CHAPTER I INTRODUCTION

I.1 Background

Indonesia is one of the largest ceramic producer country in the world. According to *Balai Besar Keramik* (BBK), Indonesia currently ranked fourth in the world as a country with the largest ceramic production capacity. According to Ministry of Industries, Indonesian ceramic is one of group sector that dependable as a backbone of national industries in last twenty five years. This is supported by the availability of abundant ceramic raw materials in Indonesia and the prospect of the national ceramics industry in the long run is quite good along the growing of domestic market that supported by the growth of national development, both property and housing (BPPI, 2017). However, based on data from Ministry of Industry in 2017, the utility of Indonesian ceramic industries is only 65% in 2016, which is makes Indonesia only ranked sixth in the world of ceramic producers. Based on Figure I.1, it is found that in the range of 2010 – 2017 export activities tend to decrease, but not too fluctuate. In contrast to export, import activity in this seven-year span increased sharply until the highest point in 2017.

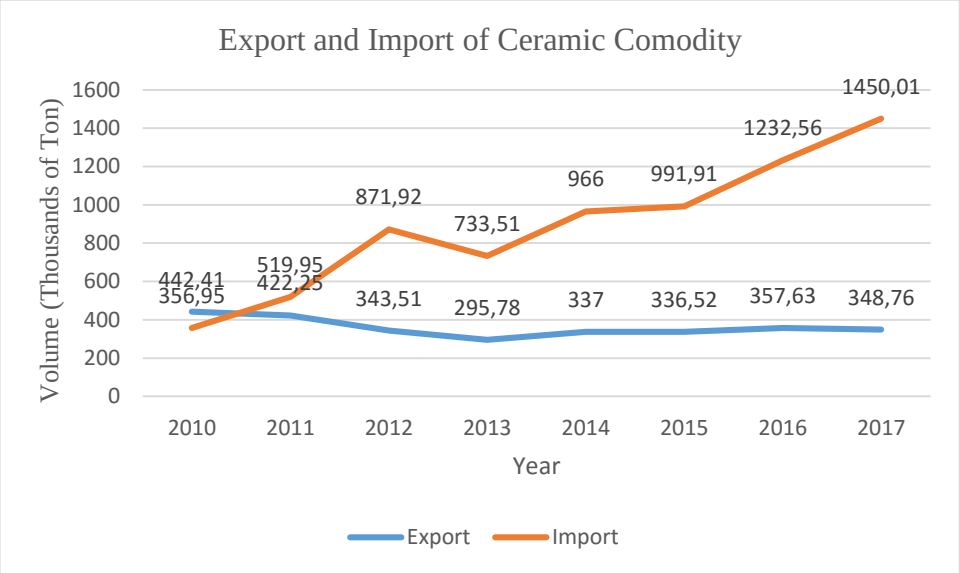

Figure I.1 Export and Import Volume of Ceramics Comodity (BI, 2018)

Huge number of imported ceramics from China, Thailand, and Vietnam is due to very cheap price and not good quality than Indonesian ceramic domestic product

(ASAKI, 2016). In fact, export value of ceramic tiles is very potential due to positive trends of exported ceramics demand.

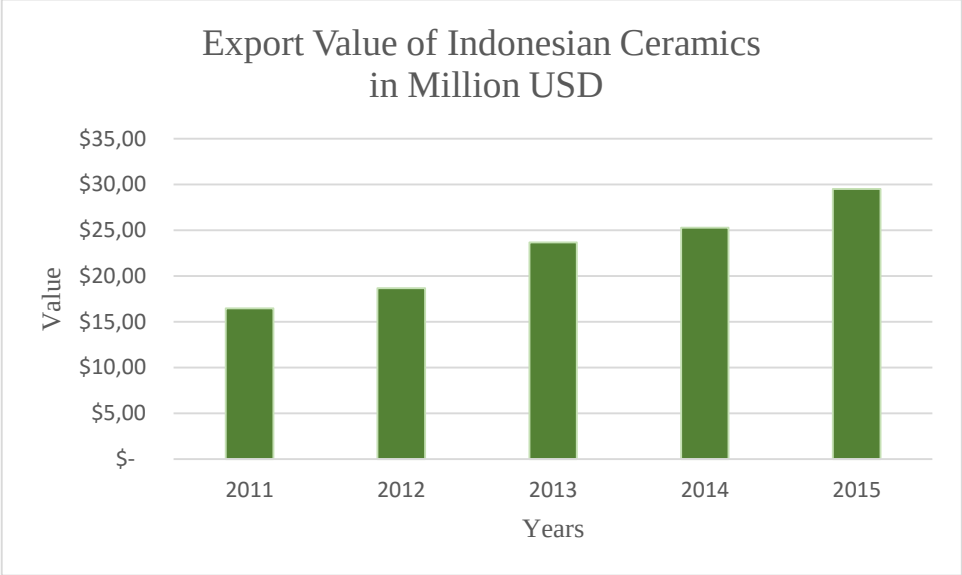

Figure I.2 Export Value of Indonesian Ceramics (Ministry of Trade, 2016)

Figure I.2 shows that ceramic export value is always increasing from 2011 until 2015, even the export volume is decreasing. It shows that, there is a huge opportunities in ceramic industries. Many national products can not be exported because Indonesian domestic ceramic does not meet the minimum regulatory standarad of the destination country. This fact demonstrates the need for improved ceramic quality and reduces of production costs, so domestic product can compete with imported product. High level of quality produces high customer satisfaction, which usually supports for high selling price and also cheaper production costs (Kotler & Keller, 2012). In traditional way, quality can be interpreted differently, depending on the point of view of each user that the products must meet the requirements of the user (Montgomery et al., 2013).

Quality control has a major impact in the production process. Consumer's feedback can be used as a measurement whether the quality control system is running well or not. Statements above are the reasons why the development of quality control system should be continued so the product produced suitable with consumer expectations (Permana, 2014). Currently, in order to inspect and classify the

ceramic defects, manufacturer using standard of SNI ISO 15405 about ceramic tiles part two: Determination of dimensions and surface quality.

According to Sari & Sulaiman (2017), in their research there are top six defects that has been found in between range of February – April 2017. The data shown in Table I.1 below. The top 6 defects founded are chip off, body shape defect, scratch, dry spot, crack, and pin hole. The method that they used were observation in the ceramic industry for three months. It is found that chip of has total 2902 appearance, followed by body shape defect with 2618, scratch with 2182 appearance, dry spots with 1882 defects founded, there are 1509 cracks founded, and the last one pin hole defect with 1350 appearance.

Table I.1 Number of Defects Founded (Sari & Sulaiman, 2017)

No.	Defects	Month			Total Number of Defect
		February	March	April	
1.	Chip Off	1150	845	907	2902
2.	Body Shape	1015	774	829	2618
3.	Scratch	763	675	744	2182
4.	Dry spots	656	565	661	1882
5.	Crack	556	471	557	1509
6.	Pin hole	482	386	482	1350

Table I.1 above underlies this research, to use the top five defects that appears mostly in ceramic industries. However for the second most defects, body shape, the research has been conducted by Luthfil (2016) and Sadewa (2016). Their research discuss about the rectangularity of ceramics body in quality inspection.

In Indonesian ceramic industries, ceramic inspection activity are still done manually through visual observation. This is certainly very difficult and requires a relatively long time due to the limitations on human vision and the differences in perceptions between individuals with each other. The inspection process is done by looking directly at the type of damage that exists on the surface of each ceramic tile. Human vision must accurately see the defects on the surface of the ceramic tile. In plain

view, worker without the need for special knowledge can distinguish a normal non-defect ceramic with ceramic that has defect. This of course require a relatively long process of inspection due to the limitations on human vision and the difference in perceptions between individuals with each other (Elbehiery et al., 2005). Therefore, a visual inspection system with digatal imagery can be an effective solution to the problem (Nurcahyani and Saptono, 2016).

Digital image processing is generally a two-dimensional image processing using computer. This image processing is done to improve the image quality so it is more easily interpreted by human eye (Fikriya *et al*, 2017). Digital image processing can be used to inspect surface and rectangularity defects on ceramic tiles. There are some research that has been conducted about automated image processing for quality inspection. Luthfil (2016) uses Harris Corner Detection method for time efficiency and increase accuracy of ceramic rectangularity and obtain the efficiency value of 62.68% from existing condition. Sadewa et al., (2010) uses Shi-tomasi method and got error value between result of test of Balai Besar Keramik with proposal test equal of 43% and time efficiency obtained of 62.68%. According to Putri et al (2017) , for the design of automation system for ceramic surface quality control using fuzzy logic method at *balai besar keramik* got the accuracy rate of ceramic inspection using design of automatic ceramic defect with offline system is 92.31%, and accuracy based on the real time system is 92.31%.

In order to design the automation system Atmaja and Herliansyah (2015) has conducted research about optimization of measurement dimension and surface defect for ceramic tile using image processing and full factorial design to know correlation between factors that affect error rate resulting from research. The results obtained from this research is 300 lux of light intensity for minimum error rate with 50 cm camera distance above ceramic tile. In this research, the system that designed wasn't in a real time, so required development of research that is able to classify the type of defect automatically and real time by using artificial intelligence (Lestari et al., 2017).

According to Defiyanti (2017), classification is a process to find a model or function that explains and characterizes the concept of class of data, for a particular interest.

Classification is and important technique in data mining, this technique can predict class labels. So the purpose of the classification is the truth in predicting value (Karangi & Jaglan, 2013). In machine learning there are various methods for classification, one of them is Bayesian Classification. Bayes' theorem was founded by an Englishman who did early reseach about probability and decision theory, Thomas Bayes. According to Han & Kamber (2006), Bayesian classification is statistical classifiers that can predict class membership probabilities that a given tuple belongs to a particular class. Further more, Han & Kamber (2006) state that Bayesian classifiers have also exhibited high accuracy and speed when applied to large databases.

Based on the research that conducted by Ying Zhang, *et al* (2010), in his research he used classification algorithm in data mining to know student retention using three algorithm, such as Naive Bayes Classifier, Support Vector Machine, and Decision Tree. The results obtained sequentially from the most accurate is Naive Bayes with 85% accuracy, followed by Support Vector Machine 83.5%, and the last one is Decision Tree with 81.3%. Another research that conducted by Shadika (2017) uses image processing to control fabric quality and classification of fabric defects. The method used is Artificial Neural Network. The results of the research are decreasing the whole processing time 29.8 second faster than the existing manual process. Level of accuracy obtained using ANN with offline system is 91% and 88.7% in real time system.

Digital image processing can be used to extract various features of image. The process runs automatically to minimize human intervention and expected to replace the inspection process which is still done manually. Based on the background, researcher focuses on designing automatic classification system for ceramics defects inspection based on image processing using Naive-Bayes Classifier.

1.2 Problem Formulations

According to research background that has been mentioned, problem formulation can be formlated as how to optimize multi-class classification of ceramic surface defect using Histogram of Oriented Gradient and Naive-Bayes Classifier?

1.3 Research Objectives

The objective that proposed in this study is optimizing multi-class classification of ceramic surface defect using Histogram of Oriented Gradient and Naive-Bayes Classifier.

1.4 Research Constraints

1. Object of this research is ceramic that has size of 30 x 30 cm plain white ceramic tiles.
2. This research only focused on the image processing and multi-class classification algorithm.
3. Ceramic defect obseved only the defect that appear in ceramic surface.
4. Chip off defect, crack defect, chip off defect, dry spot defect, scratch defect and normal ceramics are considerabled as the class to classify.
5. Image processing and quality inspection were conducted using camera with specification of Full HD 1080p.
6. Images were taken by camera at 50 cm distance above the object observed.

1.5 Research Benefits

1. Reduces labor cost by applying automation to inspect ceramic quality.
2. Increase the accuracy of ceramic quality inspection then using manual visibility inspection due to human limitations.
3. As the reference for further study.

1.6 Writing Systematics

The research shall be written in following writing systematics:

Chapter I Introduction

Introduction chapter discuss about the existing condition problem faced in ceramic tile industries, that focused on quality inspection that needed to be enhanced. And the needs of automated quality inpection.

Chapter II Theoretical Basis

This chapter discuss about the theories that used in this research that related to optimization of automated quality inspection system. It also discuss about the previous works that all related with Naive Bayes Classifier and Histogram of Oriented Gradient.

Chapter III Research Methodology

Following chapter explane the reserch method in stages. It includes the conceptual model and also problem solving systematics that will conducted in the study.

Chapter IV Data Processing

This chapter explain about the implementation details of this research. Start from designing the proposal system, image processing techniques, and the main algorithm of Naive Bayes Classifier

Chapter V Analysis and Results

Following chapter will analyze the results of the data processing. It will analyze the performance of Naive Bayes Classifier and Histogram of Oriented Image, and comparing with the existing system.

Chapter VI Conclusions and Suggestions

Last chapter consists of the conclusions that obtained from results of the study. Suggestions regarding the potential future works for further research also be mentioned in this chapter.