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Preservation, production, and packaging optimization in SMEs: A study on 'Keripik Lumba-Lumba'

Ismianti Ismianti [1]*, Ibnu Fahrul Rahman [1], Amorette Garnetta Lasmana [1], Eka Nur Anisah[1]
[1] Industrial Engineering Department, Universitas Pembangunan Nasional Veteran Yogyakarta, Jl. Babarsari Jl. Tambak Bayan No.2, Janti, Caturtunggal, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55281, Indonesia

***Corresponding Author**: ismianti@upnyk.ac.id

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ABSTRACT

'Keripik Lumba-Lumba' is a Small and Medium-sized Enterprise (SME) that specializes in the production of cassava chips and banana chips. This SME faces several problems such as raw material shrinkage due to shipping, double work, and different product shelf life between each distributor. This research designed a solution to the problems in the SME with shelf-life preservation, job design, and new packaging design. A truck equipped with a temperature control system was designed to prevent the banana raw materials from rotting during transport. Wooden boxes were also provided in the truck for separating containers, these wooden boxes were lined with a solid mixture of KMnO4, clay, and ash. To solve the problem of the production process within 'Keripik Lumba-Lumba', the job design system can be changed to schedule and allocate employees according to their respective tasks. On the issue of shelf life difference between convenience stores and distributors, the packaging material for distributors can be changed from plastic to aluminium foil. This will allow 'Keripik Lumba-Lumba' to continue to grow with the application of technology in the process of delivery, storage, packaging as well as changes in the work system.

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1. INTRODUCTION

Small and Medium Enterprises (SMEs) play a significant role in enhancing a country's economic growth. The participation of SMEs in driving economic development can be seen through job creation and the increase in national income, as measured by the Gross Domestic Product (GDP). According to World Bank GDP data, there has been an increase over the past five years, reaching $1,319.1 billion USD in 2022. Based on data from Bank Indonesia in the second quarter of 2023, the Manufacturing Industry, Wholesale and Retail Trade, and Transportation sectors have contributed to the positive growth of the country's GDP. Therefore, the presence of SMEs in Indonesia can help achieve the Sustainable Development Goals (SDGs), particularly in the economic aspect. One such SME in Malang City engaged in the snack food processing industry is Keripik Lumba-Lumba which contributes to the local economy.

"Keripik Lumba-Lumba" SME located in Jatirenggo, Talok, Turen District, Malang Regency, East Java, is involved in the food industry, specifically the production of cassava and banana chips. The SME applies a

Make to Order (MTO) system, which involves producing a product based on customer orders. This production approach provides flexibility in dealing with buyers or distributors.

The raw materials for "Keripik Lumba-Lumba" SME are sourced from independent farming and local farmers. However, the supply of raw materials for banana chips comes exclusively from local farmers. The four main suppliers of bananas are located in the southern coastal region and East Nusa Tenggara. There is an issue with the supply of raw materials for banana chips due to a decrease in the quantity of supply. The cause of this problem is the ripening of bananas during distribution.

The presence of "Keripik Lumba-Lumba" SME has created employment opportunities in the surrounding area. Employees of the SME also engage in farming on their personal land, which is used as raw material for chips production. However, the SME faces a shortage of labour. This is shown by the frequent occurrence of employees performing double jobs, where they leave the frying process to supervise the arrival of raw materials from suppliers. Such actions can result in product defects.

The products of "Keripik Lumba-Lumba" SME are distributed in major convenience stores across Indonesia and are also sold to distributors. However, the products sold in convenience stores have a longer shelf life compared to those in small retail stores. The difference in expiration dates is due to the use of different packaging materials and storage conditions.

Various issues within "Keripik Lumba-Lumba" SME can reduce the efficiency of production and marketing to consumers. The challenge in the distribution process of ripening bananas can delay and reduce the supply of raw materials. This is because the bananas required for making banana chips must be relatively young. The lack of labour due to employees performing double jobs can affect the quality of the products produced. Product defects resulting from these issues need to be addressed as they can deter consumer interest. Different shelf lives for the two types of sales are also crucial to address, as this will increase consumer trust and interest in buying the products. The problems that exist in Keripik Lumba-Lumba" SME can be seen in the Fishbone diagram in Figure 1.

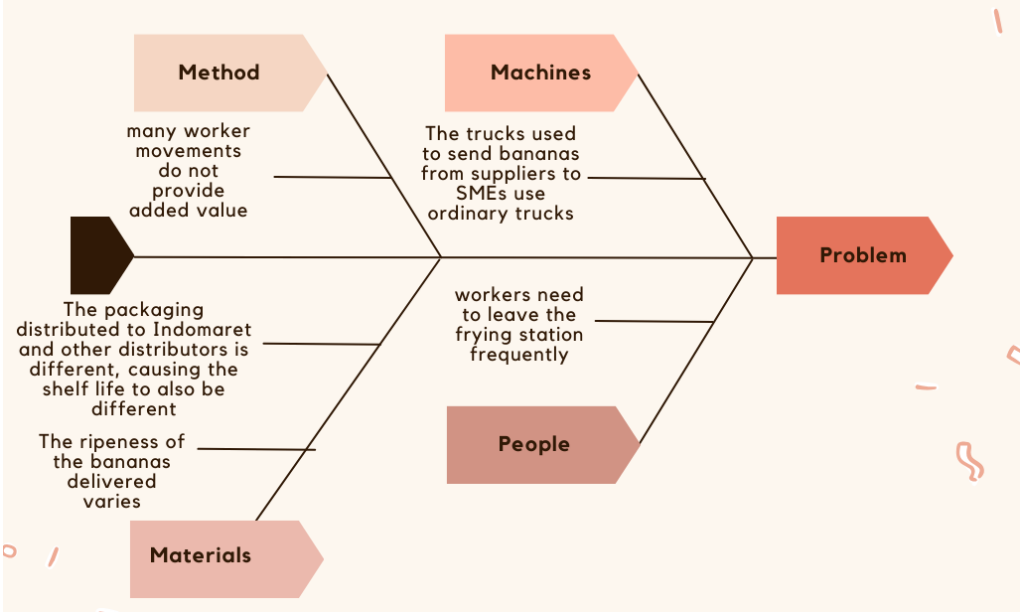

Figure 1. Fishbone diagram of problems that exist in Keripik Lumba-Lumba" SME

The purpose of this paper is to provide a design solution to the problems faced by SMEs 'Keripik Lumba-Lumba' which will help increase business productivity and product quality. The main problems faced are storage problems in the delivery of raw materials, poor work design, and packaging that makes the shelf life short.

2. LITERATURE RIVIEW

2.1 Previous Research

2.1.1. The use of $KMnO_4$ as an Ethylene Oxidizer to Extend Shelf Life

Based on previous research the increase in respiration rate during the ripening process is triggered by the autocatalytic emission of ethylene. The researchers used different concentrations of $KMnO_4$ to extend the shelf life of Raja Bulu bananas [1]. Based on the research findings, the following conclusions can be drawn:

1. The use of 7.5%, 15%, and 22.5% $KMnO_4$ can inhibit the respiration rate of bananas during storage, thereby delaying the climacteric peak of Raja Bulu bananas by 1-2 days compared to the control.
2. The use of 7.5%, 15%, and 22.5% $KMnO_4$ does not affect the physical and chemical quality of Raja Bulu bananas.

Based on other research the experimental design used was a Completely Randomized Design with two factors. The first factor was the storage temperature, specifically 15°C, 35°C, and room temperature. The second factor was the age of the bananas, categorized as bananas stored for 1 day and bananas stored for 3 days. The results of the research indicated that storage temperature and banana age could affect the production of CO_2 and ethylene gas. The most optimal storage temperature was found to be at 15°C, showing the lowest levels of CO_2 and ethylene gas respiration. Higher storage temperatures would increase the levels of CO_2 and ethylene, while lower storage temperatures would decrease these levels. The fruit ripening process, as indicated by the levels of CO_2 and ethylene, can be delayed by lowering the storage temperature of Kepok banana fruits [2] . Many other studies have also been conducted regarding the use of potassium permanganate to extend the life of bananas and other fruit [3].

2.1.2. Job Design Determination

Based on previous research, there are three factors that affect the implementation of job design namely organization, environment, and behavior. Each of these factors has several indicators. Job design based on the organization includes mechanistic approach, workflow approach, work execution approach, and ergonomic approach. The environmental factor consists of the employees and social expectations and cultural aspects, including social conditions and cultural diversity. Based on behavior, it includes autonomous job design, job variation design, job design based on task identity, and job design based on the importance of a task. The research results show that the job descriptions and positions created in each department align with the job tasks, and the employees perform them according to these three factors [4]. Job design can also influence job satisfaction and job stress [5-8].

2.1.3. Shelf Life Estimation

Based on previous research about shelf life, the research show that chemically other products (modified instant tiwul) has a shelf life approximately twice as long as the microbiologically modified product. Each product has a shelf life of about 4.88 years (packaged in polyethylene) and 8.55 years (packaged in aluminium foil) [9]. There is a lot of research on the shelf life of bananas and how to increase their shelf life for example with packaging, nanoparticle-enriched coatings, film-packaged freeze-dried banana, etc [10-12].

3. MATERIALS AND METHODS

The following are the steps in this research.

3.1. Data Collection

At the data collection stage, primary and secondary data are collected from various sources. The data collection method was carried out through interviews with the owner and some employees of the "Keripik Lumba-Lumba" SME. Data collection was carried out for around 35 days starting from October 20th to November 25th 2023. The information used includes the amount of raw material inventory, product shelf life, as well as details regarding production conditions at the "Keripik Lumba-Lumba" SME and the organizational structure implemented within it. These data are used as a basic reference for analyzing existing problems.

3.2. Problem Analysis

After collecting data, an analysis of existing problems was carried out by making a list of problems that existed in the "Keripik Lumba-Lumba" SME. From the list compiled, major issues that have a broad impact are prioritized, especially covering the supply chain in SMEs.

3.3. Flow Diagram

Making a flow diagram is a stage for creating a conceptual model to be applied in research. The supply chain flow diagram for the "Keripik Lumba-Lumba" SME was created to make it easier to understand and solve problems in the "Keripik Lumba-Lumba" SME.

3.4. Box Design

The box is designed specially where it contains potassium permanganate. The steps in designing this box include determining the material and its shape. Then, preparing the KMnO4 mixture to be used inside the box. The use of KMnO4 is based on previous research that this compound can inhibit fruit ripening. The box design is specifically created using SolidWorks software.

3.5. Truck Design

In this paper, changes are recommended to the truck used by SME "Keripik Lumba-Lumba." The changes proposed include switching to a wing box truck and equipping the truck with a temperature control system. The truck design is created using software.

3.6. Job Design

In the job design process, a literature review from various sources was carried out. Based on the literature study, it was found that job design requires three important elements in its implementation, namely organization, environment and behavior. Work design is carried out by identifying and analyzing existing work designs applied to "Keripik Lumba-Lumba" SME then evaluating and improving what already exists.

3.7. Packaging Design

The next step is to provide recommendations for changes to the packaging used by "Keripik Lumba-Lumba" SME. The changes involved both the material and the design of the packaging. The alteration of the material began with a literature study as a tool to consider the suitability of each material. Subsequently, a survey was conducted to determine the design preferred by the community. The next step involves the realization of the design.

4. RESULTS AND DISCUSSION

Various solutions were sought based on the problems faced by "Keripik Lumba-lumba" SME. The solutions offered can be implemented in the "Keripik Lumba-lumba" SME. These solutions can be broadly seen in the following diagram. Solutions diagram that can be seen in Figure 2. The supplier delivers the bananas in a box provided by the SME, which is specially designed to protect the bananas from impact and to keep them from ripening too quickly. The box is then loaded into a truck that has been designed to have sufficient air circulation to maintain the shelf life of the bananas. Once at the SME, the bananas are removed from the truck and enter the production process. In the production process, the work design of the current employees was improved to increase productivity. Once the banana chips are finished, they are packaged. The problem of varying shelf life of the packaging was solved by creating special packaging to increase the shelf life of the finished product.

4.1. Truck Design

The truck used for this design is a box-type truck. The truck design that can be seen in Figure 3. Inside the truck, there is a temperature control system so that during transportation, the fruits (in this case banana) are not exposed to high temperatures. The temperature that needs to be maintained is 15°C. Based on existing research, storing fruits at 15°C can delay ripening [13 - 18]. Typical truck deliveries can take 3-5 days from the supplier to the production site, causing the bananas to ripen and rot on the way. This is because in a normal

truck, hot air enters, causing the bananas to rot quickly. In this specially designed truck, the temperature is maintained so that the ripening of the bananas can be slowed down.

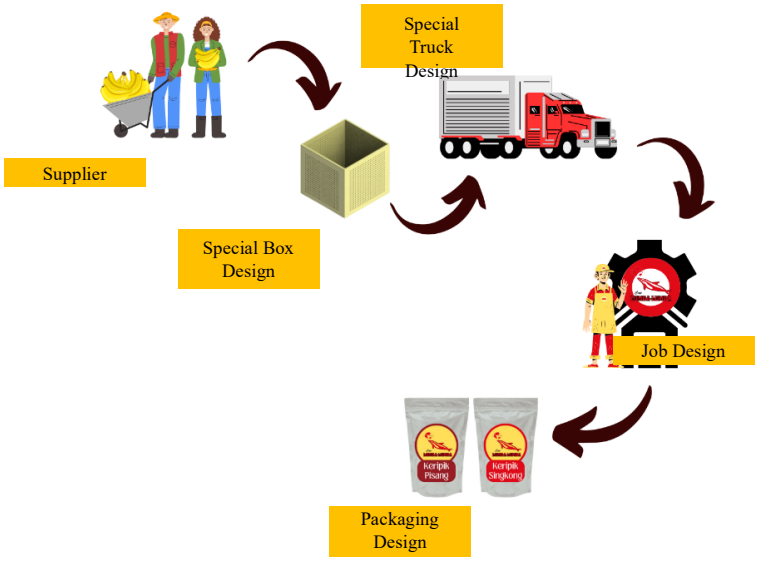

Figure 2. Solutions diagram

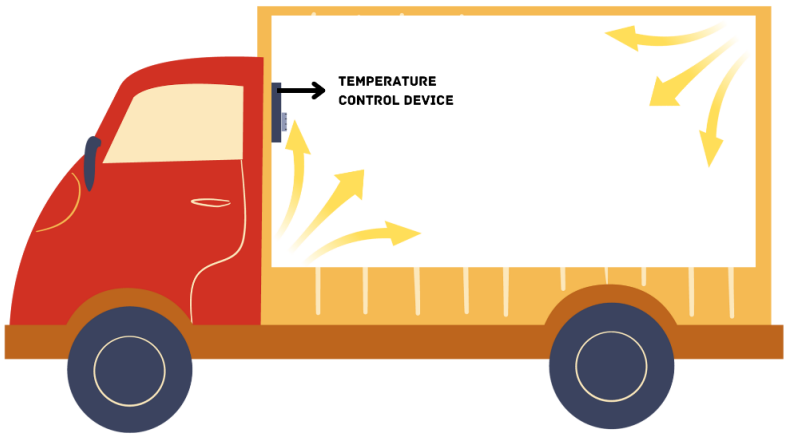

Figure 3. Truck design

4.2. Box Design

The box that is planned to be used is made of plastic and is designed specially. Inside the box, there is a layer of KMnO4 mixed with clay. The use of Potassium Permanganate (KMnO4) is based on previous research, where Potassium Permanganate (KMnO4) can oxidize ethylene [19 - 25]. Ethylene is a substance that accelerates ripening. Thus, the use of potassium permanganate can delay the ripening of bananas that will be shipped to the "Keripik Lumba-Lumba" SME. With the use of potassium permanganate, banana ripening can be delayed for approximately 3 days. As a result, the shrinkage of raw materials is reduced. The chosen material for making the box is plastic, considering that the material can be used multiple times and is relatively affordable.

To pack the bananas, the user only needs to place them inside the box. The inside of the box is lined with wire as a barrier between the bananas and KMnO4 so that the bananas do not come into direct contact with potassium permanganate and do not undergo a change in appearance. Based on previous research, if potassium permanganate touches fruits, it can alter their appearance. The use of potassium permanganate may slow down the ripening of the bananas. Figure 4 is a 3D view of the box design while Figure 5 is a view

of each side of the box. In each side, the outermost part is plastic, then inside there is potassium permanganate and coated again with a screen to keep the banana from direct contact with potassium permanganate.

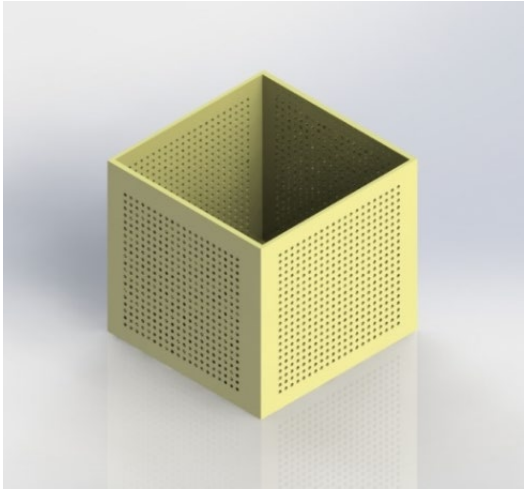

Figure 4. Box design

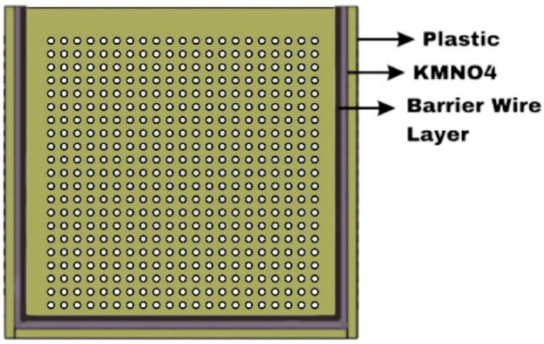

Figure 5. Structure of the box

4.3. Job Design

Job design is a method or approach to determining the tasks within a job in a company. Determining job design is an important aspect to enhance the effectiveness and increase productivity of a company [25]-[29]. Therefore, at "Keripik Lumba-Lumba" SME, it is necessary to implement job design because there is a double job activity performed by the employees.

Based on the data collected through interviews, the issue of double job at "Keripik Lumba-Lumba" SME occurs due to employees not showing up at work. Furthermore, it is also explained that task allocation is based on order requirements. For example, if the need for cassava production is 20 employees, 23 employees are assigned to ensure that if some employees are absent, the production can still proceed smoothly. Additionally, the organizational structure is not very clear as it goes directly from the owner to the 116 employees in the SME. From this case, the job design approach at "Keripik Lumba-Lumba" SME appears to be less effective.

Based on a literature review on Job Design that the author conducted, this issue can be addressed through improvements in the mechanistic element of the organization. The solution to this problem is the creation of a clear organizational structure that includes task allocation based on individual capabilities. In each division within the organizational structure, there is also a need for someone who can coordinate employees in each division. The following is an organizational structure that can serve as a solution to this problem, which can be seen in Figure 6.

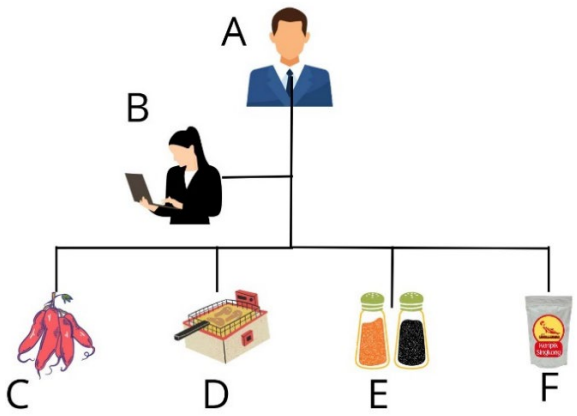

Figure 6. Proposed organizational structure

The organizational structure includes several divisions according to their job assignments, and there are managers responsible for coordinating them. These divisions include administration, peeling, cutting and frying, seasoning, and packaging. With a clear organizational structure, effective production processes can be achieved. Explanation regarding each task division in the organizational structure as well as the benefits of the proposed job design at the Small and Medium-sized Enterprise (SME) "Keripik Lumba Lumba" can be seen in Table 1.

Table 1. Explanation and benefits of proposed job design

Code	Position	Job Description	Benefit from Proposed Job Design
A.	Manager	Coordinating and monitoring the divisions under it	The tasks performed by employees in each division can be more directed.
B.	Administration	Receiving and organizing incoming orders from buyers	Incoming orders from buyers can be more organized and easily recapitulated.
C.	Peeling	Peeling cassava and bananas to be made into chips	The raw material peeling process will be more coordinated, thus reducing defects in the raw material cuts.
D.	Cutting and Frying	Cutting and frying peeled raw materials	The cutting and frying process is more coordinated, reducing double jobs.
E.	Seasoning	Adding salty and sweet seasoning to the chips	The coating process of chips can be more coordinated and reduce defective coating
F.	Packaging	Packaging cassava and banana chips that are read	The packaging process is more coordinated and reduces packaging defects.

Furthermore, there is a need for innovation in the job assignments within these divisions to enhance the business of “Keripik Lumba-Lumba” SME. Innovation can be introduced, particularly in the administrative division, to support this goal.Based on interviews, the order process is currently done only through phone calls with the admin. In this digital age, the use of a website can support the growth of the economic sector. Therefore, an innovation that can be implemented is the creation of a website that can boost the business of “Keripik Lumba-Lumba” SME. The website design can be seen in Figure 7. SMEs with limited human resources need website and application designs that make it easier for them. A simple website that can help them with day-to-day sales management but is useful in accurate record keeping. This website is designed to be able to monitor transactions ranging from incoming orders, delivery of goods to consumers, finance, and purchase of raw materials to suppliers.

Figure 7. Website design

The website contains essential components aimed at streamlining the administrative ordering process for "Keripik Lumba-Lumba" SME. "Pesanan Masuk" (Incoming Orders) displays incoming purchases to the admin quickly. "Keuangan" (Finance) shows the company's financial status, including income and expenses. "Rekapan" (Summary) displays a total recap of expenses for each month.

The solution of determining job design at "Keripik Lumba-Lumba" SME through creating clear job divisions via organizational formation will bring benefits. Effective productivity levels will be achieved through this solution. Furthermore, the quality of the human resources at "Keripik Lumba-Lumba" SME will improve. To support this, an innovation in the form of creating an administrative website is provided to enhance the business. This website contains various information about the order intake process.

4.4. Packaging Design

Shelf life is the period of time during which a product can maintain a certain level of quality or an acceptable condition, making the product safe and suitable for consumption when stored under recommended conditions. Food processing in an industry aims to extend the shelf life, maintain or improve the quality, and ensure the safety of the product. Key quality criteria or components in food commodities include safety, health, flavor, texture, color, shelf life, convenience, halal status, and price [29]. A dynamic mix of a fruit or vegetable's physicochemical characteristics and customer perception makes up its quality [30]. The characteristics of food quality include exterior elements like texture, flavor, and internal composition (chemical, physical, and microbiological), as well as external elements like appearance (size, shape, color, gloss, and consistency) [31]. Recently, Short food supply chains (SFSCs) have also emerged which are still developing phenomenon in the world of food production and distribution [32]

The main factors influencing the shelf life of packaged food products are as follows: (a) The natural properties of the food and the mechanisms by which it may deteriorate, such as sensitivity to moisture and oxygen, and the potential for chemical and physical changes within the food; (b) The size of the packaging material in relation to its volume; (c) The atmospheric conditions (especially temperature and humidity) in which the packaging is needed to protect during transportation and before use; (d) The overall resistance of the packaging material to water, atmospheric gases, and odors, including the resistance of closures, seals, and folds. These factors can result in further quality deterioration, such as lipid oxidation, vitamin degradation, protein damage, changes in taste and odor, color changes, alterations in organoleptic properties, and the potential formation of toxic substances [33].

In large-scale or commercial industries, the shelf life is determined based on laboratory analysis results supported by field distribution evaluations. With the growing number of small and medium-sized enterprises, it is considered essential to develop longer shelf life determinations as a form of food safety assurance. When determining shelf life, small and medium enterprises are often hindered by factors such as cost, time, processes, facilities, and a lack of knowledge among food producers. As seen in the case of the company "Lumba-Lumba," the shelf life of banana chips and cassava chips distributed to small distributors can only be maintained for a relatively short period, while banana chips and cassava chips distributed to convenience

stores can have a longer shelf life. Thus, the author proposed a change on the packaging design and material in order to prolong its shelf life. The packaging design can be seen in Figure 8.

Figure 8. Packaging design

The shelf life of "Keripik Lumba-Lumba" can be improved by changing the packaging. The packaging for "Keripik Lumba-Lumba" distributed to small distributors, which initially uses plastic packaging, can be replaced with packaging made from a different material such as aluminum foil. Aluminum foil has good water resistance, its surface can reflect light, making it visually appealing, it is smooth, can be shaped as desired and easily folded, it is not affected by radiation, can withstand high temperatures exceeding 290°C, tasteless, odorless, non-toxic, and hygienic. In addition to proposing a change in packaging material for "Keripik Lumba-Lumba," the author also offer an alternative design that has been created.

5. CONCLUSION

Mitigation of raw material shrinkage is carried out through two related methods. The use of boxes equipped with $KMnO_4$ layers is done to inhibit the ripening of bananas during transportation. In addition, efforts to prevent raw material shrinkage are made by equipping the truck with a temperature control device. This is done because fruits will last longer when stored at a temperature of 15°C. This innovation is considered the most suitable for implementation in the Small and Medium-sized Enterprise (SME) "Keripik Lumba-Lumba."

Job design is a critical component that can support a company's effectiveness. In the case of the SME "Keripik Lumba-Lumba," there is an issue, namely the lack of a clear organizational structure, leading to a lot of double jobs. Therefore, the solution to this problem is the creation of an organizational structure that aligns with job divisions. The organizational structure includes roles in administration, peeling, cutting, frying, packaging, and a manager overseeing them. An innovation that can enhance the business of the "Keripik Lumba-Lumba" SME is the creation of a website that will assist the administration department in receiving orders. Additionally, this website will contain various information to develop the business.

The shelf life of "Keripik Lumba-Lumba" sent to small distributors and convenience stores varies. The use of plastic for "Keripik Lumba-Lumba" distributed to small distributors results in a shorter shelf life. Therefore, an effort that can be made to extend the shelf life of "Keripik Lumba-Lumba" is to change the packaging material from plastic to aluminum foil for shipments to small distributors.

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