CHAPTER I
INTRODUCTION

This chapter contains research background, problem formulation, research objectives, problem limitations, problem assumptions, and outline of the report.

1.1 Background

Logistics is a series of activities that include planning, implementing, and controlling the efficient and effective flow of goods, services, and information from source to consumer, both in direct and reverse directions, to meet customer needs (Chopra & Meindl, 2007). The process flow in logistics is divided into two process flows, namely inbound logistics and outbound logistics. Inbound logistics focuses on vendors providing raw materials and finished product suppliers. Meanwhile, outbound logistics focuses on fulfilling demand for end consumers (Fawcett et al., 2007). One of the forms of logistics activities is distribution.

Distribution is a series of activities involved in moving goods or services from producers to consumers (Kotler, 2011). The distribution process involves vehicles as a means of transportation. According to Zaroni (2015), it is stated that effective and efficient management of transportation activities will ensure the delivery of goods from the company to customers on time, in the right quantity, in the right quality, and the right recipient. Transportation costs are the largest cost component in the logistics cost structure, with a percentage of about 60%. In addition, according to Sang et al., (2021) transportation costs occupy one third of the amount in logistics costs and greatly affect the performance of the logistics system. Transportation costs can be divided into exploitation costs and ownership costs. These two costs form the largest scope of transportation costs and many companies consider these two costs as the first priority in their calculations. Exploitation costs include fuel costs, maintenance costs, and depreciation costs. Meanwhile, ownership costs include driver salaries, vehicle taxes, insurance costs,

and vehicle purchase costs (Rabbani et al., 2015). The role of distribution and transportation systems is vital in company operations since the transportation and distribution process affects a company's competitive advantage. Reducing in transportation costs can increase company profits. The success of a company depends on its ability to deliver products to customers in a timely and accurate manner (Baihaqi & Hermansyah, 2023). Product delivery must be done efficiently and accurately to customers so that distributors can make a profit. Strategies that can be done to overcome distribution capability problems are streamlining the distribution system, allocating existing vehicles, and planning and determining the proper distribution route (Sari et al., 2016). The choice of logistics distribution route is a complicated system engineering. Selecting the appropriate vehicle route can speed up response to customer demand, improve service quality, and boost customer satisfaction. Optimizing transportation logistics and reducing transportation costs is one of the effective ways for companies to improve their competitiveness. Hence, since Dantzig and Ramser introduced the Vehicle Routing Problem (VRP) in 1959, VRP has become an interesting issue for research in logistics over recent years (Zhu & Zhai, 2017).

VRP can be defined as a problem finding the most efficient route or path from a central depot to a group of customers located in various geographical locations, with the aim of minimizing shipping costs and optimizing logistics operations (Jayarathna et al., 2022). The VRP introduced by Dantzig before has given rise to numerous variants, each designed to address the intricacies of modern supply chains. These variants emerged due to the addition of constraints to the original VRP problem, aimed at solving real-world issues and complexities. By reading the VRP literature, it can be seen that the invention of this new variant of VRP is based on different criteria such as: the capacity of vehicles (CVRP or Capacitated VRP and HVRP or Heterogeneous fleet VRP), time interval in which the order must be delivered (VRPTW or VRP time windows), customers returning product (VRPB or VRP with backhauls, VRPSD or VRP with simultaneous pickups deliveries), environmental regulation (GVRP or Green VRP), priority of customers

trust (ConsVRP or consistent VRP), depots number and collaborative distribution (MDVRP or Multi-Depot VRP), and so on (Elatar et al., 2023).

In real-world logistics operations, route planning is often plagued by uncertainties such as shifting customer demands, unexpected traffic incidents, and unpredictable weather conditions. These uncertainties can result in increased costs and inefficiencies if not properly accounted for in logistics management. Solving the VRP is a crucial step. An effective VRP solution can yield substantial benefits, including improved efficiency, reduced costs, and enhanced customer satisfaction. According to research from Yaqin (2021), implementing VRP for industrial, special, and medical gas distributors can help companies schedule and determine routes efficiently based on existing constraints such as transportation capacity and working hours. In addition, companies can save on distance traveled by an average of 23.90%.

PT Putri Kembar Gas is a company that distributes medical and industrial gas cylinders. PT Putri Kembar Gas is located on Jl. Ranah Binuang, Ranah Parak Rumbio, South Padang District, Padang City. PT Putri Kembar Gas carries out gas distribution activities in the form of cylinders for oxygen, argon, nitrogen, carbon dioxide, and acetylene. Distributed gas cylinders have two sizes, namely large cylinders (volume of 6 m^3 and weight of 46 kg) and small cylinders (volume of 1 m^3 and weight of 10 kg), can be seen in **Figure 1.1**. The company operates from Monday to Saturday, starting from 8.30 am to 5.00 pm.

(a) (b)

Figure 1.1 (a) Big Size Gas Cylinders and (b) Small Size Gas Cylinders

PT Putri Kembar Gas has customers spread across several areas, especially in Padang City. The number of customers who place orders is different every day. In addition, the demand for large and small gas cylinders varies according to customer needs per day. On average, the demand for large cylinders is higher than the demand for small cylinders. **Figure 1.2** shows data related to the number of customers per day and the number of gas cylinder demands for one month.

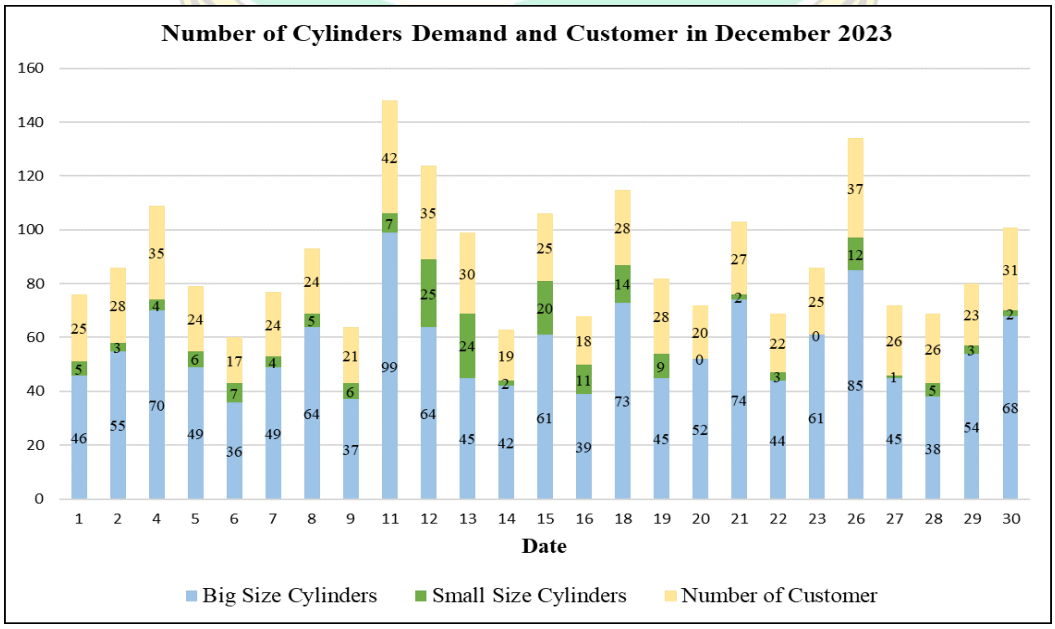

Figure 1.2 Number of Cylinders Demand and Customer in December 2023

Distribution activities carried out by PT Putri Kembar Gas begin with an incoming order from a customer. After receiving the orders, the company processed the order and make customer order list. The company will also categorize orders by region, namely upper and lower regions. The upper region includes Koto Tangah, Kuranji, and Bungus Teluk Kabung sub-districts. Meanwhile, the lower regions include North Padang, East Padang, South Padang, West Padang, Nanggalo, Lubuk Kilangan, Lubuk Begalung, and Pauh sub-districts. In the distribution process, pickup and delivery activities occur. The delivery process involves transporting filled gas cylinders and distributing them to customers. Meanwhile, empty gas cylinders are returned and this is part of the pickup process. Delivery starts at 8:30 am to 5:00 pm. However, if there are still orders that have not been delivered and have passed working hours, they must be completed on the same day. The gas cylinder distribution process carried out by PT Putri Kembar Gas can be seen in **Figure 1.3** below.

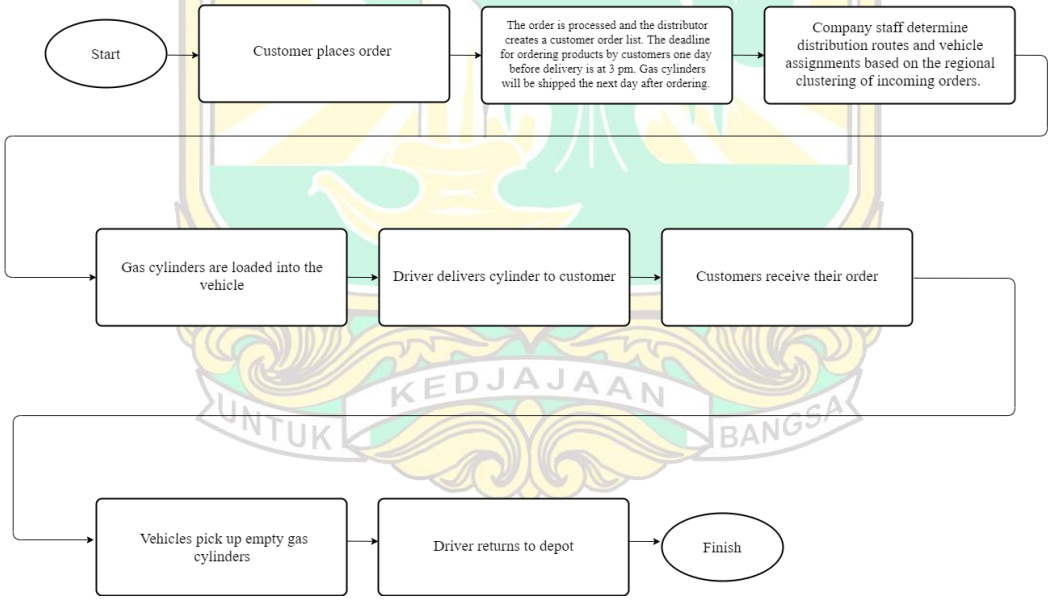

Figure 1.3 Distribution Process at PT Putri Kembar Gas

Distribution are carried out using two types of vehicles. The vehicles used are one unit Suzuki Futura pickup vehicle and three units of Suzuki APV pickups. Such vehicles have different capacities. The capacity of the vehicle used by PT Putri Kembar Gas to distribute gas cylinders can be seen in **Table 1.1**.

Table 1.1 Gas Cylinder Carrying Capacity for Each Vehicle

Type	Vehicle	Number of fleets (Unit)	Capacity (Cylinders)	Dimension (Length x Width x Height)
1	Suzuki Carry Futura Pickup	1	15	2200 x 1480 x 300 mm
2	Suzuki APV Pickup	3	25	2450 x 1670 x 365 mm

The problems faced by the company in distributing gas cylinders are the different demands for each customer, the limited number of vehicles used, the location of customers that are spread out, and the dynamic customer demand that changes every day. The current distribution route determination policy is only based on the company's regional clustering, so it is necessary to evaluate whether the current policy has provided benefits to the company and provides an optimal distribution route. Therefore, a Vehicle Routing Problem (VRP) model is needed to optimize distribution routes by considering the number of customer demands, total distance travelled, distribution time, and vehicle carrying capacity. The distribution routing model from this final project is planned to minimize the total travel costs incurred by the company and provide software that can determine dynamic distribution routes.

1.2 Problem Formulation

Based on the background of the problems previously described, the problem formulation is obtained, namely how to determine the gas cylinder distribution route of PT Putri Kembar Gas by considering the distance traveled, distribution time, vehicle carrying capacity, and the number of customer demands so that delivery becomes optimal by minimizing total travel costs.

1.3 Research Objective

The purpose of this study is to determine gas cylinder distribution route for PT Putri Kembar Gas by considering the distance traveled, delivery time, vehicle carrying capacity, and the number of customer demand in order to minimize total travel costs.

1.4 Scope of Problems

The problem limitations in this research are:

1. The vehicles used are heterogeneous.
2. The starting point and end point of distribution are the same, namely PT Putri Kembar Gas.
3. The distribution area observed is only customers in Padang City.
4. Each customer is only visited once in one distribution route.
5. The demand data used in this study is in December 2023.
6. The route used is dynamic depending on the number of customer demand.

1.5 Problem Assumptions

The assumptions used in this research are:

1. Traffic conditions are considered normal, there are no road improvements, and congestion factors are not considered in the distribution of gas cylinders.
2. The vehicle used is in roadworthy condition.
3. Vehicle speed is assumed to be around 30 km/hour.
4. Vehicle stopping time at each customer, which includes loading-unloading and payment, is assumed to be 15 minutes.

5. Available gas cylinders are considered sufficient to meet customer needs, so there will be no delays in delivery due to the unavailability of gas cylinder stock.

1.6 Outline of Report

The outline of the final project is as follows:

CHAPTER I INTRODUCTION

This chapter contains the background of problem, problem formulation, research objectives, scope of problem, problem assumptions, and outline of the final project

CHAPTER II LITERATURE REVIEW

This chapter contains theory related to problem in this research.

CHAPTER III RESEARCH METHODOLOGY

This chapter contains the steps in conducting research. These steps start from object of study, method selection, data collection, data processing, analysis, and conclusion.

CHAPTER IV DATA COLLECTING AND PROCESSING

This chapter contains data collection and processing related to determining the gas cylinder distribution route of PT Putri Kembar Gas.

CHAPTER V ANALYSIS

This chapter contains analysis of the results of the data processing that has been done.

CHAPTER VI CONCLUSION AND RECOMMENDATION

This chapter contains conclusions from the research that has been done and suggestions for further.