Analysis of Quality Control of Chicken Nugget Products by Using Six Sigma Method at PT. XYZ

Neldo Irawan*, Anny Ratnawati, and Salsa Dilla
School of Business, IPB University, Bogor, Indonesia

*irawanneldo@gmail.com

Abstract. PT. XYZ is a company that produces chicken nugget. The company faces quality problems, namely the discovery of defective products. The purpose of this research was to identify and analyze the factors causing the occurrence of defective products in the chicken nugget production process; analyze product quality and propose improvements in improving product quality. The data collection techniques used were interviews, observations and documentation conducted for 1 month on February 13, 2020 to March 13, 2020. The Six Sigma method chosen in this study as an approach to the problem that consists of 5 stages, namely, Define, Measure, Analyze, Improve and Control. The value of Six Sigma for each process was 3.69 (Industry average in Indonesia) for the selection and preparation of raw materials, 4.1 (Industry average in Indonesia) dough cutting process and 4.3 (Industry average in USA) for the coating process of cuts. The proposed strategy is divided into 6 short-term proposals and 4 long-term proposals. If this defect product problem is solved, it can maintain the brand image, reputation, profitability, and sustainability of the company. Some proposed improvements that have been applied were found to decrease the number of defects as much as 48% in dough cutting process and coating of cuts. In addition, the company could potentially maximize profits by cutting losses by approximately 8 million rupiah/year.

Keywords: Chicken Nugget, Quality Improvement, Six sigma.

1. Introduction
Indonesia noted the fastest growing meat and chicken market growth with an average increase per year (Compound Annual Growth/CAGR) of 26.7% during 2011-2015, followed by India (22%), Vietnam (15.5%), China (13.9%), and Brazil (10.9%) [1]. The products are processed meat and frozen chicken. Potential prospects of the frozen food industry or frozen food is based on changes in lifestyle or lifestyle in today's society especially the millennials where it is found that today's consumers need food that is convenience, easy to carry everywhere, and ready to be served at all times. In addition, the huge population of Indonesia is a huge market potential for the food and beverage industry considering food and beverages are the primary needs of human beings. The business development of the chicken nugget Food category make the competition in this category of the market is increasingly tight. The products offered by competitors are more and more excellent. But with the sheer number of products offered from various brands makes consumers more options. Consumers can be more selective in choosing which products to consume. This can be a challenge for the company to improve or maintain the quality of its products ranging from pre-production, production, to post production through good control or quality assurance so as to produce products that comply with consumer preferences.
As one company that prioritizes and maintains the consistency of quality of products produced, PT. XYZ is a food company engaged in the field of food processing, especially frozen processed food. PT. XYZ was established in 2015 with a trademark that is currently quite recognizable. PT. XYZ has a production house located in Bogor, West Java and has 14 types of products that are divided into 7 product lines namely line nugget, line meatballs, line Ekado, line Katsu, line dimsum, chicken roll line and chicken shrimp line. PT. XYZ has just been a limited liability company since January 2020. In addition, at this time PT. XYZ does not have a division or part that is directly responsible for R&D or quality control in the company's production process so that there are still many problems experienced by the company one of which is still the number of products defect especially on one of the best products is chicken nugget. This of course becomes one of the problems that are important to be resolved by the company in a quick time considering this problem affects the brand image or reputation of PT XYZ to the front and can affect the profitability and sustainability of the company forward.

The rapid development of industry, especially in the processed food sector, needs to be addressed with efforts to continue to maintain the quality of products produced. This quality is one of the main factors in improving the competitiveness of companies and products in the market. Food processing company prioritizes the quality of its products as product value for its customers will certainly do process control measures to continuously maintain the quality of its products. On this basis, the problem of damage of chicken nuggets product in PT. XYZ becomes one of the things that must be considered so that the risk of quality reduction can be reduced and can be set effective control level. Based on the various problems above, this research aims to:

- Analyze the quality of chicken nugget products.
- Identifying and analyzing factors-the cause of defective products in the production process of chicken nugget PT. XYZ.
- Provide improvement proposal in the quality improvement of chicken nugget products.

2. Materials and Methods

2.1 Chicken Nugget

Nugget is one of the processed meat products are printed, cooked and frozen and made from a mixture of ground meats that are given coatings or without the addition of other foodstuffs and food additives that have been allowed [2]. Nugget is one form of ready-to-food frozen food products, which is a product that has undergone heating until half cooked (precooked), then frozen [3].

2.2 Six Sigma

Six Sigma is a vision enhancing quality towards a target of 3.4 failures per million chances for each transaction of goods and services [4]. Basically customers will feel satisfied when they receive their expected value [5]. The key aspects to note in Six Sigma concept applications are:

- Customer Identification
- Product Identification
- Identify the need in producing products for customers
- Defining the Process
- Avoid mistakes in the process and eliminate all existing wastage
- Continuously improving the process to Six Sigma targets

There are several benefits of Six Sigma for the company [6], namely:

- Generate sustainable success.
- Set performance objectives for everyone
- Reinforce customer value
- Accelerate the level of improvement

2.3 Six Sigma Step

The repair process in Six Sigma is known for its several stages, Define, Measure, Analyze, Improve, Control (DMAIC). DMAIC is a process for continuous improvement (cycle) to Six Sigma targets, these
steps are performed systematically based on science and fact. The DMAIC includes steps that need to be carried out sequentially, each of which is critical to achieving the desired outcome. The successful implementation of the Six Sigma Quality Improvement Program is demonstrated through improved process capabilities to deliver products to zero failure rates.

2.4 Research Design

This research uses two types of data, namely quantitative and qualitative. The method of data collection used in this study is to conduct direct observation in the company that becomes the object of research. The data collection techniques undertaken are interviews, observations and documentation. The sampling technique taken is to use a non-probability sampling method i.e. purposive sampling. Consideration of choosing the informant conducted on this research is the informant that is directly related to operational management and has an understanding of the production process and identification of products defect faced by the company and how much the role of the informant chosen in the research process. The informant chosen in this research is an expert from the company's internal parties. Experts in the research are the company's director, operational supervisor, and the production head on the downstream line, as well as production officers.

3. Results

3.1 Product quality analysis with Six Sigma methods

3.1.2 Define

Define is the first stage in the Six Sigma process. Phase define describes issues related to quality standards or defines the causes of defective products that are the most potential cause of product results. Based on the existing problems, the product defect derived from the production portion of raw material preparation, dough cutting section, and coating parts. Based on the existing problems, the product defect derived from the production portion of raw material preparation, dough cutting section, and coating parts. The following are the results of defect products that can be seen in the table of

| No | Process                                      | Damage               | Description                                    |
|----|----------------------------------------------|----------------------|-----------------------------------------------|
| 1  | Selection and preparation of raw materials  | Chicken does not conform to standard | Chicken fillet that will be processed not as standard as dirty, excess fats, or |
| 2  | Cutting dough                                | Too thin or too wide | The cut form of the dough does not fit the standard shape like too thin, wide, or different from the |
| 3  | Cutting coating                              | Broken               | Perforated or crushed pieces                  |
|    |                                              | Fracture             | Fractured cut                                  |

Reports of production of a chicken nugget that was observed and taken for analysis is a report from 14 February to 14 March 2020 as much as 12 production described in table 2. From the production report in the period, the total known production target in the recent month as much as 11.526 PCs chicken nuggets, but the production of good quality as much as 11.091 PCs chicken nuggets or with an average of 924.25 PCs per production.
Table 2. Production Report of Chicken Nugget Pt. Xyz

| No  | Tanggal   | Target Produksi | Jumlah Produksi | Defect Produk | Pemotongan Adonan | Pelapisan Potongan |
|-----|-----------|-----------------|-----------------|---------------|-------------------|-------------------|
| 1.  | 14        | 481             | 450             | 17            | 10                | 4                 |
| 2.  | 19        | 1073            | 1020            | 36            | 5                 | 12                |
| 3.  | 21        | 1431            | 1395            | 23            | 7                 | 6                 |
| 4.  | 24        | 1056            | 1005            | 35            | 8                 | 8                 |
| 5.  | 26        | 1114            | 1056            | 44            | 6                 | 8                 |
| 6.  | 28        | 850             | 825             | 18            | 4                 | 3                 |
| 7.  | 2 Maret   | 1355            | 1305            | 43            | 2                 | 5                 |
| 8.  | 4 Maret   | 992             | 960             | 24            | 4                 | 4                 |
| 9.  | 6 Maret   | 941             | 915             | 22            | 4                 | 1                 |
| 10. | 9 Maret   | 968             | 930             | 33            | 1                 | 4                 |
| 11. | 11 Maret  | 807             | 780             | 22            | 3                 | 2                 |
| 12. | 13 Maret  | 458             | 450             | 7             | 1                 | 1                 |
|     | Total     | 11526           | 11091           | 324           | 55                | 58                |
|     | Rata - rata | 960.5       | 924.25          | 27            | 4.6               | 4.8               |

The Defect is produced in this period as much as 437 PCs of chicken nuggets with details of 324 PCs on the selection process and preparation of raw materials, 55 PCs on the dough cutting process, and 58 PCs on the coating process pieces.

3.1.3 Measure

CTQ (critical to quality) is an attribute that is very important to note as it relates to the resulting product. This method describes the results of identification for the results of the damaged and unsold product. The results of identification indicate that the critical to quality (CTQ) in the process of making chicken nuggets can be seen in Table 3.

Table 3. Ctlq Process Of Making Chicken Nuggets

| No  | Process Description                   | CTQ                          | Description                                      |
|-----|--------------------------------------|------------------------------|--------------------------------------------------|
| 1.  | Selection and preparation of raw chicken materials | Large fatty/boned chicken fillet that will be processed not as standard as dirty, excess fats, or bony |
| 2.  | Cutting dough                        | Uneven cuts                  | Wide cut, too thin, because the previous process is less uneven or human resources skills are not good |
| 3.  | Cuts coating                         | Dough/perforated, short, or broken pieces | Chicken Nuggets crushed |
|     |                                      | Method accuracy              | Availability of tools and human resources skills are not good |
After calculating the CTQ, it is necessary to do a control chart analysis of each process resulting in a defective product.

From the control chart in Figure 1, it can be noted that, the production process of selection and preparation of raw materials is controlled, it is evidenced that there is no defect level that exceeds the Upper Control Limit (UCL). However, it can be seen in production batches of 1, 2, 4, 5, 7, and 10 are the defect levels exceeding the defect average or P Bar line.

**Figure 1.** Selection and raw material preparation process control chart

From the control chart in Figure 1, it can be noted that, the production process of selection and preparation of raw materials is controlled, it is evidenced that there is no defect level that exceeds the Upper Control Limit (UCL). However, it can be seen in production batches of 1, 2, 4, 5, 7, and 10 are the defect levels exceeding the defect average or P Bar line.

**Figure 2.** Cutting dough process control chart
The control chart in Figure 2 shows that the dough cut production process is uncontrollable, which is evidenced by the defect level that exceeds the Upper Control Limit (UCL), i.e. in the first batch production. Thus, this is one of the reasons why PT XYZ should seek improvement strategies to reduce the amount of defect, in order to increase their productivity again. Several improvement strategies have been implemented since the 6th production, this leads to defect levels likely to be closer to the Lower Control Limit (LCL) line and below the average or P bar line.

The recapitulation process also shows in 2 processes i.e. dough cutting and coating of pieces found there is a decrease in the number of defect products as much as 48% after applied several proposed improvements ranging from batch 6 production. Product defect on 2 process is dough cutting and coating of chunks from batch 1 to 5 (before repairs) amounted to 74 and when repairs applied only amounted to 39 in batch production 6 to 12 (after repair)

The next step is to calculate the Defect Per Million Opportunity (DPMO) value and the Sigma value for each process. DPMO itself is a failure size in Six Sigma that can show failures per a million occasions. The goal of DPMO itself is to measure how many Six Sigma levels are caused by the defect. The counting process is also important to know the position of the company, especially in certain processes that have been selected, which is the process that produces the product defect.
Table 4. The Process Capability Of Making Chicken Nugget

| Step | Action                                         | Calculation result |
|------|-----------------------------------------------|--------------------|
| 1    | Process                                       | Selection and preparation of raw materials | Cutting dough | Cuts coating |
| 2    | Production Unit                               | 11,526             | 11,526         | 11,526       |
| 3    | Failed Unit                                   | 324                | 55              | 58           |
| 4    | Defect Rate                                   | 0.02811            | 0.00477         | 0.00503      |
| 5    | CTQ                                           | 2                  | 1               | 2            |
| 6    | DPO                                           | 0.014055           | 0.00477         | 0.00251      |
| 7    | DPMO                                          | 14,055             | 4,770           | 2,510        |
| 8    | Sigma Value                                   | 3.69               | 4.1             | 4.3          |
| 9    | Conclusion                                    | Industry average | Industry average | Industry average |

Table 4 explains the result of the value of Sigma and DPMO capabilities for selection and preparation of raw materials, dough cutting, and coating. i.e. quantity of chicken nuggets produced is 11,526 whereas as many as total 437 chicken nuggets failure/defect with 324 details in the selection process and preparation of raw materials, 55 on the dough cutting process, and 58 on the coating process pieces. CTQ in the process of selection and preparation of raw materials as many as 2 problems are too much fat or bony chicken, and dirty chicken. CTQ in the process of cutting dough as much as 1 problem is too wide or thin cut. CTQ on the coating process of 2 pieces of problems namely the broken/crushed nuggets and coating method that is less precise because of the availability of human resources tools or skills. The DPO obtained from the unit failed to be divided by the production amount is 0.014055, 0.00477, and 0.00251. After obtaining the DPO value, then converted into DPMO value obtained from the DPO value multiplied by 1 million obtained DPMO value of 14.055, 4.770, and 2.510. The DPMO value is then converted into the Sigma Value conversion table, the conclusion of table 3 capability Sigma of the process of each process shows the number 3.69, 4.1, 4.3 which means the same as the Indonesian industry average in the process of selection and preparation of raw materials. It is stated, that product defects in the selection and preparation of raw materials are considered to be less optimal then the repair strategy needs to be done in order to reduce the defect level. While in the process of cutting dough and coating pieces mean the same as the industry average USA. It can be concluded that the product defect in the dough cutting part is still considered to have not affected the product productivity and still be mined reasonable, but the repair strategy can be done to make the defect level less. In addition, when viewed from the company's economic and financial perspectives, 21,335 defective products are worth Rp 49,781,000 which means the company loses Rp 49,781,000 each time 1 million products produced or loses about 8 million rupiah annually from only one product variant.

4. Discussion

4.1 Analysis of the cause of defective products

Analyze

The results of the above three processes are the point of issue, have the value Sigma entered in the category of industry averages Indonesia for the selection process and preparation of raw materials and 2 other entered in the industry average category USA is the process of cutting dough and coating dough.
This shows that the current process is still less good and not optimal because there are still defects but potentially improved by the application of improvement measures to improve the quality of the product. Therefore, the analyse stage aims to identify and detect for certain causes that affect the defects/defect of the product.

The Fishbone diagram analysis is the next step. This diagram is a diagram used to identify elements of alleged causes that may pose problems related to the product, in this case is the product defect. This diagram serves to help identify the cause of an issue that can affect a production within the company. From the results of the observation gained that there are several factors such cause are human factors, working methods, machine, motivation and materials.

![Fishbone diagram analysis](image)

**Figure 4. Main causes of defective products**

Figure 4 shows that there are several causes that are the main cause in producing defective products including:

- **Untrained personnel**
  The poorly trained officers of course can be the main cause that causes the emergence of defective products, poorly trained officers can cause the possibility of human error increasingly higher so that the output of production will be disrupted and not optimal.

- **Dough not as per standard**
  Dough making is one of the most important processes in the manufacture of chicken nuggets, uneven dough will make the process – subsequent processes such as cutting the dough and coating the dough pieces will not run optimally and are likely to produce a higher damaged/defective product.

- **machines/tools are still not effective and efficient**
  Machines that are currently available have not been able to process the production capacity is large enough. In addition, in some processes still have to be done manually considering that the tool or machine available is not effective and efficient so it can cause WIP (wait in process) and longer production time. This of course potentially lead to employee fatigue and loss of concentration when conducting the production of chicken nuggets.

- **No person in charge in any part of the process**
  The absence of responsibility in each part of the process becomes one of the main causes of remembering this can cause employees to do the process that the officer is not skilled in doing.
so. A PIC (person in charge) appointment can be an option for the company to optimize every part of the production process and ensure that every part of the production process is done by the experts in their field.

- **No application of quality control tools**
  So far, PT. XYZ has not implemented quality control equipment so that employee awareness to suppress the number of defective products tends to be low. In addition, there is no application of quality control tools causing supervisors do not have a tool that is used as a reference to measure production performance or employee performance. The absence of regular meeting of the production team resulted in controlling activities from the office and the production party has not been formed properly. Examples are the mechanisms of reporting defects products, techniques or schedules of surveillance, good or bad performance measures, or the application of reward and punishment in PT. XYZ.

- **Raw material quality was not good**
  There is no standard for input in the procurement process. The absence of standards for input entered in the production process of chicken nuggets resulted in the raw materials used can be substandard or outside the provisions of the company.

### 4.2 Proposed improvement strategy

**Improve**

Improvement Stage is a stage of improvement that is done to produce solutions to the problem of causing defects in the chicken nuggets. Based on the results of observation, analysis, and discussion done then there are several things that should be proposed to do the improvement to get maximum results, so as to reduce the level of product defects. The proposed improvement is divided into 2 namely the proposed repairs that can be executed immediately (short-term) and proposed repairs that will be applied when the company has run longer or the scale of production done by the company has become larger.

#### 4.2.1 Proposal for short-term repairs

- To make the standard for the input goods in the procurement process and technical SOP of work (cut size, reporting, and supervision).
- Appointment of person in charge (PIC) of any critical process.
- Addition of re-check process in dough leveling activities.
- Application of quality control equipment (check sheet).
- Create regular meeting of production team and reward and punishment system implementation.
- Addition of tools in the coating process cuts.

#### 4.2.2 Proposed long-term improvement

- Addition of part in company structure. One of the parts required by the company is a research and development section that focuses on product research and development so that the company will remain active and adaptive to changes in the field and can create innovations that increase the competitive advantage owned by the company. In addition, the addition of quality control and quality assurances is also needed by the company to maintain or improve the quality of products produced by PT. XYZ in terms of inputs (pre production), process (production) and output (post production). This QA and QC can also serve as a controlling media so that the fundamental improvement strategies that have been applied in the short term remain awake and carried out according to predefined standards.
- Do data collection or recapitulation of updated and wider vendor. This vendor data collection is required to provide the company with the option to obtain optimal inputs and to the new standards set by the company. The larger production scale of course needs to be well-addressed, one of which provides the right options-options of the supplier either in materials, machinery, packaging, or other inputs.
- Develop or create a new working culture with not only prioritize the family aspect but a high professionalism aspect.
- Implement a better employee recruitment system.

**Control**

The control phase is the last operational stage in the Six Sigma Quality Improvement project. At this stage the results of quality improvement are documented and disseminated and used as a standard working method, as well as ownership or responsibility of the process which means the Six Sigma project ends at this stage. With the improvement in each process that follows the pattern of the DMAIC cycle (Define, Measure, Analyse, Improve, and Control) through this way there will be improvement in terms of organizational management and is the institutionalization of learning and sharing or transferring new knowledge in the Six Sigma organization.

**Table 5. Proposed Control Measures Using Managerial Approaches**

| Before repair | Repair plan | Proposed control |
|---------------|-------------|------------------|
| There has been no procurement technical work (example: technical reporting, production, production process) | Creating will be input can enter production technical standards work the parties | To do data recapitulation of strengthening activities. |
| There is no charge charge (PIC) handles an activity or activity that becomes a production. | Pointing to PIC in each production activity based on the work performance | Implementing a reporting system through media that has already been created and agreed upon |
| Operator in the leveling the dough standard so that uneven and defective products processes. | Standard dough is well defined and done-re-check before to the next process (dough cooking) | Provide training to each worker in the alignment part of the dough according to the specified operating |
| There is no tool reporting the the production reducing the awareness of | Make a check sheet as a tool or media quality controller. | Provide standard reporting and use of quality media. |
| There are no recurring meetings between the production team, output so that there is no application of | Create a monthly recurring meeting agenda to prepare for production to be done or evaluate the production | Develop or create a new working culture. |
| The capacity available in the coating process is | Conducting procurement of tools in the | Carry out an inventory of suitable goods |
so the product is und at risk of defects. coating process of cutting. accordance company's new standards as well as to make preventive constraints in the

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