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The Quality Of Brick Products In Brick Production Process Using Six-Sigma Method At A Brick Factory In Deli Serdang Regency

*Risma Sinaga
Department Of Industrial Engineering, Faculty Of Engineering, University Of Sisingamaraja XII, Medan - Indonesia
Corresponding Author: Risma Sinaga

***Abstract**: Increasingly tight competition in a business world drives companies to further develop ideas to obtain an effective and efficient way in order to achieve organizational goals and objectives that have been set. The same case lies with a Brick Factory in Deli Serdang regency, as one of the companies in plastic manufacturing industry. This paper aims to measure the level of quality of brick production process by using Six Sigma method. Six Sigma is a vision in improving quality to reach a target of up to 3.4 DPMO (Defect per Million Oppurtunity) through Six Sigma phases, namely: Define, Measure, Analyze, Improve, Control (DMAIC). At the measure phase, the results showed the defect of 23,239 DPMO that produces 3.44 sigma level, while the provision of six sigma is 3.4 DPMO or 3.6 sigma level. By using the six sigma method through a series of activities of Define, Measure, Analyze, Improve, Control (DMAIC), it is expected that solutions are provided to achieve the defects target particularly that of the most critical one.*

***Keyword**: Six Sigma, Production, Product Quality ,Brick Prodution, Factory*

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I. INTRODUCTION

A product with high quality is one of the keys to winning market competition. A product can only survive if the product has strong competitive advantages over other similar products. This competitive advantage is primarily aimed at product quality. To be able to produce products that meet consumer's quality standards, quality equipment and quality production processes shall be provided. From the results of observations made on the brick molding processing at the Bricks Production factory in Deli Serdang, it was found that the quality of brick products produced was always varied and sometimes did not meet the specified quality specifications. This leads to the need of conducting a research in order to determine causing factors and ways to control the production so that the quality of bricks produced satisfy specified quality specifications. Six Sigma is a method that can be used to monitor the quality of processes or products produced by the company. This method can be used to measure the level of quality that has been achieved by a company. Therefore, the use of Six-Sigma method should be tested in this research of Product Quality of Brick Production at a Brick Factory located in Deli Serdang regency.

II. LITERATURE REVIEW

Definition of Quality

The word quality has many different definitions, and varies from conventional definitions to more strategic definitions. The conventional definition of quality usually describes direct characteristics of a product such as performance, reliability, ease of use, and so on. However, managers of a company who are in competition in a global market should pay serious attention to strategic definitions, in which quality is defined as everything that is capable of meeting the needs of customers. In everyday life, we often hear people discussing the topic of quality, including the quality of foreign-made products perceived to be better off than those of domestic products. How is quality substantively defined? This question has unlimited answers, since the meanings differ from one individual who defines it to another and depends on the context. Quality itself has several characters that are constantly changing. In principal, modern quality system can be characterized by five characteristics as described below: (Vincent Gasperz, 2002)

1. Customer-oriented modern quality system.
2. Modern quality system is characterized by active participation by top management in the process of continuous quality improvement.
3. Modern quality system is characterized by each person's understanding towards specific responsibility for quality.
4. Modern quality system is characterized by activity of damage prevention-oriented measures, rather than activity oriented towards detecting damages only.
5. Modern quality system is characterized by a philosophy which assumes that quality is "way of life".

Product quality is important aspect for consumers. Product quality, whether in the form of service or product need to be defined by its dimension.

Definition of Control

Control is part of a management. Control is performed with the aim that what has been planned can be implemented properly so that it can achieve the target and the goals at the same time. Control is indeed one of the tasks of a manager. It is noteworthy to know that control and supervision are two different things, where supervision is part of a control. If control is followed up with corrective action, then supervision is a field examination which is conducted over a certain period on a repeated basis.

Six Sigma Method

Six Sigma is best defined as a method for improving business process that aims to discover and mitigate the cause factors of defects and errors, to reduce cycle time and operating costs, to improve productivity, to meet customer needs effectively, and to earn better return on investment in terms of production and service. One of the major long-term goals of all organizations that implement the Six Sigma philosophy is to be able to perform all important processes, regardless of their functional areas, at the level of six sigma capabilities. Six sigma method was discovered by Dr. Joseph Juran in 1964 by in his book entitled “Managerial Breakthrough”. This book distinguishes between controls, which means there is no change, and breakthroughs, which means there is a change. According to the six sigma program implementation manual written by Vincent Gaspersz, 2002 Six Sigma is a dragmatic method of controlling and improving quality applied by motorola companies since 1986 which was a new breakthrough in the field of quality management.

Defining Process Capacity for Variable Data

Common terms in six sigma are:

According to Vincent Gaspers (2002), there are some general terms in Six Sigma motorola namely:

a) *Black Belt*
b) *Greeen Belt*
c) *Master Black Belt*
d) *Champion*
e) *Critical to Quality (CTQ)*
f) *Defect*
g) *Defect per Million Oppurtunities*
h) *Process Capabilit*)
i) *Variation*

Phases in Six Sigma

Six sigma improvement program can be implemented using DMAIC (Define, Measure, Analyze, improve, and control) approach.

Define (D)

Define (D) is the first operational step in improving *Six Sigma* quality. At this phase, it is necessary to identify some things related to making the order of processes that occur.

Measure (M)

*Measure i*s the second operational step in an advanced program of *Six Sigma* quality improvement program. In quality management, the measurements will generate data of which once the data are analyzed properly, they will provide accurate information, and the information will be benefitial for increasing managers' knowledge in making decisions or taking management actions so as to improve quality.

Analyze (A)

Analyze (A) is the third operational step in *Six Sigma* quality improvement program. At this phase, it is necessary to investigate the sources and causes of defects or failure so that measures can be taken in order to improve performance of industrial processes using the help of *statistical tools*.

Improve (I)

Improve is the fourth phase in *six sigma*. Once the sources and root causes of quality are identified, it is necessary to apply action plans to implement *Six Sigma* quality improvement.

Control (C)

Control (C) is the last operational phase in Six Sigma quality improvement project. At this phase, as the process can be improved or repaired, the quality improvement results are documented and disseminated, the best practices that are successful in improving the process are standardized and made as work guidelines. New measurements have been obtained and can serve as a basis for continuous quality improvement. Further, Six sigma on other areas in the process or business organization is defined as new projects that must comply with DMAIC cycle *(Define, Measure, Analyze, improve, and control).* With this method,there will be increased integration, institutionalization, learning, and sharing or transfer of new knowledge in *Six Sigma* organizations.

Problem Solving Tool Type

Several tools have been created to help solve problems in quality control. Some organizations from other parts of the world have modified and adapted one or more of these *"tools"* of which they think are also *"basic"* for their operations. The tools used to solve the problem of quality control are as follows:

Check Sheet

Check sheet is a practical tool used to collect, group and analyze data simply and easily. The forms of *check sheets* vary according to their own needs and design. For example, *check sheets* for the production of certain basic materials differ from those of for the warehouse maintenance. Data should be presented in a form that can be used and analyzed quickly and easily. If possible, *check sheets* are also designed to provide information on time and location data where inconsistencies occur, since creativity plays a very important role in *check sheets* design.

Data Sufficiency Test

In this case, data adequacy test uses data of observation instead of total questionnaires. This means that observation data used derived from the variable or question of the questionnaire which is usually in the form of likert scale (1-5) or (1-7) and so on. This data adequacy test applies the following formula:

$$N' = \left(\frac{k/s\sqrt{N\left(\sum X^2\right) - \left(\sum X\right)^2}}{\sum X} \right)^2$$

Where:

N ' = Number of observations that should be done.
K = The level of trust in observation.
If confidence level is 99%, then k = 2.58 ≈ 3
If confidence level is 95%, then k = 1.96≈ 2
If confidence level is 68%, then k≈ 1
S = Degree of accuracy in observation.
If confidence level is 99%, then s = 1%
If confidence level is 95%, then s = 5% and so forth
N = Number of observations done.
Xi = Data of Observation.

The determination of k/s is based on your trust of the data collected that should amount to 99% which means that the data are trusted, accurate, thus leading you to use k=99%=3, hence leaving the error caused is only 1% which means that you use s=1% (K=99%+s= 1% then 100%), however, if you are less confident with your data because, as you take the data, you are sleepy and consequently your respondents do not understand your explanation, then your error could be s=5% so k=95%. Then if N ≥ N', which leads to the conclusions that the data is sufficient to be a sample.

Control Chart or Control Chart

Control chart is a graph used to determine whether a process is in a stable state or not. If all data are within the control limit, then the process is said to be within the control limits. This chart shows changes over time but does not indicate the cause of the deviation, although irregularities will be seen in the control chart. This chart is a line graph showing maximum and minimum limits that constitute as control areas.

Chart control can be divided into two general types, namely:

1. Attribute control charts (properties) are used when the quality cannot be expressed numerically.

The three attribute control charts used are:

1. Control chart for rejected part (p)

Related to non-conforming product parts produced by a process and is called control chart for the rejected part or part p.

2. Control chart for nonconformity (c)

This chart is designed to study the number of defects or non-conformities observed from non-conforming parts.

3. Control chart for per-unit nonconformity (µ)

This chart is useful in circumstances where the average number of per unit nonconformity is a better basis for process control.

2. Control chart variable is used when quality characteristics can be measured and expressed in numbers.

Variable control chart is divided into:

1. $\overline{X}$ and R control chart

Average (x) quality level process is usually controlled by a recognizable chart. Dissemination can be controlled by a control chart or a range called R chart.

2. $\overline{X}$ and S control chart

If the sample size (n) is large enough (n> 10), the range method loses its efficiency, since the range ignores all information in the sample between Xmin Xmax.

3. Individual control chart (X)

This chart is used when the sample size (n) = 1. This often happens when:

a. Measurement inspection and technology are automatic and each production unit is examined.
b. Production level is too slow to use sample size n> 1.
c. Unavailability of data is very slow and waiting for larger samples is impractical or make the whole control procedure too slow to react to problems.
d. Repeated measurements are different due to laboratory or analysis errors, as in many chemical processes.

This control chart may provide three kinds of information that are all required to fulfill the next phase.

The three information include:

1. Diversity of basic quality characteristics.
2. Consistency of appearance (performance).
3. Average level of quality characteristics.

Steps in using $\overline{X}$ and R control chart:

1. Preparing for determination in control chart:

- Determining the purpose of using control chart
- Selecting a variable
- Setting the basis for making sub-groups
- Setting the size and frequency of sub-groups
- Preparing data sheet form
- Specifying measurement method

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2. Starting to use control chart

- Making measurements
- Creating measurement results and other related data.
- Calculating $\overline{X}$ average for each subgroup

$$\overline{X} = \frac{x1 + x2 + x3 + \ldots + Xn}{n} \quad \text{or} \quad \overline{X} = \frac{\sum_{i=1}^{n} Xi}{n}$$

- Calculating range for each subgroup

R = Xmax - Xmin

Where: Xmax = the largest data in a subgroup

Xmax = the smallest data in a subgroup

- Plotting $\overline{X}$ chart
- Plotting R chart

3. Determining the limits of research control
   - Specifying the number of subgroups needed before the control limits are calculated
   - Calculating R, range average

$$\overline{R} = \frac{R1 + R2 + R3 + \ldots + Rn}{n} \text{ atau } \overline{R} = \frac{\sum_{i=1}^{n} Ri}{n}$$

- Calculating the upper and lower control limits for R
- middle line = $\overline{R}$

Upper Control Limit (UCL) = D4. $\overline{R}$

Lower Control Limit (LCL) = D4. $\overline{R}$

- Calculating $\overline{\overline{x}}$, the average of $\overline{x}$ value

$$\overline{\overline{x}} = \frac{\sum_{i=1}^{n} \overline{xi}}{n}$$

- Calculating the upper and lower control limits for x

middle line = $\overline{\overline{x}}$

UCLx = $\overline{x}$ + 3 σ x for A2R = 3 σ x then UCLx = $\overline{\overline{x}}$ + A2. $\overline{R}$

LCLx = $\overline{x}$ – 3 σ x for A2R = 3 σ x then LCLx = $\overline{\overline{x}}$ – A2. $\overline{R}$

Where: A2, D3 and D4 are obtained from the table based on the number of subgroups in the appendix.

- Describing the centerline and boundary lines on the chart

4. Preliminary conclusions from the charts
   - Identifying control or lack of control.
   - A clear connection between what is being done by the process and what the process should do.
   - Actions proposed by control chart

th5. Continuing the use of chart
- Revising the centerline and control limits for $\overline{R}$
- Revising the centerline and control limits for $\overline{x}$
- Using charts for taking actions related to the process
- Using charts for taking actions related to specifications.

Revision of $\overline{X}$ and R control chart

If there is data outside of control limits in which the cause can be detected, a revision of the control chart is made by removing data outside of control limits and recalculating the control limits.

New prices for $\overline{x}$, R, and σ are:

$$\overline{\overline{X}} \text{ new} = \frac{\sum x - \overline{x_d}}{g - g_d}, \ \overline{R} \text{ new} = \frac{\sum R - R_d}{g - g_d} \text{ and } \sigma_o = \frac{R}{d_2}$$

Control limits for the new $\overline{X}$ chart are:

UCLx = $\overline{\overline{X}}_O$ + A. σ_o

LCLx = $\overline{\overline{X}}_O$ - A. σ_o

The control limits for the new R are:

UCLR = D2. σ_o

LCLR = D1. σ_o

Where : $\overline{X}_d$ = **O**ut-of-control sub-group prices.

R_d = Out-of-control price range.

g_d = Out-of-control amount of data.

The amount of d1 A, D1 and D2 is the factor for forming a variable control chart and is obtained from the table provided in the attachment. The basic difference of out of control on the $\overline{X}$ and R control chart are:

1. To find R (range), by entering the price of D4, and D3 in the appendix table.
2. To search for UCL and LCL on R chart, $\overline{X}$ price is not included, while to search for UCL and LCL on $\overline{X}$ price, R chart is included. LCL on R chart is always 0 (zero) for D3 price in the table.

Stratification

Stratification is an effort of grouping data into groups of similar characteristics. The purpose of stratification is to find the main factor and thoroughly study problems at hand. Criteria for good stratification are:

a. Type of damage
b. Cause of damage
c. Location of damage
d. Material
e. Product
f. Production date
g. Work group
h. Individual operator, and others.

Opportunity-Based Measurements

Below are some terms and methods for calculating opportunity-based measurements (Peter S. Pande, 2002):

a. Unit, an item being processed, service or final product, which is being delivered to customer, such as: a car, hotel services, and more.
b. Defects, failure to meet customer requirements
c. Defect per Opportunity, indicating the proportion of defects on the total number of opportunities in a group.
d. Defect per Million Oppurtunities, indicating the number of defects that appear in a million occasions.
e. Sigma size, size obtained by converting DPMO value by using sigma size table.

Steps in Calculating Sigma Level

The following are the steps that can be used in calculating sigma level, (Vincent Gaspers, 2002):

1. Determining what process is being measured
2. Determining the number of units examined through the process
3. Determining the number of failures that occur
4. Calculating the degree of aggravation
5. Determining the number of CTQs that may result in defects or failures
6. Calculating Defect per Opportunity (DPO)

$$DPO = \frac{Jumlah\ Defect}{Jumlah\ Unit \times Jumlah\ CTQ}$$

7. Calculating Defect per Million Oppurtunities (DPMO)

$$DPMO = DPO \times 1.000.000$$

Converting DPMO into sigma scale using sigma table contained in attachment

III. RESEARCH METHODOLOGY

Preliminary studies

The preliminary study was conducted with the aim of discovering company's real condition for it to be used as the basic rationale in the next phases.

Literature review

A case study was conducted with the aim of identifying appropriate method for data processing suitable with the data.

Data collection

The data were collected in the following ways:

1. Conducting direct observation over the object under study for the purpose of getting data on the number of defective products.
2. Conducting interviews with the company that can help provide information needed to support discussion section.

Data processing

After performing data collection, then the next phase to be done is data processing. Phases of data processing using Six Sigma method are as follows:

1. **Define (D)**
2. **Measure (M)**
3. **Analyze (A)**
4. **Improve (I)**

Control (C).

IV. DATA COLLECTION AND DATA PROCESSING

Data collection

Data obtained from this company were done in several ways, among others:

1. Making direct observation.
2. Documenting data and information available in the company.
3. Conducting interviews with the parties who can provide necessary information.

The data obtained resulted from observations conducted at a Bricks Factory in Deli Serdang is not a sample but all data obtained from 30-day-observation of one work shift and observation time was done for 30 working days.

Table 5.1. Data on the Number of Defects and Type of Defects in a Brick Production Process

No	Date	Total Items examined (Unit)	Type of Defect		Total Defects (Unit)
			Sompel (Unit)	Fragile Bricks (Unit)	
1	10/02/2017	1350	65	10	75
2	11/02/2017	1500	67	11	78
3	12/02/2017	1520	64	15	79
4	13/02/2017	1860	81	14	95
5	14/02/2017	1560	67	13	80
6	16/02/2017	1400	60	16	76
7	17/02/2017	1760	78	12	90
8	18/02/2017	1600	71	11	82
9	19/02/2017	1500	64	15	79
10	20/02/2017	1780	76	17	93
11	21/02/2017	1550	66	14	80
12	23/02/2017	1380	65	10	75
13	24/02/2017	1460	63	13	76
14	25/02/2017	1650	66	18	84
15	26/02/2017	1420	60	16	76
16	27/02/2017	1850	78	16	94
17	28/02/2017	1310	56	19	75
18	02/03/2017	1350	60	15	75
19	03/03/2017	1430	61	14	75
20	04/03/2017	1460	63	12	75
21	05/03/2017	1580	70	11	81
22	06/03/2017	1450	66	10	76
23	07/03/2017	1450	61	15	76
24	09/03/2017	1440	62	13	75
25	10/03/2017	1680	75	11	86
26	11/03/2017	1570	68	14	82

27	12/03/2017	1750	74	16	90
28	13/03/2017	1430	66	10	76
29	14/03/2017	1410	63	12	75
30	15/03/2017	1360	64	11	75
	Total	**45810**	**2000**	**404**	**2404**

Source: 2017 (Data processed)

Data Sufficiency Test

Based on an observation conducted, the trust level is at 95%, and the level of accuracy is 5%, then $\frac{k}{s} = \frac{2}{0,05} = 40$

$$N' = \left(\frac{k/s\sqrt{N\left(\sum X^2\right) - \left(\sum X\right)^2}}{\sum X} \right)^2$$

Table. 5.2. Data for Calculating X ^ 2 In Brick Production Process

No	Date	Total Items Examined(X)	X^2
1	10/02/2017	1350	1822500
2	11/02/2017	1500	2250000
3	12/02/2017	1520	2310400
4	13/02/2017	1860	3459600
5	14/02/2017	1560	2433600
6	16/02/2017	1400	1960000
7	17/02/2017	1760	3097600
8	18/02/2017	1600	2560000
9	19/02/2017	1500	2250000
10	20/02/2017	1780	3168400
11	21/02/2017	1550	2402500
12	23/02/2017	1380	1904400
13	24/02/2017	1460	2131600
14	25/02/2017	1650	2722500
15	26/02/2017	1420	2016400
16	27/02/2017	1850	3422500
17	28/02/2017	1310	1716100
18	02/03/2017	1350	1822500
19	03/03/2017	1430	2044900
20	04/03/2017	1460	2131600
21	05/03/2017	1580	2496400
22	06/03/2017	1450	2102500
23	07/03/2017	1450	2102500
24	09/03/2017	1440	2073600
25	10/03/2017	1680	2822400
26	11/03/2017	1570	2464900
27	12/03/2017	1750	3062500
28	13/03/2017	1430	2044900
29	14/03/2017	1410	1988100
30	15/03/2017	1360	1849600
	Total	**45810**	**70634500**

Source: 2016 (Data processed)

$$\sum X = 45810$$

$$\left(\sum X\right)^2 = 2098556100$$

$$N' = \left(\frac{k/s\sqrt{N\left(\sum X^2\right) - \left(\sum X\right)^2}}{\sum X} \right)^2$$

$$N' = \left(\frac{40\sqrt{30(70634500) - (2098556100)}}{45810} \right)^2 = 15,61$$

$N' = 15{,}61 \approx 16$
Conclusion: Since the value of N '<N (16 <30), then the observation data is sufficient.

Data processing
In data processing, *six sigma* method has several phases, as follows:
Define Phase
The define phase is the first step in *six sigma* method. At this phase, the quality of process is defined or explained by ordering the processes that occur under diagrams *Suppliers, Inputs, Processes, Outputs, Costumer* (SIPOC).
Measure Phase
The measure step is the second operational step in six sigma method. At this phase, the measurement is done on quality of brick production produced by a Brick Factory in Deli Serdang.

Defining Critical to Quality
Critical to quality is an element of a product, a process or an activity that has a direct impact on customer satisfaction. In bricks manufacturing, there are 2 types of *Critical to Quality* that affect customer satisfaction, namely:
1. Sompel
Sompel is a defect where the brick is cut off during cutting process, that is state of the brick comply with the standard set by the factory.
2. Fragile Bricks
Fragile Bricks are a type of defect where the brick is not clear or visible at all.

Control Chart
Control chart is used to investigate production process that occurs is within the control limits or not. If the process is within control limits, then it can be concluded that the process is stable, otherwise if the process is beyond control limit, the proportion of destruction, lower control limit (UCL), lower control limit (LCL), and centerline (CL) needs to be first determined. In connection with the non-conforming product parts produced by a process, then *control chart* is used for the rejected part or part p. From the data table 5.1. calculation of control limits for control chart creation is performed. The calculation of control limits are as follows:
Calculation of Control Limits

$$\bar{p} = GT = \frac{Total\ Defect\ Units}{Total\ Checked\ Units}$$

$$\bar{p} = GT = \frac{2404}{45810} = 0{,}0524$$

Sub Group 1:

$$n_1 = 1350$$

Number of defects = 75
$GT = \bar{p} = 0{,}0524$

$$BKA_p = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n_i}}$$

$$BKA_p = 0{,}0524 + 3\sqrt{\frac{0{,}0524(1-0{,}0524)}{1350}} = 0{,}0706$$

$$BKB_p = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n_i}}$$

$$BKB_p = 0{,}0524 - 3\sqrt{\frac{0{,}0524(1-0{,}0524)}{1350}} = 0{,}0342$$

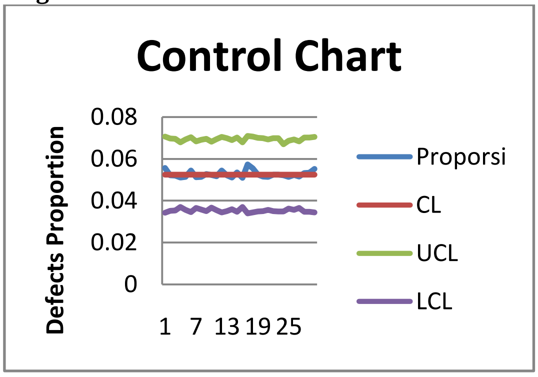
The result of control limit for next sub group can be seen in table 5.3. below:

Table 5.3. Calculation Results of Control Limits

No.	Total Examined Items(Unit)	Total Defects (Unit)	Proportion	GT	UCL	LCL
1	1350	75	0,0556	0,0524	0,0706	0,0342
2	1500	78	0,0520	0,0524	0,0697	0,0351
3	1520	79	0,0519	0,0524	0,0695	0,0352
4	1860	95	0,0510	0,0524	0,0679	0,0369
5	1560	80	0,0513	0,0524	0,0693	0,0355
6	1400	76	0,0543	0,0524	0,0703	0,0345
7	1760	90	0,0511	0,0524	0,0683	0,0365
8	1600	82	0,0513	0,0524	0,0691	0,0357
9	1500	79	0,0526	0,0524	0,0696	0,0349
10	1780	93	0,0522	0,0524	0,0682	0,0366
11	1550	80	0,0516	0,0524	0,0694	0,0354
12	1380	75	0,0543	0,0524	0,0704	0,0344
13	1460	76	0,0520	0,0524	0,0698	0,0350
14	1650	84	0,0509	0,0524	0,0689	0,0359
15	1420	76	0,0535	0,0524	0,0701	0,0347
16	1850	94	0,0508	0,0524	0,0679	0,0369
17	1310	75	0,0573	0,0524	0,0709	0,0339
18	1350	75	0,0555	0,0524	0,0706	0,0343
19	1430	75	0,0524	0,0524	0,0700	0,0348
20	1460	75	0,0514	0,0524	0,0699	0,0349
21	1580	81	0,0513	0,0524	0,0692	0,0356
22	1450	76	0,0524	0,0524	0,0699	0,0349
23	1450	76	0,0524	0,0524	0,0699	0,0348
24	1440	75	0,0521	0,0524	0,0670	0,0348
25	1680	86	0,0512	0,0524	0,0687	0,0361
26	1570	82	0,0522	0,0524	0,0692	0,0356
27	1750	90	0,0514	0,0524	0,0683	0,0365
28	1430	76	0,0531	0,0524	0,0701	0,0347
29	1410	75	0,0532	0,0524	0,0702	0,0346
30	1360	75	0,0551	0,0524	0,0705	0,0343
Total	**45810**	**2404**				

Source: 2016 (Data processed)
The above calculation results is further illustrated in the following control chart:

Figure 5.2. P Control Chart of Brick Production



Source: 2016 (Data processed)

From the picture above, it can be seen that all the processes that occur are within the control limit, thus indicates that the production process is in a stable state.

Defining Process Capability

Once the process is in a stable state, then calculation of process capability is performed. The value of the process capability for attribute data is calculated by its proportional value first, or by using a control chart calculated from its centerline. Below is the formula to calculate the process capability value for attribute data.

Determining process capability value

$$Cp = 1 - \bar{p}$$
$$Cp = 1 - 0{,}0524 = 0{,}9476$$

Process capability is the ability of the process to produce or deliver output in accordance with customer expectations and needs. From the above calculation of process capability, it can be seen that the ability of process production process in fulfilling customer needs is 94,76%.

Sigma Level Measurement

To perform Sigma level measurement, the following steps are used:

Phase 1: Determining which process is being measured

The process of which the sigma level is measured is the process of molding bricks

Phase 2: Setting the number of units examined

The number of units examined in the brick molding process is 45806 spoons

Phase 3: Determining the number of defects that occur

The defect is found on 2404 bricks

Phase 4: Calculating the defect rate (proportion)

$$\bar{p} = \frac{2404}{45810}$$
$$\bar{p} = 0{,}0524$$

Phase 5: Setting the number of Critical to Quality (CTQ)

Number of CTQ = 2 types

Phase 6: Calculating defect rate per characteristic (defect per opportunity)

$$DPO = \frac{Number\ of\ Defects}{Number\ of\ Units\ \times\ CTQ}$$
$$= \frac{2404}{45810\ \times 2}$$
$$= 0{,}0262388$$

Phase 7: Calculating defects per million opportunities

$$DPMO = DPO \times 1.000.000$$
$$DPMO = 0{,}0262388 \times 1.000.000$$
$$DPMO = 26.238{,}8 \approx 26.239$$

Phase 8: Converting DPMO value to sigma value using Conversion table DPMO (attachment)

By using DPMO conversion table to sigma value, it was discovered that with the value of DPMO 26.239, *sigma level* of 3.44 *sigma* was obtained.

From the calculation results, it was discovered that the process of molding bricks produced by the factory amounted to 3.44 *sigma*. The calculation of DPMO value for each sub group on the brick process produced by the Brick Factory in Deli Serdang is illustrated in table 5.4. below:

Table 5.4. Data on Proportion and DPMO of Brick Production Process

No.	Total Examined Items (Unit)	Total Defects (Unit)	Proportion (Pi)	DPMO
1	1350	75	0,0556	27.777
2	1500	78	0,052	26.000
3	1520	79	0,0519	23.235
4	1860	95	0,0512	25.537
5	1560	80	0,0513	25.641
6	1400	76	0,0543	27.142
7	1760	90	0,0512	25.568
8	1600	82	0,0513	25.624

9	1500	79	0,0525	26.333
10	1780	93	0,0522	26.123
11	1550	80	0,0516	25.806
12	1380	75	0,0543	27.173
13	1460	76	0,0522	26.027
14	1650	84	0,0509	25.454
15	1420	76	0,0535	26.760
16	1850	94	0,0508	25.405
17	1310	75	0,0573	28.626
18	1350	75	0,0554	27.778
19	1430	75	0,0524	26.206
20	1460	75	0,0514	25.684
21	1580	81	0,0513	25.632
22	1450	76	0,0524	26.206
23	1450	76	0,0527	26.206
24	1440	75	0,0521	26.041
25	1680	86	0,0512	25.595
26	1570	82	0,0523	26.114
27	1750	90	0,0513	25.714
28	1430	76	0,0531	26.573
29	1410	75	0,0532	26.595
30	1360	75	0,0551	27.573

Source: 2016 (Data processed)

The sigma value for each sub group can be seen in table 5.5. below:

Table 5.5. Convertion Results of DPMO Value to Sigma Value for Each Sub Group

No.	DPMO	Sigma Value
1	27.777	3,40
2	26.000	3,44
3	23.235	3,49
4	25.537	3,45
5	25.641	3,45
6	27.142	3,42
7	25.568	3,45
8	25.624	3,45
9	26.333	3,44
10	26.123	3,44
11	25.806	3,45
12	27.173	3,42
13	26.027	3,44
14	25.454	3,45
15	26.760	3,43
16	25.405	3,45
17	28.626	3,40
18	27.778	3,42
19	26.206	3,44
20	25.684	3,45
21	25.632	3,45
22	26.206	3,44
23	26.206	3,44

24	26.041	3,44
25	25.595	3,45
26	26.114	3,44
27	25.714	3,45
28	26.573	3,43
29	26.595	3,43
30	27.573	3,42
Amount	**786.148**	**103,17**
Average	**26.205**	**3,44**

Source: 2016 (Data processed)

Analyze Phase

Analyze phase is the third operational step in six sigma method. At this phase, an analysis conducted on the data obtained. This data analysis needs to be performed in order to determine the root cause of defects or failure.

Stratification

The stratification process aims to group data in groups with the same defective characteristics. The data that has been grouped according to the type of defect that occurred are elaborated in the following table.

Table 5.6 Grouping data by type of defect

Symbol	Type of Defect	Number of Defects	Percentage of Defects (%)
X1	Sompel	2000	83,19
X2	Fragile Bricks	404	16,81
Total		**2404**	**100,00**

Source: 2016 (Data processed)

Table 5.7 Percentage of Defects after Ordering

Symbol	Type of Defects	Number of Defects	Percentage of Defects (%)	Cumulative Percentage (%)
X1	Sompel	2000	83,19	83,19
X2	Bricks break easily	404	16,81	100,00
Total		**2404**	**100,00**	

Source: 2016 (Data processed)

Improve Phase

The improve phase is the fourth phase in six sigma method. Once the source or root cause of the quality problems are identified, it is necessary to look for actions that can need to be done in an effort to reduce the defects that occur. From the root of problem obtained in the cause and effect diagram, some steps need to be prepared, including:

1. Machine
2. Operator
3. Working Methods
4. Environment

Control Phase

Control is the last operational phase in an effort to improve six sigma quality. At this phase, the results of brick quality improvement are documented and disseminated, and the best working procedures that worked in improving the process are then standardized and disseminated. The purpose of the standardization system is to enforce a six sigma quality system that has proved to be the best in quality improvement and made as a work guideline in the future. The type of control chart will enable us to comment on the process of control of the machine being used in the brick molding process. As such, it is expected that in the future, a desired condition is found for providing an assessment on the machine. After calculating control chart, the interpretation obtained is an irregular control chart. This control chart occurs because of interference from outside.

V. CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Upon applying six sigma method on Brick Products in a Brick Factory in Deli Serdang Regency, the conclusions are drawn as follows:

1.The define phase or explanation of the process quality that has been measured by ordering the processes that

occur can be done by using diagrams Suppliers, Inputs, Processes, Outputs, Costumer (SIPOC). As a result, the brick-production defect often occurs in processes.
2.From the results of data processing, it was obtained that DPMO value achieved by the company amounted to 23,239 DPMO and the sigma level value obtained by the company was 3.44 sigma. This means that the value of quality obtained is still far from the provision of Six Sigma which is 3.4 DPMO or 6 Sigma.
3.The source or cause of defects or failure in the production process is hot molding machine, which leaves the results of molded bricks imperfect.
4.Improvement action can be done by checking the cooling channel and water pipe of plastic injection molding machine which will leave the mold not easily heated

Suggestions
Based on the above-mentioned results, the suggestions are made as follows:
1. Companies need to check trough all production processes before the production starts, especially the plastic molding machine, thus during the mold production process the machine is not easily heated.
2. The company can measure the quality level it has achieved by using Six Sigma method continuously in monitoring the measurement that has been achieved by the company. The measurements obtained can be used as a baseline to conduct further measurement in an effort to increase Quality to level 6 sigma, according to the target of six sigma

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