from the observations on the current production process are recorded, as well as the results of in-depth interviews on SMEs owners as data sources. The time of the production process for the scraping and steaming phase, the production capacity of scraping and steaming, the fuel usage cost, the frequency of each production process, and the raw material requirements will be recorded and analyzed for increased productivity and efficiency. The constraints faced are also explored more deeply with interviews including the availability of power resources, the availability of raw materials, the cleanliness of equipment, etc.

2.2. Work measurement

The steps in conducting the time study are as follows:
In this study, it has been determined that the dough molding will be analyzed because it determines the quality of the semi-finished products and is more handled by humans. In the process, this task is divided into three elements, namely placing the base for the mold, put the dough in the mold and molding the dough, and clean the mold and place the molded product into the space provided. After recording the time of observation of each element with 12 times replication, then calculated data adequacy with the formula as follows [24]:

\[
N' = \frac{c}{S\sqrt{\frac{N(\sum x_i^2) - (\sum x_i)^2}{\sum x_i}}} 
\]

\( c = \text{constant; we use 2 for 95\% confidence level (cl)} \)
\( s = 1 - \text{cl} = 1 - 0.95 = 0.05 \)
\( N' \text{ should } \geq N \)

To calculate the observed time, normal time and standard time we use the formula [21]:

**Figure 1.** The steps of time study.
1) Observed Time (OT):

\[ OT = \frac{\sum x_i}{N} \]  

Where:

- \( OT \) = Observed time (second)
- \( \sum x_i \) = Sum of recorded times
- \( N \) = Number of observations

2) Normal Time (NT):

\[ NT = OT \times PR \]  

Where:

- \( NT \) = Normal time (hours)
- \( PR \) = Performance rating (we use The Westinghouse Rating System [25])

3) Standard Time (ST):

\[ ST = NT \times AF = NT \times \frac{1}{1-%allowance} \]  

Standard Output = \( \frac{1}{ST} \) (units/hour)

Where:

- \( ST \) = Standard time (hours/unit)
- \( AF \) = Allowance factor

4) Piece Work Rate (PWR):

\[ PWR = \text{Hourly Basic Wage} \times \frac{1}{\text{standard output}} \]  

Where:

- \( PWR \) = Piece Work Rate (IDR)

3. Results and discussion

Samilcr cracker is one of the traditional foods that are mostly available in ready-to-fry form. Many urban communities are not yet familiar of this food product. Samiler crackers are mostly produced by SMEs in rural areas with simple equipment. One of Samiler crackers producing areas is located in Pasuruan caused by the abundance of cassava as the main raw material. At present, the price of unfried Samiler per kilogram is about 10,000 IDR within the price of cassava 1,500 IDR per kilogram. The SMEs are capable to produce 40-50 kg Samiler made from 45-50 kg of cassava daily, yet, Samiler crackers production has still not been fully able to meet market demand. In addition to unfried Samiler, the market demands ready-made Samiler crackers. However, this demand is unable to meet because of the limited production capacity of raw Samiler, so the production to prepare ready-made Samiler is lack of manpower and processing time. In fact, ready-made Samiler crackers possibly increase the profit up to 50-70 percent. Furthermore, cassava as raw material can be easily are collected from local farmers, so the continuity of raw materials supply is assured. Within 30 days of production, in the average, SMEs can produce 1.2-1.5 tons of Samiler crackers with production conventionally done by 8-10 workers daily and with workers are women aged 30-40 years. Therefore, the production process and the potential waste generated from Samiler crackers are seen in Table 2.
Table 2. Stage in production process and potential generated waste in Samiler crackers.

| No | Production Stage | Process  | Waste                                                                 |
|----|------------------|----------|----------------------------------------------------------------------|
| 1  | Peeling          | Manually | Cassava skin is bought by cattle raiser used as animal foods         |
| 2  | Washing          | Manually | Wastewater                                                            |
| 3  | Scrapping        | Manually | Small scale of cassava                                                |
| 4  | Seasoning        | Manually | None                                                                  |
| 5  | Shaping          | Manually | None                                                                  |
| 6  | Steaming         | Manually | Traditional steamer is not made from stainless steel                  |
|    |                  |          | Using firewood as fuel.                                               |
| 7  | Drying           | Manually | None                                                                  |
| 8  | Packaging        | Manually | None                                                                  |

Table 2 shows that steaming process does not use stainless steel steamer, yet it uses the traditional steamer with fire fuel (see Fig. 1). This can not only potentially damage environment, but also unhygienic as the black smoke highly possibly falls into the products during scrapping and seasoning. In scrapping, 40 minutes per 8 kilograms cassava is needed and 25 minutes for each steaming process.

Figure 2. Steaming process with traditional steamer using fire fuel.

Another problem is a solvent that uses a motor with high electrical power considering for SMEs. To overcome this problem, the solvent is designed with two machines; one uses fuel resources to solve power limitation, and two uses gas-fueled steamers. Both use stainless steel base material for hygienic purpose. The design of both machines is shown in Figure 3 and Figure 4.

Figure 3. Design of scraper machines.

Notes:
1. Chopper knives
2. In (material chopped)
3. Out (material chopped)
4. Chopping knives Motor
Figure 4. Design of steamer machines.

By operating the designed machines, the production results are seen in Table 3.

Table 3. Comparison of Productivity of Scraping Machine Before and After Trial.

| Production Activity                      | Scraping Machines |
|------------------------------------------|-------------------|
|                                          | Before            | After             |
| Production time (8 kilogram cassava)     | 40 Minutes        | 10 Minutes        |
| Production capacity                      | 12 Kg per hour    | 48 kg per hour    |
| Fuel                                     | Firewood          | LPG 3 kg         |
|                                          | (600,000 IDR/month) | (20 tube, 340,000 IDR/month) |
| Production process                       | 4 times           | twice             |
| Raw materials                            | 45 – 50 kg/day    | 45 – 50 kg/day   |
|                                          | (48 kg for 4x processes) | (96 kg for 2x processes) |
| Electricity/ Gas Fuel                    | 1/6 pk, 200 watt  | 2 liter per 2 hours |

Table 4. Comparison of productivity of steamer machine before and after trial.

| Production Activity | Steamer Machines |
|---------------------|------------------|
|                     | Before           | After             |
| Production Time     | 25 Minutes       | 10 Minutes        |
| Total racks         | 6 rack /12 per each | 6 rack /16 per each |
| Result              | 2.5 Kg for 72 Samiler | 3.3 Kg for 96 Samiler |

Table 3 shows that with the same ingredients of 8 kg, the scraping time decreases by 75% (only needs 10 minutes), the production capacity increases by 300% (from 12 kg to 48 kg per hour), and fuel consumption cost decreases by 43% (changing from firewood to gas). For the productivity of the steaming machine, processing time decreases by 60% (from 25 minutes to 10 minutes), and the shaping process increases from 72 to 96 pieces. By eliminating the lack of applying appropriate technology and low financing, has proven the increasing productivity of SMEs [26]. The more encouraging result is that the process becomes more hygienic because all the tools use stainless steel, thereby avoiding raw materials from corrosion. In addition, the conversion of fuel wood to gas makes air pollution more viable as well as it helps the government succeeding in the environmental sustainability program and uncontrolled illegal logging as UNHCR feared [27].

From the observation of each element of the production process, the time recorded then calculated each of N’ of each element. Unlike the study done by [28], we use constant 2 because it uses 95% level of confidence with 5% significance, so obtained the ratio of c/s equal to 40 and not 20.
Table 5. The observation time of each element uses a stop watch.

| ELEMENTS                                | Observed Time (second) | N'   |
|-----------------------------------------|------------------------|------|
| 1 Placing the base for the mold         | 5.91 6.19 10.91        | 85.59|
|                                         | 7.57 12.28 8.03        |      |
|                                         | 7.75 11.47 9.88        |      |
|                                         | 7.43 9.78 11.53        |      |
|                                         | 11.53 11.87 15.22     |      |
| 2 Put the dough in the mold and molding | 15 16.25 16.53         | 35.34|
| the dough                               | 12.57 11.28 13.57     |      |
|                                         | 12.25 10.28 14.78     |      |
|                                         | 15.31 19.85 17.5      |      |
| 3 Clean the mold and place the molded   | 13.84 13.32 15.86     | 20.13|
| product into the space provided         | 15.28 17.5 14.33      |      |
|                                         | 17.68 15.69 15.25     |      |

Performance Rating:
1. SKILL: 0.06
2. EFFORT: 0.12
3. CONDITION: -0.03
4. CONSISTENCY: 0.03
Total Performance rating = 0.18

Performance Rating used is PERFORMANCE RATINGS SYSTEM WESTINGHOUSE TABLE

Normal Time = Average Time Total of each Work element x Performance Rating
= 544.2986 second
= 0.151194 hours

Allowance = Allowance time for permitted employees (in this case, the allowance assumption is 30 minutes for personal needs, 20 minutes delay, and 15 minutes fatigue)

Total Allowance = 65 minutes
If it is assumed 1 shift = 8 hours = 480 minutes,
Then the allowance percentage = 65/480 = 13.54 %, so:

Standard Time = 0.151194 x \( \frac{1}{1-13.54\%} \)
= 0.1748 (hours/unit)

Standard Output = \( \frac{1}{5.718} \) (units/hour)
= 5.718 (unit/ hours)

If we assumed Hourly Basic Wage = 6,000 IDR, then:
Piece Work Rate = Hourly Basic Wage x \( \frac{1}{standard \ output} \)
= 6,000 x \( \frac{1}{5.718} \)
= 1,049 IDR per unit

Based on these calculations, we can develop a basic wage and incentive plan as follows.
### Table 6. Calculation of wage and incentive plans.

| Unit Output Per Hour | Basic wages and / or incentives | Wages received per hour |
|----------------------|---------------------------------|-------------------------|
| 1                    | Basic wage                      | 6,000                   |
| 2                    | Basic wage                      | 6,000                   |
| 3                    | Basic wage                      | 6,000                   |
| 4                    | Basic wage                      | 6,000                   |
| 5                    | Basic wage                      | 6,000                   |
| 10                   | Basic wage + Incentives         | 6,000,- + [(10 – 5) x 1,049] = 11,245,- IDR |
| 80                   | Basic wage + Incentives         | 6,000,- + [(80 – 5) x 1,049] = 84,675,- IDR |

The table above shows that if each operator is able to produce less than or equal to 5,718 ~ 5 products per hour, then the operator will get a regular salary of 6,000 IDR. However, if the operator is able to produce more than 5 products, the operator will earn wages plus incentives of 1,049 IDR per additional product produced.

### 4. Conclusion

The results show that the application of appropriate technology (scraping machine and steamer machine), can increase productivity. Scraping time decreases by 75%, the production capacity increases by 300%, fuel consumption cost decreases by 43%, processing time for steaming machine decreases by 60%, and the shaping process increases from 72 to 96 pieces. In addition, through the time study, obtained the standard output of 5,718 ~ 5 products per hour. These results can be used as a basis for incentives of 1,049 IDR per additional product generated by the operator. However, it is highly dependent on SMEs how able it is to provide basic wages through wage and incentives plans. Involving SMEs actors in this study as research team give influential effect on the success in increasing productivity. Decreasing production time will certainly allow the SMEs to meet market demand which previously unfulfilled. In addition, consumers will certainly add more value as the product is more hygienic by using stainless steel-based machinery, so those certainly increase consumer interest to buy the product. In general, implementing appropriate technology will provide the best results for SMEs. Hence, by involving SMEs in the study, practicality is well referred not just theory. The Government in both central and regional, universities and other stakeholders need to synergize to develop and strengthen the SMEs in Indonesia.

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