Quality control analysis for minimize of defect in potato chips production using six sigma DMAIC

S A Mustaniroh, B A Widyanantyas and M A Kamal

Department of Agroindustrial Technology, Faculty of Agricultural Technology, Universitas Brawijaya, Malang, Indonesia

E-mail: asmaul_m@ub.ac.id

Abstract. SMEs (Small Medium Entreprises) Rama is one of the potato chip producers in Batu city with the brand named "Rama Djaya". To produce competitive products, SMEs must continue to improve the quality of products by minimizing defects in the production. The defects in the quality of potato chips occur in color, crunchy and size. The purpose of this research is to identify and analyze the factors that can cause defects in potato chips. The research method used is Six Sigma DMAIC (Define, Measure, Improve, Analyze, and Control). The results showed that for the defined stage, the main priority for quality improvement using the CTQ (Critical To Quality) was color change by 92%. In the measurement stage, the value of process capability produced the final yield of 51.69% which showed a lower percentage compared to the Indonesia National Standard of 69.2%. The analysis result of DPMO (Defect Per Million Opportunity) value was 483,091.79, equal to 1.54 sigma so it needed to improve its strategy in production.

1. Introduction

One of Batu City's potential as an agropolitan city is the variety of horticultural commodities such as fruits (apple and orange), vegetables (potato and carrot), and decorative plants (chrysanthemum and rose). According to the Indonesian Statistical Bureau of Batu City, the total production of potatoes in Batu during 2015-2017 was 78,009, 88,270, and 93,878 quintals, respectively, showing the annual increase of potato production [1]. The agroindustry of potato chips keeps increasing annually [2]. This statement is indicated by the increase in demand for potatoes as a raw material by the potato chip industries. In Batu, there have been 50 business units which have been producing chips and potato chips since 2008. However, until this time, only 13 business units still exist producing potato chips with a more strict competitiveness level and average production capacity of 250-300 kg of potatoes. SMEs Rama is one of the small and medium enterprises in Batu, which produces potato chips with the brand name of "Rama Djaya".

The competitiveness in the business field becomes more strict which encourages the company to keep developing and improving the quality of production outcome, which presses the defect number of product in the production process and control on the product quality [3] as the success key of production system [4]. A defective product is defined as a product that does not fulfill its specification and matches the quality of standard that has been determined before [5]. Industrial activity highly needs quality control which is beneficial to maintain the production result and fulfill customer expectation to obtain
the product which fits the demand [6]. During the production process, an attempt that is used to minimize the risk (risk management) can produce a product that has good quality and complies with the company's standard.

The problem in SMEs Rama is related to the quality of potato chips which includes the color, integrity, and crunchiness of potato chips which can cause performance decrease either in less maximized quantity or potato chips' quality in there. Therefore, SMEs Rama requires improvement analysis and quality control strategy which aims to minimize the defect number on potato chips by integrating the Six Sigma DMAIC (Define, Measure, Improve, Analyze, and Control) method.

Six Sigma is an approach which is mostly used to identify and eliminate defect, error, or failure so that the company can fix the process through sustainable improvement [7]. Six Sigma is exerted to increase the existing process by reducing product defects [8]. Systematically, DMAIC is done based on science and fact to get a six-sigma target of 3.4 DPMO (Defect per Million Opportunity) [9]. In this research, the researchers employed six-sigma DMAIC which is aimed to improve the quality of potato chips in SMEs in Rama. This aim of the research is to identify and analyze factors that can cause defects on potato chips as the basis to conduct quality control which aims to minimize the defect number through a method of six sigma DMAIC.

2. Research Methods

This research was conducted in SMEs Rama through 5 steps by exerting the six-sigma DMAIC method. The steps of six-sigma could be seen in Table 1. Within this research, the steps were restricted up to the analyze step, because the improvement and control steps were supported by Fuzzy FMEA analysis.

### Table 1. Six Sigma Steps.

| Step   | Activity |
|--------|----------|
| **Define** | ● To create SIPOC (Supplier, Input, Process, Output, Customer) diagram and determine CTQ of potato chips production in SMEs Rama |
| **Measure** | ● To make a control chart of potato chips production |
|  | ● To calculate DPMO |
|  | ● To calculate the **sigma** level |
| **Analyze** | ● To analyze dominant defect in potato chips production |
|  | ● To develop a causal or fishbone diagram |

3. Results and Discussion

SMEs Rama was one of the small and medium enterprises in Batu, which produces potato chips product that was divided into three quality levels: potato chips in first and second quality which were produced from the first until sixth potato slices that sold in gift outlets, while the third quality was obtained from the potato slices after the sixth until last slices, the size was smaller and sold in small outlets. The production capacity per day was approximately ± 210 kg with suppliers of potato raw material from the cooperation around Batu, with a total of ± 5 tons of potatoes per month.

Six-sigma was a new management strategy that functioned within quality control to identify product error or defect, so the company could improve the efficiency of the production process and increase product quality which met the customer expectation. Moreover, six-sigma was an important instrument of production management which aimed to keep, fix, and maintain the product quality [10]. The Six-sigma method used several statistical tools to control the product quality, save cost, reduce product defects and production time, improve market share, and maintain customers [11].

3.1. Define

In the define step, the researcher would identify the problems of product quality in this research. The problems of potato chip production in "Rama Djaya" were related to the color, crunchiness, and integrity of chips. Based on the field condition, the researchers found these results:
a. Color indicator. 60% of potatoes experienced color change into brownish color as the effect of rainy season changes which impacted the nonmaximal drying process. The drying process with limited sunlight would affect the less maximum quality of the product which was indicated by the brownish color change [12]. Potato chips are generally yellow and white that the difference lies in the lime water immersion [13]. Potato chips made from thinly sliced potato tubers are immediately dried, after that, they are fried, they will turn yellow, whereas if the potato tubers are sliced thinly soaked in lime water, white potato chips are successfully produced.

b. Integrity indicator. The total potato chips defects were about 2% during frying and packaging steps. The thin and crunchy texture makes the potato chips crumbled easily so that when frying the amount should not be too much with a measure using a slicer and it is thought that there is room to expand, besides that when packing the potato chips it must be arranged so that not much is destroyed. The fruit and vegetable chips could be easily crushed because their texture was thin and crispy/crunchy [14]. The frying and packaging process needs to be considered and controlled so that not many products are destroyed. Wholeness is one of the physical characteristics that can be used as an indicator for observing the quality of chips [15].

c. Crunchiness indicator. The defect was about 3% on return potato chips because of a little bit of rancid flavor and not crunchy texture. Fried products can easily become less crunchy due to the packaging that is not tight and the age of the product that exceeds the expiration limit. Quality chips are those that have a color according to the flesh of the fruit, taste delicious, and have a crunchy texture [16]. The crunchiness is the main thing used to determine the quality of chips and consumer acceptance.

Next, the researchers made a SIPOC diagram which was an overall process that took place from the beginning until the end which covered the supplier, input, process, output, and customer. The supplier was the provider of raw material, input was raw material which would be used in a production process, the process consisted of structured stages that needed to produce a product, output was a product that resulted from the manufacturing process, while the customer was the last step on this diagram which related to product customer or receiver [17].

a. The supplier of this potato chips business was taken from cooperation in Batu with the input of potato raw material. The cooperation was one and the only supplier used since it offered a lower price from the other suppliers.

b. The process consisted of the preparation stage of potato raw material, potato skin peeling, washing, cutting, soaking in lime water, draining, boiling, and seasoning, 2 days drying under the sunlight, frying, packaging, and labeling.

c. The production process output was potato chips in original taste, crunchy, and yellowish-white color which meant that the chips were ready to be marketed to the customer, for example, the gift shops or other small outlets.

The analysis of the Pareto diagram was functioned to identify the most dominant defect on potato chips as a quality control equipment to identify the main cause of product failure as a base to do the quality improvement. The defect of quality on potato chips was related to the color change, integrity, and crunchiness as would be figured in Figure 1.
Based on Figure 1, the main priority of improvement or CTQ was the product of color change defect in approximately 92%. The concept of the Pareto diagram complied with the rule 80-20 or 80% of activities was caused by 20% of factors [18]. The use of drying technology which still benefitted sunlight was supposed to be the main cause of the color change of potato chips. The drying process worked and spent maximally under the sunlight for 2 days, so the chips could be immediately dried and white. But, if the chips could not be dried immediately, the drying process would need more than 2 days and might cause the color of potato chips turning into brown. The process of drying could save more energy and cost than the drier from other industries. Besides, the sunlight drying would result in high quality and also an environment-friendly product with low emission of CO2 [19].

3.2 Measure
The result of measurement was informed into a chart of control p, valuation on process capability, DPMO, and Sigma value.

a. Analysis of control chart p
In this research, it exerted control chart p, because the researchers wanted to know the defect proportion to whole situations which exerted attribute data. The control chart p was a tool of process control which statistically used the defect size in form of defect product proportion in each sample taken to find out whether the data exerted within six sigma calculations would be in control limit or not [20]. The analysis result of the control chart p could be seen in Figure 2.
This fluctuating control chart is following the existing conditions in SMEs where the production process is unstable due to limited manpower, machines, and environmental conditions that cause the quality of potato chip products are also not the same, namely, there are potato chips with good quality and some are defective. The high risk of failure in the cottage industry is due to the low level of supervision for each processing process. Business owners must step in and directly control not only the final product but each processing station in the hope that the workforce can be more careful and thorough in doing their work. The fluctuated graphic on the control chart was caused by the unstable or bad process of product processing that could be identified from several factors as an operator, machine, and method [21].

a. Valuation of process capability
The analysis of process capability was an important step of quality control which exerted to know the feasibility of the process which resulted in a product. The process capability analysis was an analysis method that predicted how consistent the process could fulfill the specification that was determined by the customer [22]. The process was called capable if it was able to produce almost 100% of output that fitted to the specification. It was supported by Spano (2009) who has found that the process capability analysis was used to identify how good the process could meet the specification and how good the performance of a process, so it could be compared to the previous and next process of quality improvement [23].

In this research, the data was the product defect which became the attribute data, thus, the valuation of process capability for the sample with attribute data was seen from % of final yield process. The value of the final yield was useful to see how great the process capability could produce output without defect [24], while Pande (2009) has said that a process was valued as good if the value % of final yield ≥ 99.99% for international standard and ≥ 69.2% for local or Indonesia standard [25]. The calculation result of the final yield showed that the drying process was still under the industrial standard in Indonesia since the value was 51.69% ≥ 69.2%. The final yield with a value of 51.69% showed that the process capability was rated 51.69% and defect product 48.31%, and this was because the number of samples was beyond the limit of control. It could be seen from the high quantity of potato chips which underwent a color change during the rainy season since the maximal drying process was still highly needed in the sunlight. Manual drying requires a relatively long drying time, a lot of labor, depending on weather conditions (sunshine, wind, and humidity), contamination of materials that are dried with dust from the environment around the drying, it takes a large area and the resulting chips are white and there are still a lot of chips that were crushed because of colliding with other chips. The simple conversion of six sigma could be seen in Table 2 [26].

Table 2. Simple conversion of six sigma.

| Yield  | DPMO   | Sigma Level |
|--------|--------|-------------|
| 30.9   | 690,000| 1           |
| 69.2   | 308,000| 2           |
| 93.3   | 66,800 | 3           |
| 99.4   | 6,210  | 4           |
| 99.98  | 320    | 5           |
| 99.9997| 3.4    | 6           |

Source: Pheng and Hui (2004)

b. Valuation of DPMO and Sigma
DPMO measurement was done to identify the distortion of color change during the drying process. The whole total sample examined was 414 kg and the defect was 200 kg. The calculation result of Defect per Unit (DPU) 0.48309179 and DPMO 483.091,79. The DPMO value would be converted into sigma value, and it obtained the sigma value 1.54. The standard of sigma level achievement could be seen in Table 3.
Table 3. Table of sigma level achievement.

| Sigma level achievement | DPMO               |
|-------------------------|-------------------|
| 1                       | 691,462 (very uncompetitive) |
| 2                       | 30,538 (industrial average of Indonesia) |
| 3                       | 66,807             |
| 4                       | 6,210 (industrial average of USA) |
| 5                       | 233 (industrial average of Japan) |
| 6                       | 3.4 (world-class industry) |

Source: Gasperz and Fontana (2018)

The valid six sigma for the world-class industry has a DPOM value of 3.4, while the industrial average of Indonesia was still on the 2nd level of sigma which has a DPOM value of 2.00 [24]. The sigma value 1.54 indicated that the production of potato chips in SMEs Rama was still on 1st level of sigma that was caused by 60% color defect during the rainy season, then, it still needed an improvement of process to improve the product quality and process capability into the up level. The company could get the loss if they did not do the improvement on the production process which aimed to press the level of product defect from every production process since this strategy could improve the sigma level of the company [25].

3.3 Analyse

On the analyze step, the researchers made a fishbone or causal diagram which referred to a diagram that would indicate the main factors which affected the quality and caused problems. In this step, the researchers would determine the improvement priority, which determined the dominant type of defect, and identified the causal factors of product defect by using a fishbone diagram [10]. The causal analysis was done only to potato chips that underwent color change based on the result of the Pareto diagram, particularly the color defect caused more than 80% defect from the total defect number. The fishbone diagram on the color change of potato chips could be seen in Figure 3.

![Fishbone diagram of potato chips color change.](figure3)

**Figure 3.** Fishbone diagram of potato chips color change.

a. Human

The cause of potato chip defects that change brownish color can come from human factors, namely limited labor and no clear policy. The labor limitation factor occurs when some workers are absent, which causes only 4 workers to come on that day so that the time for removing chips that must be dried is longer and the drying time becomes too late. Unclear policy factors due to the absence of
work scheduling cause some workers to easily miss work at events without any restrictions from SMEs owners. Human factors are unavoidable in a production process, but mistakes due to human factors can be reduced by always controlling by superiors [27].

b. Method

The method factors that contribute to the discoloration of the potato chips are the lack of regular supervision of each process and the lack of training by the business owner. In SMEs Rama there are only 2 people that can control all processes, acting to carry out supervision of the production process in turn so that the supervision for each process station is not optimal. Lack of workforce training results in a lack of workforce to handle the whole process so that the process becomes a bit hampered. SOP for the process of making potato chips already exists but has not been implemented optimally, so that sometimes the results of work between one worker are inconsistent. SMEs Rama has not done the evaluation process for conformity with SOPs, so there is a need to strengthen the understanding and implementation of SOP processes for workers.

c. Raw material

The raw material contributes to the discoloration of the potato chips due to the unequal level of potato quality. The raw material for potatoes is taken directly from the cooperative because the price is relatively cheaper compared to other suppliers and the payment can be made at the end. The raw materials are one of the important factors so that the production process can run smoothly [28]. The company will buy raw materials from suppliers by considering several factors. The factors that are considered by companies in selecting suppliers are price, quality, service, location, supplier policies, and flexibility [29]. Price is usually a major factor in supplier selection, companies will choose suppliers with relatively lower costs, but sometimes companies may also pay higher costs for better product quality. Supplier selection is also influenced by supplier special services such as replacing damaged products. The location of the supplier that is closer to the place of production has a greater chance of selecting the main supplier. Supplier policies that become a consideration for supplier selection, such as payment policies, and maintaining the availability of raw materials. Flexibility such as the ability of suppliers to respond to changes in design requests.

d. Machine

So far, the drying of potato chips at SMEs Rama still relies on sunlight which causes drying cannot be controlled optimally because it depends on weather conditions. The use of a drying machine to handle the rain season could not still overcome color change on potato chips. The factor which must be identified in the fishbone diagram was the machine [30]. In the industrial field, the chips could use a drying machine as an auxiliary machine for drying under sunlight to dry the chips [31]. There are two drying methods are known among the public, namely drying with the help of sunlight and artificial drying using an oven [32]. Drying with the help of sufficient sunlight will be more efficient than using tools because it does not cost more for the energy required and can reduce production costs, while artificial drying can be used when the weather is cloudy or rainy so that drying continues.

The performance of the dryer used can be seen from the efficiency of energy use by measuring several parameters, namely changes in solar irradiation, drying temperature, humidity, wind speed of electrical energy, and additional heating energy. The greater the room temperature for drying material, the greater the efficiency of drying the material, this happens because high temperatures can evaporate water on the material, evaporation of water from the material results in reduced moisture. One solution to improve the drying process requires a dryer that can dry materials quickly and can reduce dust contamination from the environment, through the Greenhouse Effect Cabinet (GEC) dryer. GEC dryers are drying devices that utilize solar energy using transparent covers on all parts of the dryer building walls [33]. The use of the GEC dryer type at SMEs Rama for 28 hours continuously, even in the rainy season, the quality of the potato chips produced is whiter than the sunlight method and the product is free from dust contamination from the surrounding environment.

e. Environment

Environmental conditions greatly affect the color change of potato chips. If the weather conditions are bright, the drying process can last for 2 days at a maximum and krecek will quickly dry yellowish
white. If the weather conditions are rainy, the drying cannot take place optimally which causes the krekcek to turn a brownish color. The frequent rainfall causes the drying process to be not optimal and the chips turn brownish. The high sugar content in potatoes will reduce the color quality of potato chips because it will accelerate the Maillard browning reaction between reducing sugars and primary amine groups to produce melanoidin compounds which produce brown products and are undesirable in making potato chips [34]. The environmental conditions of the production room are another factor that can affect the production process [35]. Therefore, company which the drying materials are still carried out conventionally using sunlight needs to find alternative drying solutions to minimize the occurrence of production failures when sunlight is not enough [14].

4. Conclusions
The analysis result of quality control of potato chips from the brand "Rama Djaya" exerted Six sigma DMAIC method which indicated that the main priority of improvement or CTQ of product defect was 92%. The final yield of the drying process was 51.69% and is still considered under the industrial standard in Indonesia of 69.2%. Moreover, the DPMO value of 483,091.79 which was then converted into sigma value 1.54 was still under the industrial standard in Indonesia 2.00. The other factors which caused color change defect on potato chips included labor force limit and indefinite policy, lack of supervision and lack of training, different level of quality, less optimal drying materials, and environmental aspect as weather change.

References
[1] BPS-Kota Batu 2018 Kota Batu dalam angka 2018 CV. Aska Putra Pratama. Batu (Batu City in numbers 2018 CV. Aska Putra Pratama) [In Indonesian].
[2] Harahap S E 2017 Karakterisasi kenyahan dan kekerasan beberapa genotipe kentang (Solanum tuberosum L) Hasil Pemulianan (Characterization of Crispness and Hardness of Potato Chips Made from Various Genotypes of Potato (Solanum tuberosum L.) Breeding) J. Pangan. 26 3 1-7 [In Indonesian].
[3] Almansur, Sukardi, Machfud 2017 Improving performance of biscuit production process through lean six sigma Di PT. XYZ. Indonesian J. Business and Entrepreneurship. 3 2 45-58.
[4] Parwati C I, Sakti, R M 2012 Pengendalian kualitas produk cacat dengan pendekatan kaizen dan analisis masalah dengan seven tools (Control the quality of defective products using the Kaizen approach and problem analysis using seven tools), Prosiding Seminar Nasional Aplikasi Sains & Teknologi (SNAST) Periode III Yogyakarta 2012 1 2 P12 [In Indonesian].
[5] Windarti T 2014 Pengendalian kualitas untuk meminimasi produk cacat pada proses produksi besi beton (Quality control to minimize defective products in the concrete iron production process) J. Teknik Industri. 9 3 173-180 [In Indonesian].
[6] Rimantho D, Desak M M 2017 Penerapan metode six sigma pada pengendalian kualitas air baku pada produksi makanan (Application of the Six Sigma method to control the quality of raw water in food production) J. Ilmiah Teknik Industri. 16 1 1 – 12 [In Indonesian].
[7] Hill J, Thomas, Mason J, El-Kateb 2018 The implementation of a lean six sigma framework to enhance operation Production and Manufacturing Research. 6 1 26-48.
[8] Pyzdek T, Keller 2010 The six sigma handbook: a complete guide for green belts, black belts, and managers at all levels (New York: McGraw Hill Companies).
[9] Rumana P, Darshak A D 2014 Review paper: quality improvement through six sigma DMAIC methodology Int. J. Engineering Sciences & Research Technology. 3 12 169-175.
[10] Girmanova L, Solc, Kliment J, Divokova A, Miklos 2017 Application of six sigma methodology in the process of product quality control in metallurgical operation Acta Technologica Agriculturae. 20 4 104-109.
[11] Smętkowska M, Mrugalska 2018 Using six sigma DMAIC to improve the quality of the production process: a case study Procedia - Social and Behavioral Sciences. 238 1 590-596.
[12] Aisyah Y, Rasdiamsyah, Muhamin 2014 Pengaruh pemanasan terhadap aktivitas antioksidan pada beberapa jenis sayuran (Effect of heating on antioxidant activity of some vegetables). *J. Teknologi dan Industri Pertanian Indonesia*. 6 2 28-32 [In Indonesian].

[13] Asgar A, Asih K, Asep S, Henna T 2010 Pengaruh lama penyimpanan, suhu dan lama pengeringan kentang terhadap kualitas kering kentang putih (Effect of Storage, Temperature and Drying Duration of Potato on Potato Chip Quality) *Berita Biologi*. 10 2 217-226 [In Indonesian].

[14] Airlangga D, Lilis S, Obin R 2016 Pengaruh metode pengeringan terhadap mutu fisik daging giling ayam broiler (the effect of drying methods on quality of physical grounded dengeng (dried meat) of broiler chickens) *Jurnal Unpad*. 5 4 1-13 [In Indonesian].

[15] Ahza A B, Tiaranissa I, Subarna S 2015 Physical, sensorial and chemical characteristics of simulated chips of cassava (Manihot esculenta Crantz): Rice (Oryza sativa L.) mix. *Procedia Food Science*. 3 1 82-95.

[16] Tunick M H, Charles I O, Audrey E T, John G, Sudarsan M, Shiowshuh, Cheng-Kung, Nicholas L, Mariana R, Peter H 2016 Critical evaluation of crispy and crunchy textures: A Review *Int. J. Food Properties*. 5 16 949–963.

[17] Sabir B, Bouzekri T, Mohammed B 2015 Using the integrated management system and sipoc approach in higher education for the evaluation and improving the quality students life *Quality in Higher Education J.* 2 3 141-156.

[18] Lind D A, William G M, Samuel A W 2008 Teknik-teknik statistika dalam bisnis dan ekonomi menggunakan kelompok data global (Statistical techniques in business and economics use global data sets) (Jakarta :Salemba Empat) [In Indonesian].

[19] El-Sebai A A, Shalaby S M 2012 Solar drying of agricultural products: A review. *Renewable Sustainable Energy Reviews J.* 16 1 37–43.

[20] Khomah I, Endang S 2013 Aplikasi peta kendali p sebagai pengendalian kualitas karet di PTPN IX Batujamur/ Kerjoarum (Control p Chart Application as Quality Control Tools for Rubber Production in PTPN IX Batujamur/Kerjoarum) *J. Agraris*. 1 1 13-24 [In Indonesian].

[21] Pasmawati Y, Zahri 2016 Peningkatan kualitas produk menggunakan pendekatan six sigma (Improving product quality uses the six sigma approach) *J. TEKNO*. 13 1 23-34 [In Indonesian].

[22] Trijayanti R, Sigit N, Jose R 2016 Analisis kapabilitas proses menggunakan pendekatan bagan kendali (Process capability analysis uses a control chart approach) *E-Jurnal Statistika*. 2 1 1-17 [In Indonesian].

[23] Spanyo A 2009 Public value creation and management control systems *Int. J. Public Administration*. 32 3 328-348.

[24] Saghaei M, Fazayeli L, Shojae M R M 2012 Strategic planning for a lubricant manufacturing company *Australian J. Business and Management Research*. 1 1018-24.

[25] Pande 2009 *The six sigma way*. (New York :McGraw-Hill).

[26] Pheng L.S, Hui 2004 Implementing and applying six sigma in construction *J. Construction Engineering and Management*. 130 4 482-489

[27] Mumawan H, Mustofa 2014 Perencanaan produktivitas kerja dari hasil evaluasi produktivitas dengan metode fishbone di perusahaan percetakan kemasan PT. X (Work productivity planning from the results of productivity evaluation using the fishbone method at the packaging printing company PT. X) *J. Teknik Industri HEURISTIC*. 11 1 27-46 [In Indonesian].

[28] Hakim L 2015 Implementasi Just In Time (JIT) dalam meningkatkan produktivitas dan efisiensi biaya produksi (Just In Time (JIT) implementation in increasing productivity and efficiency in production costs) *J. Research and Technology*. 1 1 2477-6165 [In Indonesian].

[29] Stevenson W J 2002 *Operations management*. (NewYork :Boston McGraw Hill).

[30] Coccia M 2017 A Theory of General Cause of Violent Crime: Homicides, Income Inequality and Fallacies of the Heat Hypothesis and of the Model of Clash *Aggression and Violent Behavior*. 4 2 190-200.
[31] Histifarina D 2016 Pengaruh Perlakuan Pencelupan dalam Larutan CaCl2 dan Pemblansingan Terhadap Mutu Keripik Terubuk (The Effect of Immersion Treatment in CaCl2 Solution and Blanching on the Quality of Powdered Chips) *Buletin Hasil Kajian*. 6 9-13 [In Indonesian].

[32] Beigi M 2016 Energy efficiency and moisture diffusivity of apple slices during convective drying *Int. J. Food Science and Technology*. 36 1 145-150

[33] Fekawati R 2010 Uji performasi pengering efek rumah kaca hybrid tipe rak berputar pada pengering jamur tiram putih (Pleurotus ostreatus) (Performance test of rotating rack type hybrid greenhouse effect dryer on white oyster mushroom dryer (Pleurotus ostreatus)) Skripsi. Jurusan Teknologi Pertanian. IPB. Bogor [In Indonesian].

[34] Mandei J H, Alim M N 2017 Pengaruh cara perendaman dan jenis kentang terhadap mutu keripik kentang (The effect of submersion and potato type on the quality of potato chips) *J. Penelitian Teknologi Industri*. 9 2 123-136 [In Indonesian].

[35] Hekmatpanah M 2011 The Application of cause and effect diagram in the oil industry in iran: the case of four liter oil canning process of sepahan oil company *African Journal of Business Management*. 5 26 10900-10907