CHAPTER I
INTRODUCTION

1.1 Research Background

Cement is an essential element for a nation's economy because it acts as the binder for buildings materials used in infrastructure and property development. Hence, cement sales usually give worthwhile information about the savings and investment of a country. The rapid acceleration of domestic cement sales shows that the infrastructure and property sectors are going well (Cement Industry Indonesia, 2016).

Several factors have been affecting the rising of cement sales in Indonesia, especially the government's immense infrastructure agenda which includes the construction of thousands of kilometers of road, dozens of airports, and so forth. In order to fulfill the increasing demand, cement industry performers have greatly invested in cement production facilities and cement plants. Furthermore, with the addition of the cement industry's expansion, new market entrants have been leaving out impacts on the production capacity. More performers in the cement industry are joining the marketplace (Cement Sales in Indonesia Have Increased Rapidly in Recent Years, with 2016 Set to Follow that Trend, 2017). As a result, it leads to more intense market competitiveness which nowadays, are usually carried out through the refinement of the products' quality and process productivity (Silva, Filho, Agostinho, & Junior, 2019). Therefore, in order to survive in the competitive market growth, improving product quality and production process productivity is an essential key for every company (Sharma & Suri, 2017).

PT Semen Padang is the first cement plant in Indonesia which was established on March 18, 1910 under the original name of NV Nederlandsch Indische Portland Cement Maatschappij (NV NIPCM). The company started to grow gradually from Indarung I Plant (operating until 1999) with the production capacity of 330,000 tons/year until the most recent plant, Indarung VI, with the

production capacity of 3,000,000 tons/year (History of PT Semen Padang, n.d.). In general, there are two types of cement produced by PT Semen Padang, i.e., bulk cement and bagged cement. Bulk cement consists of Ezpro, Dupro + HSR: MSR, and Ultrapro while bagged cement only consists of Portland Composite Cement (PCC) (Semen Padang Products and Services, n.d.).

PCC is chemically reactive with water so it has to be stored and transported carefully in a special cement bag. 'Bag' is a wrapping packaging usually made from paper or plastic which has the main objective to secure the goods inside of it from damage and any other unwanted condition. The cement bag helps to ensure the product's safety and gives a sale unit to the seller. Cement bag also minimizes the transportation cost because it helps cement to be transported in various amounts to the customer. Therefore, in addition to the manufacture of high-quality cement, PT Semen Padang also produces cement bags under the Bureau of Cement Bag Plant located at Pampangan Nan XX, Lubuk Begalung, Padang City, West Sumatra.

The Bureau of Cement Bag Plant is a work unit that focuses on the production of cement bags for PT Semen Padang. Originally, there are four types of cement bags produced by the Bag Plant, i.e., Sewing Bag Kraft, Sewing Woven Bag, Pasted Bag, and Block Bottom Bag within four production lines. Nevertheless, there are only two production lines which are still operating since 2011 until the present time: production Line III and production Line IV. Both of these production lines produce Pasted Bag in 40 kg and 50 kg size. Sewing bags are no longer being produced because the selling price for cement using this bag is not going well in sales, due to its high production cost.

The materials used for creating a cement bag are semi-extensible sack kraft paper, potato glue, printing ink, and a patch valve. The patch valve is an additional coating paper that acts as the strengthening agent for the cement valve when it is holding the cement weight in the Packing Plant. The materials are ordered by the Central Procurement Unit so the lead time and other ordering policies are handled by the unit involved. **Figure 1.1** below shows the universal design of a Pasted Bag.

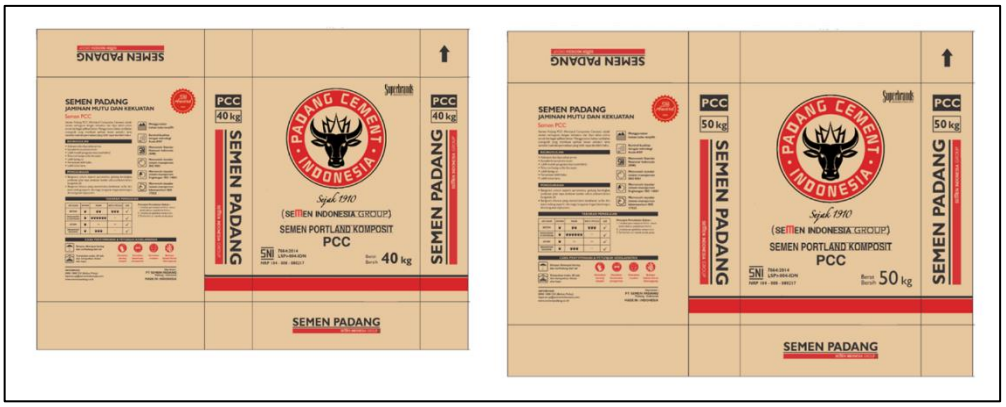

Figure 1.1 The Universal Design of Pasted Bag

(Source: the Bureau of Cement Bag Plant of PT Semen Padang)

The production process of cement bags is done using two enormous machines with 23 detailed processes. These machines are the Tubing Machine and the Bottomer Machine. The role of Tubing Machine is producing semi-finished cement bag called as 'tube' and the role of Bottomer Machine is doing the finishing process for turning the tube into a final cement bag product. Initially, the speed of the Tubing Machine is up to 240 tubes/minute but in the actual operational process, the running speed is maintained around 140 – 180 tubes/minute. The speed decrease is done under the consideration of the operator's safety and to minimize the risk of defective products (reject).

Within the 23 detailed processes of cement bag production, there are several unwanted events that occur. These events lead to another problem such as product variations that have the potential to generate defects and undesirable loss. As a means to prevent the occurrence of defective products and undesirable loss, the production process of cement bags is monitored under three stages of Quality Assurance (QA). According to the Analytic Quality Glossary, QA is the collections of policies, procedures, systems, and practices designed by an organization in order to achieve, maintain, and enhance quality. QA can be both an internal and external process (Williams, 2016). The QA system for the cement bag production process at the Bag Plant of PT Semen Padang consists of three main stages, i.e., pre-production QA, during the production process QA, and post-production QA.

However, the occurrence of product variation which mostly leads to defects still can't be avoided. **Table 1.1** below shows the percentage of defective tubes within 24 months, started from January 2019 until December 2020. The total defects for tubes in 40 kg and 50 kg cement bag size are considered as one because the process for these cement bags is exactly the same, aside from the dimensional difference.

Table 1.1 Defective Tubes from January 2019 – December 2020

Period	Tube (Sheet)	Cement Bag (Sheet)	Defective Tube (Sheet)	Defect (%)
Jan-19	3,283,915	3,252,000	31,915	0.97
Feb-19	3,101,468	3,072,000	29,468	0.95
Mar-19	2,962,823	2,928,000	34,823	1.18
Apr-19	2,279,970	2,260,000	19,970	0.88
May-19	1,222,314	1,208,000	14,314	1.17
Jun-19	827,166	816,000	11,166	1.35
Jul-19	2,266,119	2,240,000	26,119	1.15
Aug-19	1,850,612	1,804,000	46,612	2.52
Sep-19	2,058,065	2,048,000	10,065	0.49
Oct-19	2,076,263	2,048,000	28,263	1.36
Nov-19	2,247,852	2,228,000	19,852	0.88
Dec-19	1,991,047	1,968,000	23,047	1.16
Jan-20	1,556,028	1,528,000	28,028	1.80
Feb-20	2,781,599	2,752,000	29,599	1.06
Mar-20	3,303,403	3,284,000	19,403	0.59
Apr-20	1,686,912	1,668,000	18,912	1.12
May-20	955,632	944,000	11,632	1.22
Jun-20	1,481,226	1,460,000	21,226	1.43
Jul-20	3,234,784	3,212,000	22,784	0.70
Aug-20	2,039,460	2,032,000	7,460	0.37
Sep-20	2,558,440	2,528,000	30,440	1.19
Oct-20	3,039,025	3,012,000	27,025	0.89
Nov-20	1,313,947	1,300,000	13,947	1.06
Dec-20	2,896,230	2,864,000	32,230	1.11
Total	53,014,300	52,456,000	558,300	

(Source: the Bureau of Cement Bag Plant of PT Semen Padang)

For the total production of each month, the company has assigned the maximum percentage of defects to be 1.2% at most. Based on **Table 1.1**, we can

see that in several months, e.g., August 2019 and January 2020, the percentage of defective tubes already exceeded the acceptable limit. In August 2019, the percentage of defective tubes reached 2.52% and in January 2020, the percentage of defective tubes reached 1.8%. Needless to say, the tube is not the finished product which means that it has to go through a further series of the production process where more defects have the potential to occur.

According to the preliminary study which was done on 17 February 2021, there are several types of feasible defects that can be found in the production process of a cement bag. For example, two of these defects are blurred print and poorly folded cement bag bottom. Blurred print may happen due to several factors such as the low quality of printing ink or the failure of ink drying while poorly folded cement bag bottom happens because of the failure in Bottomer Machine.

Figure 1.2 Poorly Folded Cement Bag Bottom

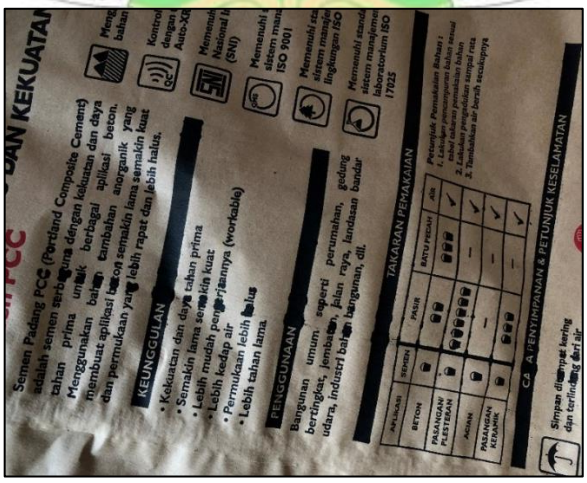

Figure 1.3 Blurred Print

Stop time and machine downtime have also become inevitable conditions during the production process of a cement bag. The production process usually stops because of the set-up time, shift exchange, paper splicing, printing stamp switch, ink jam, worship activity, and far more. Machine downtime normally happens because of mechanical and electrical repair. **Table 1.2** below shows the recapitulation of machines' performance in the production system of cement bags started from January 2019 until December 2020.

Table 1.2 Machine Performance Data from January 2019 – December 2020

Period	Time (Hour)				Downtime %
	Available	Stop	Effective	Downtime	
Jan-19	424	105.74	318.26	38.41	9.06
Feb-19	390	92.97	297.03	35.05	8.99
Mar-19	394	108.55	285.45	43.47	11.03
Apr-19	322	101.84	220.16	20.05	6.23
May-19	350	227.62	122.38	34.42	9.83
Jun-19	247	155.33	91.67	57.17	23.15
Jul-19	414	138.92	275.08	74.76	18.06
Aug-19	378	154.43	223.57	81.27	21.50
Sep-19	398	160.89	237.11	99.39	24.97
Oct-19	444	206.10	237.90	139.94	31.52
Nov-19	424	172.16	251.84	97.66	23.03
Dec-19	407	176.07	230.93	116.07	28.52
Jan-20	364	171.30	192.70	106.46	29.25
Feb-20	632	282.19	349.81	213.95	33.85
Mar-20	753	330.35	422.65	238.95	31.73
Apr-20	380	178.79	201.21	97.62	25.69
May-20	744	627.27	116.73	78.59	10.56
Jun-20	720	Not available	720	Not available	Not available
Jul-20	744	Not available	744	Not available	Not available
Aug-20	442	210.77	231.23	141.27	31.96
Sep-20	701	388.52	312.48	308.52	44.01
Oct-20	681	315.96	365.04	237.96	34.94
Nov-20	420	188.56	231.44	122.06	29.06
Jan-19	744	400.83	343.17	234.33	31.50

(Source: the Bureau of Cement Bag Plant of PT Semen Padang)

Machine downtime is one of the assignable causes of product variation in a manufacturing system. Machine downtime is referred to off-the-time periods when a machine is not productive or is not ready for the assigned work due to various

matters. Downtime is an essential subject in manufacturing because it is linked to process productivity (Nwanya, Udofia, & Ajayi, 2017).

In accordance with the given explanation above, the Bag Plant of PT Semen Padang has the potential spot of improvement for improving their product quality. Within the field of quality improvement, Lean Six Sigma has become one of the most proven methodologies. Lean Six Sigma is an approach that focuses on the improvement of quality, variation reduction, and waste elimination based on the combination of two methodologies, i.e., Lean and Six Sigma (Ghaleb, El-Sharief, & El-Sebaie, 2015). Lean Six Sigma transforms an organization's strategic goals into a near-perfect service through the enhancement of customer satisfaction, quality, process rate, invested capital, and cost (Bhat, Gijo, & Jnanesh, 2014). Therefore, the implementation of Lean Six Sigma methodology within the production process of cement bags at the Bag Plant of PT Semen Padang is beneficial for improving the product quality, along with the production process productivity.

1.2 Problem Statement

Based on the given background description, the problem statement discussed in this research is "How to improve the product quality of cement bag at the Bag Plant of PT Semen Padang?".

1.3 Research Objectives

The objective of this research can be put into detail and explained in several points as follows:

1. Identifying the types of defects that occur within the production process of cement bags at the Bag Plant of PT Semen Padang.
2. Determining the underlying cause(s) of defects for the cement bag product.

3. Proposing improvement solutions that will assist the quality improvement of cement bags at the Bag Plant of PT Semen Padang.

1.4 Research Scopes

This research is done under several limitations as a means to make it more focused. Therefore, the research scopes are:

1. The production line observed in this research is production Line IV of the Bag Plant of PT Semen Padang.
2. The types of cement bags being examined in this research are the 40 kg and 50 kg pasted bags.
3. The statistical data used in this research is recorded from January 2019 – December 2020.
4. Cost and anything related to it are not being discussed.

1.5 Outline of the Research

CHAPTER I INTRODUCTION

This chapter is composed of the background of the research, the problem formulation, research objective, research scope, and the outline of the research.

CHAPTER II LITERATURE REVIEW

The literature review is a chapter that represents the overview of the theoretical basis used to complete this research. In general, this chapter describes the cement industry, waste concept, quality control, Lean Six Sigma, tools or methods used to process the data, and the review of associated previous research.

CHAPTER III RESEARCH METHODOLOGY

Research methodology is a chapter that describes the systematic approach step-by-step used to perform this research, so it is able to meet all of the expected objectives or outcomes.

CHAPTER IV SIX SIGMA METHODOLOGY

Six Sigma methodology represents the detailed view of data collection and data processing of this research. This chapter shows the methods or techniques applied started from the Define stage of the Six Sigma methodology until the Control stage.

CHAPTER V CONCLUSION AND SUGGESTION

This chapter consists of conclusions as well as suggestions learned through the process of completing this research.