CHAPTER 2
LITERATURE REVIEW

2.1. Previous Research

Martinez et al. (2009) express that sustainability is a key challenge in present-day production. Therefore, the company strategy is play a significant role in providing more feasible system to support the sustainable production, i.e. more environmental-friendly. Clean environment is one of the key factors needed by companies, especially the air. To reach the clean environment needs a good cleaning system, like application of cleaner machine at production floor.

The textile industry is one of the most productive and active sectors of Asia, with a high level of export and high added value. In the framework of improvement of the production process and the quality of products, the capability for rational use of resources and selection of optimized production process plays a significant role. “Moreover, the capability to select and apply environmentally optimized process, which minimize the pollution of the environment is a key factor of efficiency” (Metaxiotis, 2004). Environmental legislation and its enforcement have undoubtedly forced the textile industry to be rather cautions in selecting the appropriate processes and equipment. “The most efficient, economic and minimal pollution processing method will be increasingly demanded throughout the 1990s” (Metaxiotis, 2004).

In current days, many companies perform improvement to their business strategy to avoid losing competition with other companies by application of SWOT analysis. After analyzing external environmental opportunities and threats, and assessing firm strengths and weaknesses, enterprises typically develop new product development strategies that maximize their own benefit. “New product development is closely related to product design activities” (Marxt and Hacklin, 2005). Also Booker et al. (2005) stated that effective product development is key to enterprise survival and maintaining competition advantage, it means that product development/improvement with particular purposes can give the competitive advantage to the company, such as win the market, win the technology, and finally win competition with other competitors. Nevertheless a good design must meet the goals established in product development strategies and follow appropriate product design procedures (Barczak et al. 2007).

“Integrating product design management with ISO 14001 Environmental Management System can be promising way to fulfill a corporate strategic goal on the triple bottom line, economic, environmental, and social” (Yang, 2005). According to Yang (2005) already clearly explained that integrate between product design management with environmental management system is an important aspect, it means that the good environmental condition is one of the company success factor, such as clean air, clean water, and clean production floor. Good environmental condition also give impact to the economic aspect, for example in the yarn company, the air cleanliness affect to the quality of yarn, clean air means good yarn, more good yarn will attract the customers, finally sales will be increased and profit will be high. Therefore many of companies do the product design or improvement to achieve those objectives, for example design for product/machine to make or keep the environment clean. Additionally, many researchers have demonstrated that the design process is an important resource for enterprises, “an important mechanism for integrating product development functions and a crucial loop in the overall value chain” (Gemser and Leenders, 2001 and Sheldon, 2004).

This research will be conducted at PT. Kusumaputra Santosa to help the company reduce dust level in the air at production floor especially for spinning work center. The high level of dust in the air is not good for the quality of yarn, make the yarn surface rough, that is why need a feasible dust cleaner machine to reduce the dust level in the air. This paper will show about the design improvement of dust cleaner machine at spinning work center. This design improvement has the goal to reduce the dust level in the air at spinning work center optimally. The comparison between previous research and present research shown in table below:

Table 2.1 The Comparison between Previous Researches with Current Research

Author	Title	Objective
Martinez et al. 2009	An Assessment Method and Design Support System for Designing Sustainable Machine Tools	This paper addresses the machine tool industry and proposes specific tools and methods to enable sustainable design of future machine tools, as an enabler for sustainable manufacturing. The main contributions of this paper are a machine tool sustainability index (MTSI) for assessing the sustainability of machine tools and a design support system (DSS) for assisting designers in building more sustainable machine tools.
Metaxiotis, 2004	RECOT: An Expert System for the Reduction of Environmental Cost in the Textile Industry	This paper presents such an expert system, designed and implemented in four stages: formal description of the key factors that affect the dyeing process in the textile industry, development of models for the representation of relevant information, development of models for the representation of knowledge and integration of the above-mentioned models in a unified information system that supports the decision-making process in the management of textile enterprises.
Marxt, C. and Hacklin, F., 2005	Design, Product Development, Innovation: all the same in the end? A Short Discussion on Terminology.	This paper tries to broaden the view on what “design” means. Additionally, the paper highlights the accordance and differences between the terms design, product development and innovation, and attempts to derive implications for organizing research practice in such a broader context.

Table 2.1. Continued

Author	Title	Objective
Booker, J.D., Swift, K.G., and Brown, N.J., 2005	Designing for Assembly Quality: strategies, guidelines and techniques	This paper reviews the current assembly-orientated design techniques available to detect potential quality problems and identifies the key issues relating to assembly quality, including the relationship between the components, operations and assembly technologies used.
Yang, 2005	Managing Sustainable Product Design by Integrating Corporate Product Development Practice with ISO14001 Environmental Management Systems	By focusing on the process of managing product development toward corporate sustainable development policy in manufacturing firms, the dissertation advances the first integration management theory and discovers that, to be effective and comprehensive, corporate integration management of SPD with ISO14001 EMSs should be implemented in four levels: policy integration, organization integration, process integration, and tool integration. The dissertation further develops relevant models to formalize corporate SPD and management activities. Together, these findings form the basis for developing guidelines for the integration management of SPD with ISO14001 EMS and contribute to the new paradigm for corporate sustainable innovation management.

Table 2.1. Continued

Author	Title	Objective
Barczak, G., Sultan, F., and Hultink, E.J., 2007	Determinants of IT Usage and New Product Performance.	To investigate the relationship of IT usage and new product performance (NPP) success.
Gemser, G. and Leenders, M.A.A.M., 2001	How Integrating Industrial Design in the Product Development Process Impacts on Company Performance	This article sheds more light on how and when integrating industrial design in the product development process can enhance a company's competitive position. The basic premise is that the impact of industrial design on company performance is not unconditional, but dependent on industry evolution and design strategy.
Sheldon, D.F., 2004	A Review on the Relevance of Design Science in a Global Product Development Arena	This paper reviews the state of the art of academic design research over the past decade and explores the relationship of present academic activities to that of a product development scenario within the wider global industry practices.

Table 2.1. Continued

Author	Title	Objective
Firmansyah, 2013	Improving Dust Cleaning System to Decrease Air Contamination at Spinning Work Center at PT Kusumaputra Santosa	This research has goal to providing proposals about design improvement of dust cleaner machine by adding appropriate number of exhaust system to maximize the ability of absorbing the dust in order to help PT. Kusumaputra Santosa clean the air condition around spinning work center. Hope that the new design of dust cleaner machine can absorb the dust optimally, then the air condition is clean and product that not standard can be reduced, because of that the production time at finishing work center can be reduced, then bottleneck problem can be solved, finally product can be finished on time based on production planning.

2.2. Theoretical Approach

2.2.1. Understanding of Design

The next discussion shows the theory and understanding of design as the basic of thinking, where the result of this research is provide the new design of dust cleaner machine that has relation with design activity.

Gupta and Murthy (1980) state that everyone has a need, while the human wish to use it. Starting from that problem, man has an idea how to satisfy that need. The idea is meaningless if it is not manifested. The idea should produce something real that can fulfill and satisfy the need. Therefore, the process by which man generates ideas to response a certain need and then carry out their transformation into reality is generally termed designing. Based on that theory, the result of design activity is producing visible material, where that material is used to fulfill the man's or even society's need.

Kroemer (2001) states that "design is a process to analyze, assess, improve, and create optimal products or tools for the future by utilizing existing information". The correct information has an important role to produce a proper design. There are some information resources that can be used to create products or tools, but the important thing is the information should relevant and has relationship to the objective, or with the other word the information should support to the process of creating products.

Madyana (1996) states that design is problem solving activities and technology innovation which purposes are to find the best solution of system, process, physical configuration, and then realize it to the reality creatively. The technology innovation is important thing, for example some company used SAP Software to manage and control all their company organizations and business process. So there is an act from company in order to become one of the leading companies.

Asimow (1962) states that design are "sequential processes that consist of design operations". The example of design operations are:

1. Look at alternative systems to meet specific needs,
2. Formulate a mathematical model from the best concept system,
3. Specialize components that are specific to construct components from a sub-system,
4. Select material to produce component.

Each operation needs information in order to give the best result. The correct information is very important and often the most difficult step in the design process. The information should relevant and has relationship to the operation.

2.2.2. Design Method

"Design methods are any procedures, techniques, aids, or 'tools', for designing. They represent the number of distinct kinds of activities that the designer might use and combine into an overall design process" (Cross, 1994). "The most common design method can be called the method of 'design-by-drawing'. That is to say, most designers rely extensively on drawing as their main aid in designing" (Cross, 1994). Like in this research, before go to the final design of dust cleaner machine, starts from using PowerShape software to draw the detail model of the dust cleaner machine in order to get the proper form. In this software the detail model is shown, start from the dimension of the part of the machine until the final form of the machine. The picture is the basis in designing the real new model of dust cleaner machine.

"In fact, the general body of design methods can be classified into two broad groups: creative methods and rational methods" (Cross, 1994). The main idea of creative method is brainstorming activity, this activity has purpose to generate the ideas to find the best solution to solve a certain problem. But in this research will not explore more about that method, because in this is research will use rational method, where the rational method provide more systematic approach to design than creative method. Rational method involves the customer to the process design; like in this research customer determine the criteria of the new design of dust cleaner machine. This research will solve the real problem which produce the real new design of dust cleaner machine, there should be consider about cost, energy, and time consumption, so there will be not relevant use the creative method which only emphasis on brainstorming activity. The next rational method developer by Cross is explored (1994).

2.2.3. Rational Methods

"One of two design method is called rational methods which encourage a systematic approach to design" (Cross, 1994). Nevertheless, these rational methods often have similar aims to the creative methods, such as widening the search space for potential solutions, or facilitating team work and group decision-

making. The function of the new design of dust cleaner machine that will be made is to widen the idea to the design.

There are several ways of rational design method that should be determined in order to reach the proper design procedure, as we have seen in the long list above, covering all aspects of the design process from problem clarification to detail design. The selected set is as follows (Cross, 1994):

a. Clarifying Objectives

First step is clarifying objectives. “The aim is to clarify the design objectives and sub-objectives, and the relationships between them” (Cross, 1994). In this step, there are list of objectives of the design, it can be more than one objective, and even in the each objective there are sub-objectives, which show more specific objective or the way to achieve the objective. The objectives or sub-objectives can be determined by the client, customer, discussion in the design team, and others stakeholders. There is Objective Tree to showing hierarchical relationships and interconnections between objectives and sub objectives.

b. Establishing Function.

Second step is establishing function. “The aim is to establish the functions required, and the system boundary, of a new design” (Cross, 1994). In this step show the all functions for the design in the ‘black box’ form. Then the black box should be break down to show the sub-functions for the design. Inside the black bock there are list of sub-functions, these sub-functions show more specific and complete function for the product to be design. There is system boundary defines the functional limits for the product to be designed, this system boundary is use to specify the function based on the objective.

c. Setting Requirements.

Third step is setting requirements. “The aim is to make an accurate specification of the performance required of a design solution” (Cross, 1994). In this step show the detail specifications of the product that will be designed to achieve an objective, it can be product alternatives, product types, dimension of the product, and product features.

d. Determining Characteristics.

Fourth step is determining characteristics. “The aim is to set targets to be achieved for the engineering characteristics of a product, such they satisfy customer requirements” (Cross, 1994). In this step there are lists of customer requirement to the product to be designed. After the customer needs determined,

then determine the engineering characteristics. The engineering characteristics are point of view of engineer to see the customer requirement. Then the last, based on engineering characteristics there are target values to be achieved in the product to be designed in order to satisfy the customer needs.

e. Generating Alternatives.

Fifth step is generating alternatives. “The aim is to generate the complete range of alternative design solutions for a product, and hence to widen the search for potential new solutions” (Cross, 1994). In this step there are show the features to the product. The feature is determined by the designer based on the objective that will be achieved. Each feature has own alternatives. The alternatives means list of solutions of design possibility. One feature possible to has more than one design alternatives. There is morphological chart to show the possible different solution combinations.

f. Evaluating Alternatives.

Sixth step is evaluating alternatives. “The aim is to compare the utility values of alternative design proposals, on the basis of performance against differentially weighted objectives” (Cross, 1994). There is objectives tree for assigning relative weights to sub-object. The point of this step is to evaluate the alternatives of design, then choose the proper one based on the best overall utility value, it show by weighted objectives evaluation chart.

g. Improving Details.

Seventh step is improving details. “The aim is to increase or maintain the value of product to its purchaser whilst reducing its cost to its producer” (Cross, 1994). The point of this step is to reducing the cost consumption that used to product to be designed. One way to do that is material selection. So there is list of materials of the product, and then choose the cheapest one but not reducing the quality of material itself, which is become the best solution.