CHAPTER I
INTRODUCTION

Chapter I describes the background of research, problem formulation, research objective, research scopes, and outline of the report.

1.1 Background

Sustainability has become an important issue since the world came to realize the threats to our planet's survival. Sustainability is defined by the World Commission on Environmental and Development as development that meets the needs of the present generation without compromising the ability of future generations to meet their needs (Moktadir *et al.*, 2018). Sustainable development has been expressed as a value system aimed at the orientation of decision makers and their management to transform their responsibility for environmental, economic and social behavior into business practices within the legitimacy of the society at large (Olugu *et al.*, 2010).

Businesses or industries are considered as key actors in the implementation of sustainability. Sustainability is vital for creating more inclusive and resilient markets and economies. Increased disclosure on environmental, social and economic impacts by organizations leads to greater transparency which helps to inform better decision making. This helps to build trust with stakeholders, and ultimately paves the way for a more sustainable economy and the world (GRI, 2016).

Sustainable manufacturing practices have recently received significant attention in academia and within industries to improve supply chain practices. Sustainable manufacturing practices have recently gained popularity due to increased consideration for environmental, social, and economic issues (Moktadir

et al., 2018). Manufacturing has traditionally been associated with undesirable environmental side effects as manufacturers are responsible for transforming resource inputs into useful outputs (Pathak *et al.*, 2017). Manufacturing also involves the disposal of product after their end of life, management of waste arising from these end of life products. Therefore, it is necessary to integrate this waste management into the supply chain by making it a closed loop (Olugu *et al.*, 2010).

Over the last decades, the environmental burden linked to industrial activities has become an important global issue. Awareness about the impact of human activities on global environments has promoted the environmental degradation prevention practices, such as, industrial ecology, green supply-chain management, and product life-cycle management (Pathak *et al.*, 2017). Green supply-chain management can be described as screening suppliers for their environmental performance and then allowing only those suppliers who perform satisfactorily to enter into business agreements with the manufacturer (Gajendrum, 2017). Th totality of this green purchasing, if combined with green manufacturing and material management, green distributor and marketing, as well as reverse logistics can be defined as a closed-loop supply chain (Olugu and Wong, 2012).

Closed-loop supply chain (CLSC) is a method to design and/or redesign the supply chain that incorporates recycling of metals and plastics, repair and reuse of parts and components for the production of new devices, and remanufacturing and/or refurbishing of entire discarded products for use as second-hand devices. Operations and potential flow of materials in a closed-loop supply chain should combine the forward and reverse chain (Olugu and Wong, 2012). While forward logistics handles and manages the flow of goods downstream in the supply chain from suppliers to customers, reverse logistics manages the flow of returned goods upstream (Hansen *et al.*, 2018). Reverse logistics is the movement of products or materials in the opposite direction to create or recapture value, or for proper disposal (Lembke and Rogers, 2015). It means that CLSC includes the manufacturing and distribution of new products and the returns of the used products from the customers

back to manufacturing plants through reprocessing operations and back to the suppliers.

Reverse logistics management is a need for effective implementation of green supply chain management. Reverse logistics is used for closing the loop after the customer (Olugu *et al.*, 2010). PT Tirta Investama Plant Solok has implemented reverse logistics in its supply chain. PT Tirta Investama Plant Solok is a company that incorporated into the Danone Group. Danone Group produces many kinds of products, such as baby food, coffee, dairy products, bottled water, dietary supplements, etc. As one of the subsidiaries, PT Tirta Investama Plant Solok only produces the bottled water called "AQUA". There are three types of bottled water produced by PT Tirta Investama Plant Solok, namely AQUA 600 mL, AQUA 1500 mL, and AQUA Gallon. All these products have been implemented reverse logistics in the supply chain processes.

Although leaving waste, bottled water is favored by the public because of the convenience offered and the relatively affordable prices set by the company. The waste produced by bottled water is plastic. Plastics are lightweight, strong, cheap, and easily adapted into different shapes and colors. Plastics are commonly used for single-use items (Ross, 2019). Because of the factors above, many sectors in this world produce more plastics. However, excessive use of plastic can pollute the environment because of the character of plastic is difficult to decompose, about 50 – 100 years. Data from the Indonesian Olefin and Plastic Industry Association (INAPLAS) and Badan Pusat Statistik (BPS) shows that plastic waste in Indonesia reaches 64 million tons per year and 10 billion pieces of plastic bags are thrown into the environment per year or as many as 85.000 tons of plastic bags (BPS, 2019).

Nowadays, PT Tirta Investama Plant Solok promotes a program called "#BijakBerplastik" that concern to the environment and commit to reuse the waste, which is plastic bottles. Starts from 2015, 25% of the plastic bottle materials are using recycled materials. Conducting the recycling process to plastic bottles can mean PT Tirta Investama Plant Solok has implemented reverse logistics in its

supply chain (Junqueira and Junior, 2015). PT Tirta Investama Plant Solok is working with the waste banks to collect plastic bottles that have been used for recycling into the new ones. The closed-loop supply chain of PT Tirta Investama Plant Solok can be described as **Figure 1.1**.

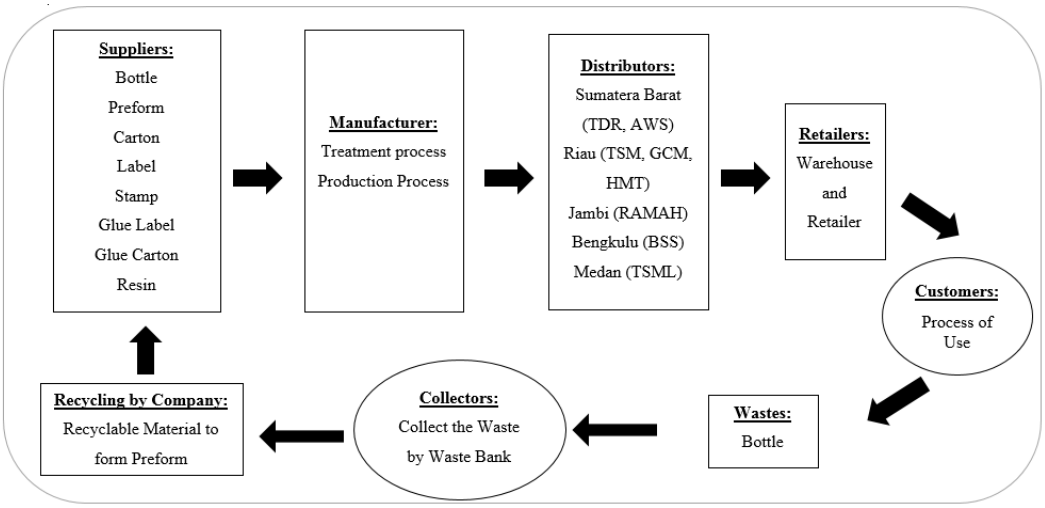

Figure 1.1 Closed-Loop Supply Chain PT Tirta Investama Plant Solok

Currently, a new bottle making factory which is usually located in Bandung, was built in the PT Tirta Investama Plant Solok area and start the operation in early 2020. The purpose of developing the bottle making factory is to reduce paper usage. Bottles are usually sent from Bandung to Solok using 450 boxes every day. With the development of a new bottle making factory in the Plant Solok area, the use of disposable boxes can be stopped and replaced with baskets that can be used repeatedly. Those show PT Tirta Investama Plant Solok's concern for the environment and an effort to achieve sustainability in the supply chain.

Closed-loop is a strategy towards achieving a sustainable supply chain. Closed-loop will involve changes in organizations' manufacturer philosophy, such as, sourcing and selecting suppliers, assessing suppliers, environmental performance, modifying and managing processes, reducing packaging and overall waste, developing more eco-friendly products, reducing carbon emissions associated with manufacturing and transportation of goods, etc (Olugu and Wong, 2012). Therefore, it requires continuous effort and improvement in the supply

chain. Some researchers have conducted researches on the closed-loop supply chain. Olugu *et al.* (2010) developed a new model for closed-loop supply chain performance measurement for the automobile industry. Meanwhile, Olugu and Wong (2012) measure the performance of the automobile industry using the evaluation framework adopted from Olugu et al. (2010). On the other hand, Jarosz (2016) presented the specifics of closed-loop supply chain management implementation in the food industry. To solve the lack of knowledge regarding to the assessment of international reverse supply chains, Butzer *et al.* (2017) defined a performance measurement system to assess international reverse supply chains. This study aims to support the circular economy and the remanufacturing industry with an approach to optimize international reverse supply chains and become more sustainable.

PT Tirta Investama Plant Solok has applied a closed-loop supply chain since 2015. After interviewing with the company staff, PT Tirta Investama Plant Solok doesn't know how well the supply chain is performing. Performance measurement conducted by PT Tirta Investama Plant Solok is the only measurement for one of the actors involved in the supply chain i.e., the suppliers, which is called supplier service level. The company has been not conducted the performance measurement to the entire supply chain actors. Thus, it becomes urgent for the company to measure the performance of their closed-loop supply chain. The closed-loop supply chain is a continuous process that is perfected over a period of time, and it becomes imperative to measure its performance from time to time (Olugu *et al.*, 2010). A model for closed-loop supply chain performance measurement is needed to assess the implementation of a closed-loop supply chain in PT Tirta Investama Plant Solok. The model used in this research covers various essential aspects of the closed-loop supply chain, including measurements relating to cost, company management, product, consumer, supplier, and waste.

1.2 Problem Formulation

The problem formulation in this research is how the closed-loop supply chain performance of PT Tirta Investama Plant Solok.

1.3 Research Objective

The objective of this research is to assess the closed-loop supply chain performance of PT Tirta Investama Plant Solok.

1.4 Research Scopes

The scopes of the problem in this study are:

1. The closed-loop supply chain performance is assessed only to products of AQUA 600 mL and AQUA 1500 mL.
2. The product distribution is limited to only the West Sumatera area.

1.5 Outline of Report

The outline of this final project report is divided into six chapters, as follows:

CHAPTER I INTRODUCTION

Chapter I contains the background of research, problem formulation, research objective, research scopes, and outline of the report.

CHAPTER II LITERATURE REVIEW

Chapter II contains the theories related to this research, consist of the supply chain, supply chain management, sustainable supply chain management,

closed-loop supply chain management, performance measurement in the closed-loop supply chain, performance measurement in beverage industry, fuzzy set and logic, and fuzzy rule-based system.

CHAPTER III RESEARCH METHODOLOGY

Chapter III contains the stages in conducting this research, consist of preliminary study, literature study, problem identification, problem formulation, development of performance measures and metrics, data collection, data processing, discussions and conclusions.

CHAPTER IV DATA COLLECTION AND PROCESSING

Chapter IV describes the data collection and processing conducted in the final project research. The data is processed using the fuzzy rule-based system. The steps of data processing using the fuzzy rule-based system are determining fuzzy sets and fuzzy inputs, implementing fuzzy operators, implementing function implications, compose all outputs, and defuzzification.

CHAPTER V DISCUSSIONS

Chapter V contains discussions on the results of data processing based on the research objective. The discussions of this research consist of the closed-loop supply chain performance of PT Tirta Investama Plant Solok, and proposed improvements for the closed-loop supply chain performance of Pt Tirta Investama Plant Solok.

CHAPTER VI CONCLUSIONS

Chapter VI contains the conclusion of the research and suggestions for future research.