The Application Lean Six Sigma Method Approach to Minimize Waste

H Henny¹, I Andriana², A N Latifah³, H Haryanto⁴
Departement of Industrial Engineering, Universitas Komputer Indonesia, Indonesia
Email: henny@email.unikom.ac.id

Abstract. The purpose of this research is to analyze the problems in the production process in the occurrence of waste. This method used lean six sigma approach to define, measure, analysis, improve and control (DMAIC). The results of the study were the ability for saus sambal to be at level 3 sigma, while the shrimp sauce was at level 4 sigma. The analysis found two waste production process. First, waste transportation, is in the form of activities to move the labelling table and the labelling table is placed close to the pallet during the packing process. The second is waste processing in the form of sorting activities and manually re-stripping the raw material in the compounding process. As for the improvements suggested by the researchers, the first is to improve the packing area layout and use conveyors to move the cans to be packed and the second suggestion is to standardize Rpm and the appropriate amount of release rubber to produce optimal fresh raw material peels.

1. Introduction
In the era of global industry, knowledge becomes crucial things, companies must be able to keep up with technological progress to continue innovating and creating products also services in order to companies can control the market in the field of industry. In addition, companies demand to continue paying attention to efficiency, cost and quality [1]. Quality can consider as good if it has effective procedures and controls at various stages of production, improving quality will reduce waste and increase production and company profits [2]. To identify and help reduce waste, researchers use the lean six sigma approach, lean six sigma methods are implemented using approaches to define, measure, analyze, improve and control or known as DMAIC [2]. Six Sigma focuses on process performance to reduce product variation, while lean focuses on reducing process complexity [3].

The use of the lean six sigma method in this study refers to research conducted by Pregiwati Pusporini and Deny Andesta with the title of lean six sigma integration model to improve product quality [4]. As with previous studies with the title of the application of lean six sigma for configuration control in the Intel production and development environment made by Rahul Panat and co-authors [5]. In addition there are also some researchers who have used the six sigma method in their research including Lenka Girmanova et al. (2017) Application of Six Sigma Using Dmaic Methodology in the Process of Product Quality Control in Metallurgical Operation [6], Jirasukprasert et al. (2014) A Six Sigma and DMAIC application for the reduction of defects in a rubber gloves manufacturing process [7], Saeid Hakimi et al. (2018) Application of Six-Sigma DMA methodology in plain yogurt production process [8], Mazen Arafeh et al. (2017) Using Six Sigma DMAIC Methodology and Discrete Event Simulation to Reduce Patient Discharge Time in King HusseinCancer Center [9], Nirav Sindha and Kinjal Suthar (2017) Review on
Implementation of Six Sigma DMAIC Methodology in Manufacturing Industries [10], Alicja Maleszka and Magdalena Linke (2016) Improvement of Management Process by Using Lean Six Sigma Tools in Some Big Organizations of Food Industry [11], Jiju Antony et al. (2012) Application of Six Sigma DMA methodology in a transactional environment [12], Naveen Khatak et al. (2017) Implementation of Six Sigma to Reduce Rejection Rate in Screw [13].

This research used approach of lean six sigma method to identify and help reduce waste in the production of chili sauce and shrimp sauce. Lean Six Sigma is a well known method that can help improve quality and waste processes. Lean Method of lean six sigma is implemented using the approach to define, measure, analysis, improve and control or known by the DMAIC [2]. Six sigma focuses on the performance of the process to reduce product variation, whereas lean it focuses on decreasing the complexity of the process [3].

2. Method
DMAIC is an approach to lean six sigma for continuous quality improvement by removing process steps that are not productive in order to achieve the target of six sigma [14]. As for the stages in the research conducted data collection of form production and the amount of data also the number of defects in the production of chili sauce and shrimp sauce, and did a DMAIC phases in order. In the define has found the identification of waste. Waste is defined as activities that do not add value (value) on the process throughout the value stream [14] and categorize each waste based on the type and the message, there are 7 types of waste that can be minimized using the method of lean [15,16]. The measure carried out calculations of the DPMO and sigma levels. Defect per Million Opportunities (DPMO) is the unit of measurement of the performance of process. While the capability sigma level shows that have achieved a process. This is the reason for waste and analysis of waste that should be prioritized for repair (waste critical). Failure modes that must be prioritized first was failure modes with causes that have a value greater than the value of the RPN criticality. The last stage is being improved stage in this study, at this stage given the proposed fixes for critical waste that has been analyzed in the previous stage.

3. Results and Discussion
The step of lean six Sigma DMAIC approach can be done by identifying the waste that occurs, both the visible as well as hidden and any waste category. Therefore the next step provide a solution for any cause which has been analyzed [17]. Using the DMAIC steps and structured steps can help increase the quality and identified properly [18].

3.1. Define Phase
After conducting identification on activities throughout the value stream, obtained waste that occurs in the process of production of chili sauce. The waste is categorized based on the type and the Table 1. The following table is waste that occurs in the production of chili sauce.
Table 1. Waste production process of chili sauce

| No. | Operation                  | List of Waste                                                                 | Categories Of Waste          |
|-----|----------------------------|-------------------------------------------------------------------------------|------------------------------|
| 1   | Preparation of raw materials (weighing) | Move the scales                                                              | Transportation               |
|     | Send the rest of the raw materials to the ripening |                                                                                     | Transportation               |
| 2   | Compounding                | There is no waste                                                              | -                            |
| 3   | Smoothing                  | The repeated process of milling grinder                                        | Over Processing              |
| 4   | Ripening                   | Cook tanks wait activity improved due to *downtime*                           | Waiting                      |
| 5   | Filling                    | Activities waiting for the filling process to complete                         | Waiting                      |
| 6   | Pasteurization             | There is no waste                                                              | -                            |
| 7   | Cooling down               | There is no waste                                                              | -                            |
|     | The activities take the label that runs out to the room inventory           | Transportation                 |                              |
|     | Move a table *labelling* in order to be close to the pallet of sauce        | Transportation                 |                              |
| 8   | Packing                    | The repetition of the activities of the inspection lid firmness                | Over Processing              |
|     | The waiting activity box is not ready and must be in the first form         | Waiting                        |                              |
|     | Broken lid                 |                                                                                     |                              |
|     | *Can* dent                 |                                                                                     |                              |
|     | Weight less                |                                                                                     |                              |

The production of shrimp sauce, *waste* and *waste* categories which occur are outlined in Table 2 below.

Table 2. Waste production process of shrimp sauce

| No. | Operation                  | List of Waste                                                                 | Categories Of Waste          |
|-----|----------------------------|-------------------------------------------------------------------------------|------------------------------|
| 1   | Preparation of raw materials (weighing) | Move the scales                                                              | *Transportation*             |
|     | Send the rest of the raw materials to the ripening |                                                                                | *Transportation*             |
|     | Sorting and manually reset the skin peeling on the process of compounding   |                                                                                 | *Over Processing*           |
| 2   | Compounding                | Move the scales for use in the compounding materials *manufacturing*           | *Transportation*             |
| 3   | Smoothing                  | There is no waste                                                              | -                            |
| 4   | Ripening                   | Clean raw material is wasted when pasting into Cook tanks                     | *Over Processing*           |
| 5   | Filling                    | Fix machine *filming* korin experiencing *downtime*                           | *Over Processing*           |
| 6   | Pasteurization             | *There is no waste*                                                            | -                            |
| 7   | Cooling down               | *There is no waste*                                                            | -                            |
| 8   | Packing                    | Throw shrimp paste that has been packaged to *press* machine                  | *Motion*                    |
|     | *Seal* don't mess with     |                                                                                 | *Defects*                   |
3.2. Measure Phase

From the data on the amount of production and the number of defects recorded during the six periods, namely January, February, March, April, May, and June 2017, the researchers calculated the value and ability of DPMO, chili sauce and shrimp sauce products. Calculations are carried out using equations 1 and 2. Table 3 below is the result of the calculation performed.

| Products   | The Number of Production | The Number of Defects | CTQ | DPMO | Sigma Level |
|------------|--------------------------|-----------------------|-----|------|-------------|
| Chili sauce | 25658                    | 626                   | 3   | 8132.62 | 3.90        |
| Shrimp sauce | 128016                  | 2364                  | 4   | 4616, 61 | 4.10        |

3.3. Analysis Phase

Total number of RPN on waste process acquired chili sauce of 298 and causing waste to occur as many as 15 causes. The next stage to determine the value of the RPN critically using equation 1. Following are the results of the calculation of the value of the RPN from critical production of chili sauce.

\[
Critical\ RPN\ Value = \frac{298}{15} = 19.87
\]  

Based on the value of the RPN criticality that has been obtained from the calculation, the following diagram shows the waste with the cause of the most critical and should be prioritized for repair (See Table 4).

| No. | List of waste | The Cause of The Waste | The Value of the RPN |
|-----|---------------|------------------------|----------------------|
| 1   | Move a table labelling in order to be close to the palette of the sauce | Layout the less good | 48                   |
| 2   | The repetition of the activities of the inspection lid firmness | Workers in the process of tightening at random and excessive | 30                   |
| 3   | Broken lid | Tightening tool still used manual | 42                   |

While the total number of RPN on waste of shrimp paste chilli sauce with 342 process and causing waste to occur as many as 13 causes. The next stage to determine the value of the RPN critically using equation 2.

Following are the results of the calculation of the value of the RPN critically from the production of chili sauce.

\[
Critical\ RPN\ Value = \frac{342}{13} = 26.31
\]
Based on the value of the RPN criticality that has been obtained from the calculation, the following diagram shows the waste with the cause of the most critical and should be prioritized for repair. (See Table 5).

Table 5. Waste critical of shrimp sauce

| No. | List of waste                                                                 | The Cause of The Waste                              | The Value Of The RPN |
|-----|-------------------------------------------------------------------------------|-----------------------------------------------------|---------------------|
| 1   | The process of sorting and manually reset the skin peeling on the process of compounding | The low Rpm and lack of rubber releases               | 35                  |
| 2   | Fix the machine filling korin repaired due to downtime                        | The schedule service is irregular                    | 49                  |
| 3   | Clean raw material is wasted when pasting into Cook tanks                     | There are no tools to incorporate raw materials      | 35                  |
| 4   | Shrimp sauce that has been packaged; it must be thrown into a machine press   | The distance between a palette and press the hand is not reachable | 42                  |
| 5   | Weight less                                                                    | Performance of filling korin machine reduced         | 42                  |

4. Conclusion

After identifying and analyzing, this research provide company to minimize waste. In the production of chili sauce, for critical waste in the form of moving a labeling table close to the sauce palette, researchers provide a better form of regional packaging and use conveyors to move cans to be packed. In critical waste repetition activities from the inspection of firmness of closure, researchers have the form of a standard arrangement of the process of checking firmness to be done sequentially from right to left or from left to right and continuously without stopping. In critical defect waste, closing the proposed proposal is a manual replacement tool that uses an automatic lid binding machine. While shrimp paste production, the critical waste manual re-sorting and skin stripping proposed is to determine and standardize Rpm and the appropriate amount of release rubber. In cleaning critical wastes, the raw material that is roasted when entering the cooking tank proposal gives researchers to use hopper funnels. Critical waste that is waiting to be repaired because of the downtime proposed by researchers is to schedule services, replace components, and always take care of the engine after use. This is critical waste in the form of removing shrimp paste which is packed into the press, the researcher has the right to use a packaging machine to use the conveyor to move the product to the press machine. In less critical wastes, namely downtime, researchers provide advice in the form of service schedules, replace components, and always maintain engine maintenance after use.

References

[1] Kostic, N. S., and Nikolic, I. (2013). Lean Six Sigma in Food Industry. Serbia: International Journal of Basic and Applied Sciences, 13, 2227-5053.
[2] Hassan, M. K. (2013). Applying lean six sigma for waste reduction in a manufacturing environment. American Journal of Industrial Engineering, 1(2), 28-35.
[3] Kornfeld, B., and Kara, S. (2013). Selection of Lean and Six Sigma projects in industry. International Journal of Lean Six Sigma, 4(1), 4-16.
[4] Pusporini, P., and Andesta, D. (2012). Integrasi Model Lean Sigma Untuk Peningkatan Kualitas Produk. Jurnal Teknik Industri, 10(2), 91-97.
[5] Panat*, R., Dimitrova, V., Selvy Selvamuniandy, T., Ishiko, K., and Sun, D. (2014). The application of Lean Six Sigma to the configuration control in Intel’s manufacturing RandD environment. International Journal of Lean Six Sigma, 5(4), 444-459.
[6] Girmanová, L., Šolc, M., Kliment, J., Divoková, A., and Mikloš, V. (2017). Application of Six Sigma using DMAIC methodology in the process of product quality control in metallurgical operation. *Acta technologica agriculturae, 20*(4), 104-109.

[7] Jirasukprasert, P., Arturo Garza-Reyes, J., Kumar, V., and K. Lim, M. (2014). A Six Sigma and DMAIC application for the reduction of defects in a rubber gloves manufacturing process. *International Journal of Lean Six Sigma, 5*(1), 2-21.

[8] Hakimi, S., Zahraee, S. M., and Mohd Rohani, J. (2018). Application of Six Sigma DMAIC methodology in plain yogurt production process. *International Journal of Lean Six Sigma, 9*(4), 562-578.

[9] Arafeh, M., Barghash, M. A., Haddad, N., Musharbash, N., Nashawati, D., Al-Bashir, A., and Assaf, F. (2018). Using Six Sigma DMAIC Methodology and Discrete Event Simulation to Reduce Patient Discharge Time in King Hussein Cancer Center. *Journal of healthcare engineering, 2018*, 165.

[10] Alblawi, S. A., Antony, J., and Lim, S. A. H. (2015). A systematic review of Lean Six Sigma for the manufacturing industry. *Business Process Management Journal, 21*(3), 665-691.

[11] Maleszka, A., and Linke, M. (2016). Improvement of management process by using Lean Six Sigma tools in some big organisation of food industry. *Polish Journal Of Natural Sciences, 31*(1), 101-112.

[12] Antony, J., Singh Bhuller, A., Kumar, M., Mendibil, K., and Montgomery, D. C. (2012). Application of Six Sigma DMAIC methodology in a transactional environment. *International Journal of Quality and Reliability Management, 29*(1), 31-53.

[13] Sharma, R., Gupta, P., and Saini, V. (2018). Six sigma DMAIC Methodology Implementation in Automobile industry: A case study. *Journal of Manufacturing Engineering, 13*(1), 042-050.

[14] Wahyani, W., Chobir, A., and Rahmanto, D. D. (2013). Penerapan Metode Six Sigma Dengan Konsep Dmaic Sebagai Alat Pengendali Kualitas. *Institut Teknologi Adhi Tama Surabaya (ITATS), Surabaya*.

[15] Isa, M. F. M., and Usmen, M. (2015). Improving university facilities services using Lean Six Sigma: a case study. *Journal of Facilities Management, 13*(1), 70-84.

[16] Hindom, S. D., Poeng, R., and Lumintang, R. C. (2015). Pengaruh Variasi Parameter Proses Pemesinan Terhadap Gaya Potong pada Mesin Bubut Knuth DM-1000A. *JURNAL ONLINE POROS TEKNIK MESIN UNSRAT, 4*(1).

[17] Gupta, S., and Jain, S. K. (2013). A literature review of lean manufacturing. *International Journal of Management Science and Engineering Management, 8*(4), 241-249.

[18] Laureani, A., and Antony, J. (2017). Leadership characteristics for lean six sigma. *Total Quality Management and Business Excellence, 28*(3-4), 405-426.