CHAPTER V

METHODOLOGY IN TRANSPORTATION

5.1 Introduction

Eleven major customers are to be considered in this thesis. All of them are located around the company. The transportation schedule for each customer is made solely by experiences of the delivery officers. Therefore, some schedules are not optimal. In this chapter, new routes and new schedule in improving the transportation operation in the company is focused. The existing routes are analysed and the improved schedules are made. Processes included in analysing the transportation operations are shown in Fig. 5.1.

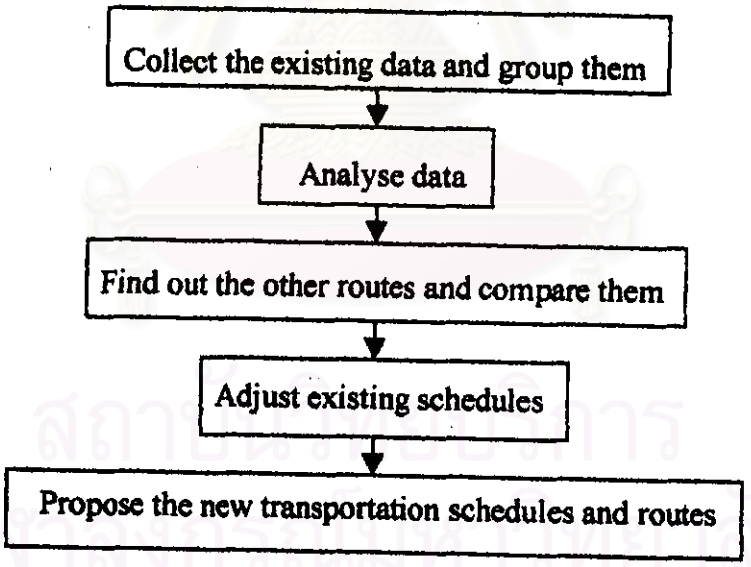


Fig. 5.1: The processes of making new transportation routes and schedules.

5.2 Collect and Group the Existing Data

For each customer, more than one route (from the company to the customer location) is usually possible. Drivers plan their routes using their experiences. However,

if the company has more than one customer, the drivers may not achieve the optimal routes and schedule.

In this thesis, the existing information is collected using the company's delivery documentation and private communication. Some other routes are obtained from the highway map. In addition, to confirm some information such as distance reported in the document, some routes have been investigated.

Our proposed procedures are that the customers are grouped according to their location. For example, the customers which are located in the same industrial estate are grouped together. After that, the drivers will generate the tour to each customer. This process is based on the capacity of the trucks and the distance constraint. Fig. 5.2 shows the highway map, the groups of customers and delivery tours.

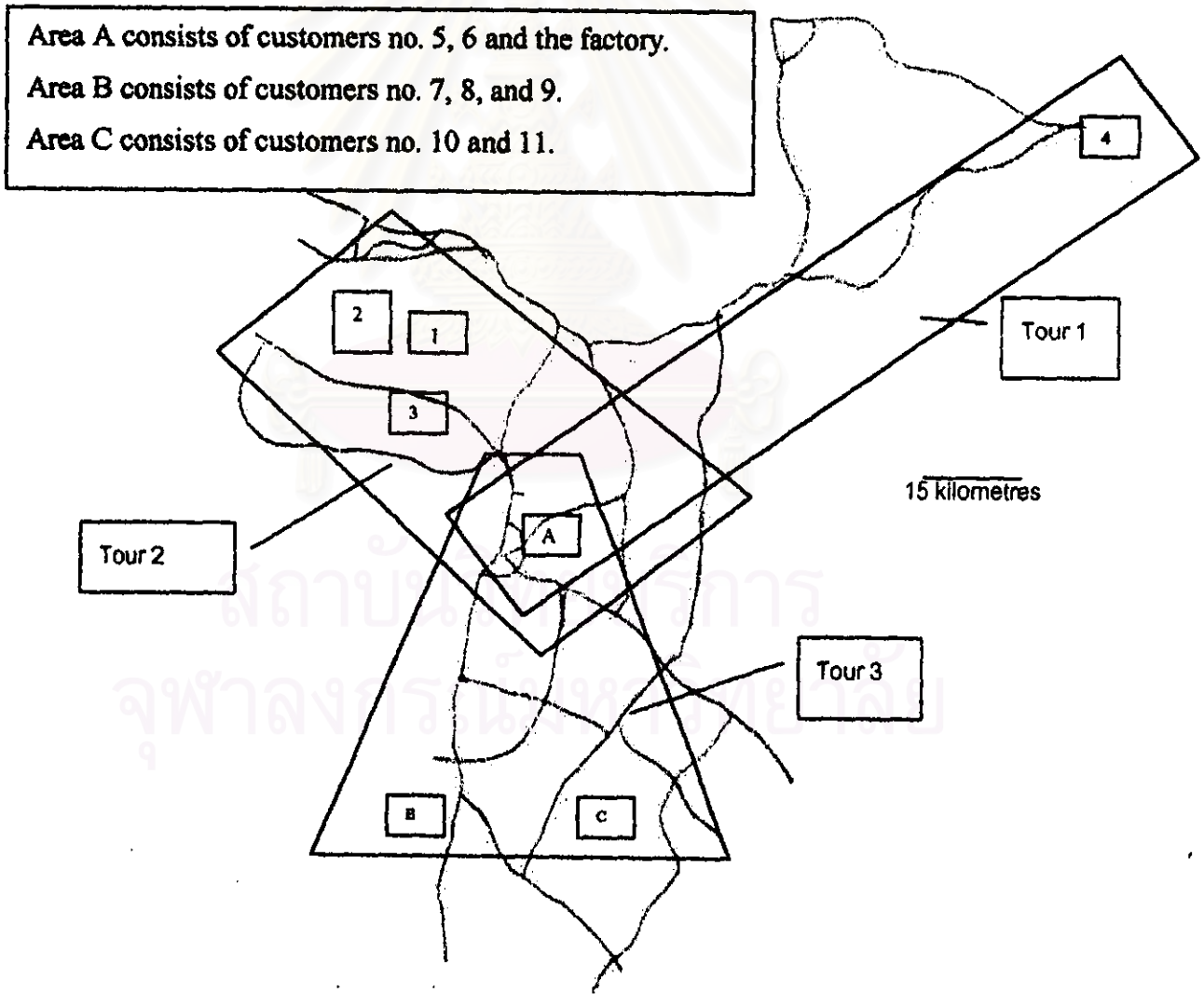


Fig. 5.2: Location of Customers on the highway map.

After collecting the existing information, the details of transportation routes and schedules to customers are shown in Table 5.1 below.

Table 5.1: Details of transportation routes and schedules to each customer.

Customer No.	Route	Schedule	Distance (km.)	Est. time (Min)
1	Suvintavong, Chalongkung, Ladkabang Industrial estate	Everyday	80	100
2	Suvintavong, Minburi-Romkral	Once a week	84	100
3	Bangna-Trad km.21	Everyday	42	60
4	Kabinburi-Korach	3 times/week	151	150
5	Bangpakong Industrial estate	Everyday	2	5
6	Bangpakong Industrial estate	Everyday	5	20
7	New Pataya Bypass, LamChabung Industrial estate	Everyday	48	60
8	New Pataya Bypass, LamChabung Industrial estate	Everyday	48	60
9	New Pataya Bypass, LamChabung Industrial estate	2 times/week	48	60
10	Banbung, Huakunjar, Sattaheap Industrial estate	Everyday	68	90
11	Banbung, Huakunjar, Sattaheap Industrial estate	Everyday	68	90

5.3 Information Analysis

All the existing transportation routes and schedules are analysed in each tour. The important tours are the tour numbers 1, 2, 3, and 4 because they are run on the routine basis everyday.

In the tour no. 1, it consists of only customer no. 4. There is only one optimal route which should be used. The proper vehicle is a small truck. The frequency of delivery is every other day. The location of this customer is farthest from the company. As a result, it takes the longest time to travel to and from this customer.

For the tour no. 2, there are three customers in this group. There are many possible routes to each customer. In addition, each route has its constraints, such as the Motorway has added extra cost to our tour. Each route is also depending upon the schedule to each customer. The route to customer no. 3 should be the last before returning to the factory since this customer locates on the same highway as the factory. Furthermore, customer nos. 1 and 2 require an Isuzu truck to deliver their finished products.

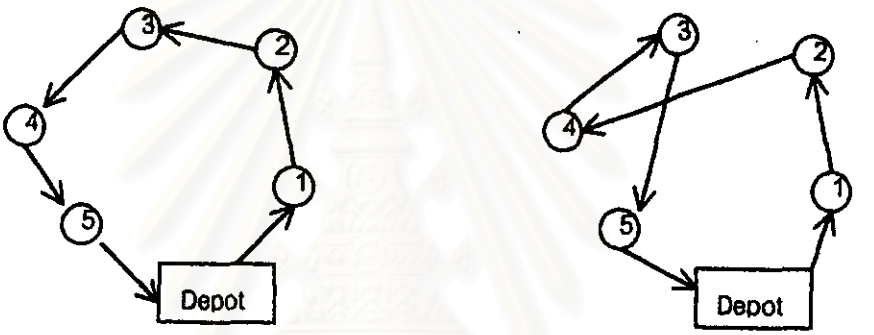
In the tour no. 3, there are two main areas of customers. As a result, the customers in the same area are grouped and called area B and area C. In the area B, there are three customers. They are all located at Lamchabung Industrial estate. The optimal route to go to Lamchabung is now operated by the company. In the area C, there are two customers. There are two routes from the factory to both customers. However, for the shorter route, the truck must travel through a narrow road. On the other hand, the road is much wider on the other route.

The tour no. 4 is near to the factory in area A. There are two customers near to the factory; they are customer nos. 5 and 6. The routes are very short. Hence, there is only one route to both customers.

For the tour no. 5, it consists of minor customers which occasionally require the products. They may require the product only once a month. Therefore, this route is neglected in this thesis.

5.4 Determining New Routes

In this factory, the 'vehicle routing problem' method can be adapted to achieve the optimal route. There are two major processes in the vehicle routing problem [Bodin et al., 1983]. Firstly, the drivers have to plan the delivery tour. Secondly, the tour improvement process is calculated. The 2-opt technique is widely used to improve routing. This technique is called 'branch exchange heuristics'. There are two steps in the branch exchange heuristics: they are the exchange procedure, and comparing the tour improvement. An example of 2-opt is as follows in Fig. 5.3:



Conventional route Trial by 2-opt method

Fig. 5.3 : 2-opt method used in a tour improvement procedure.

In this company, the number of customers per tour are not many. In addition, the capacity of the truck is limited. There are about two or three customers per tour. As a result, the vehicle routing problem can be solved manually. The delivery routes are classified as follows:

5.4.1 The Tour Number 1

There is only one customer and the route to that customer is now optimal. Therefore, the new route or new schedule is not necessary.

5.4.2 The Tour Number 2

There are three customers. Fig. 5.4 exhibits the location and the routes to these customers.

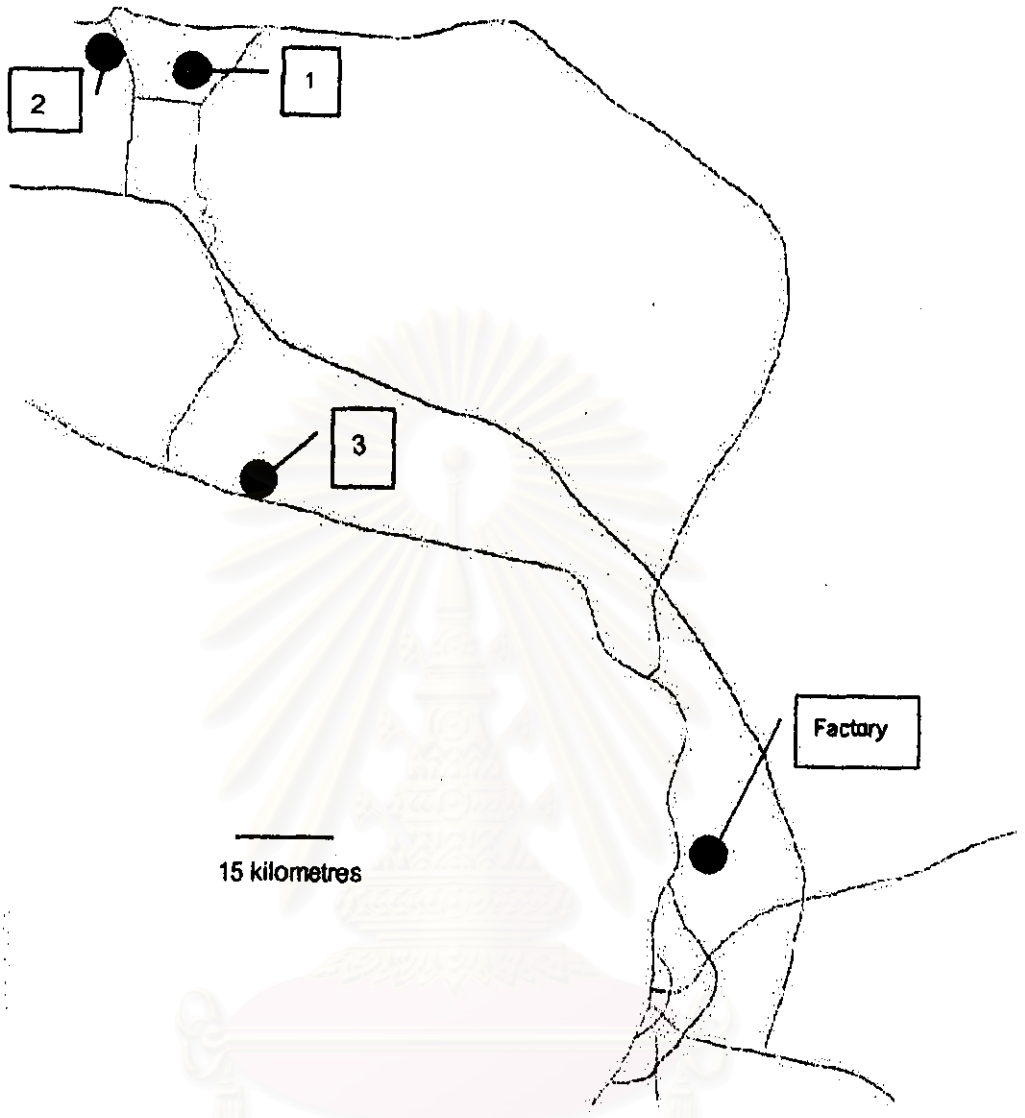


Fig. 5.4 : Location and routes to customers in the tour number 2.

Two vehicles are used in delivering finished products to these customers. The six wheels truck is always used to delivery finished products to the customer nos. 1 and 3 because both of them require large amount of products, exceeding the capacity of a small truck. For the customer no. 2, the amount and size of the delivered products of this customer are smaller than that of the customer no.1, therefore, a small truck is used to deliver finished products to this customer. However, both customer nos. 1 and 2 require ISUZU trucks to deliver their finished products.

In this tour, there are three proposed routes: the new route for six wheels truck, the new route for small truck and the combined route.

5.4.2.1 Six Wheels Truck Route

A six wheels truck is assigned to deliver products to customer nos. 1 and 3 everyday. The existing route seems to be satisfactory. The route is shown in Fig. 5.5 below.

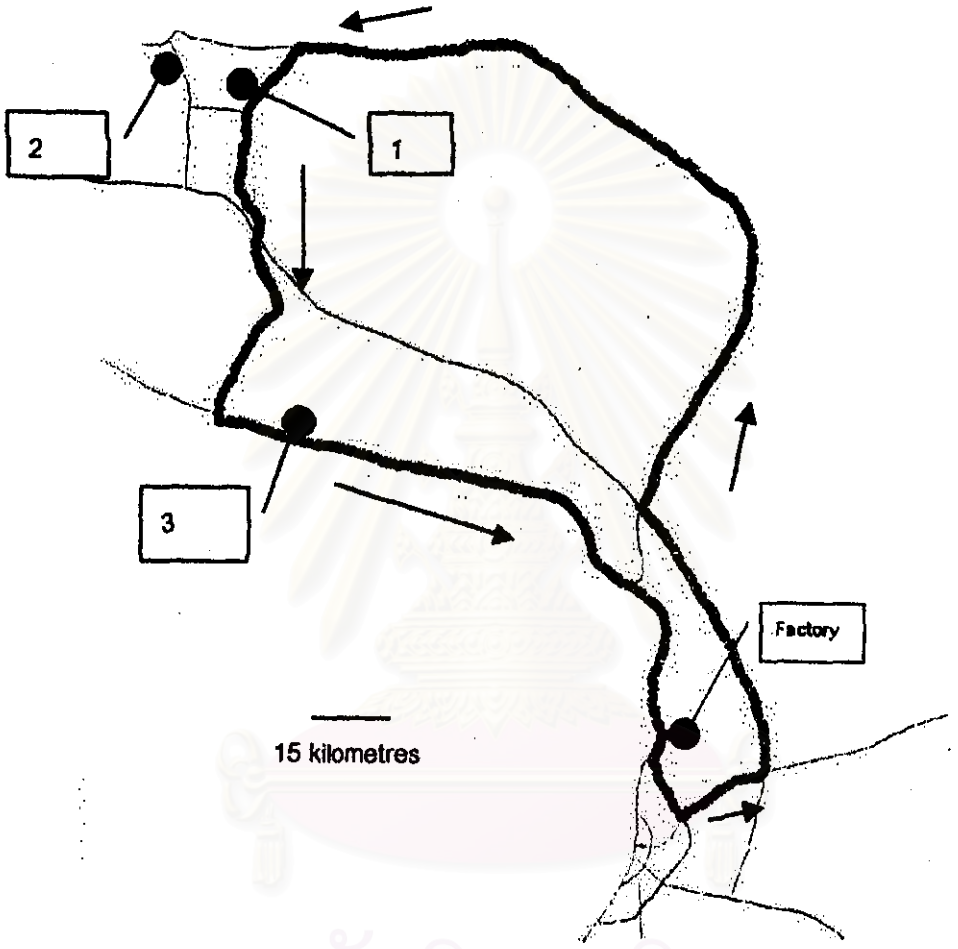


Fig. 5.5 : The route to customer nos. 1 and 3.

An alternate route is via the Motorway. The outbound route is via the Motorway while the inbound route has to be the Bangna-Trad Highway because both the customer no. 3 and our factory are on the Bangna-Trad Highway. Fig. 5.6 shows the route when the truck travels via the Motorway.

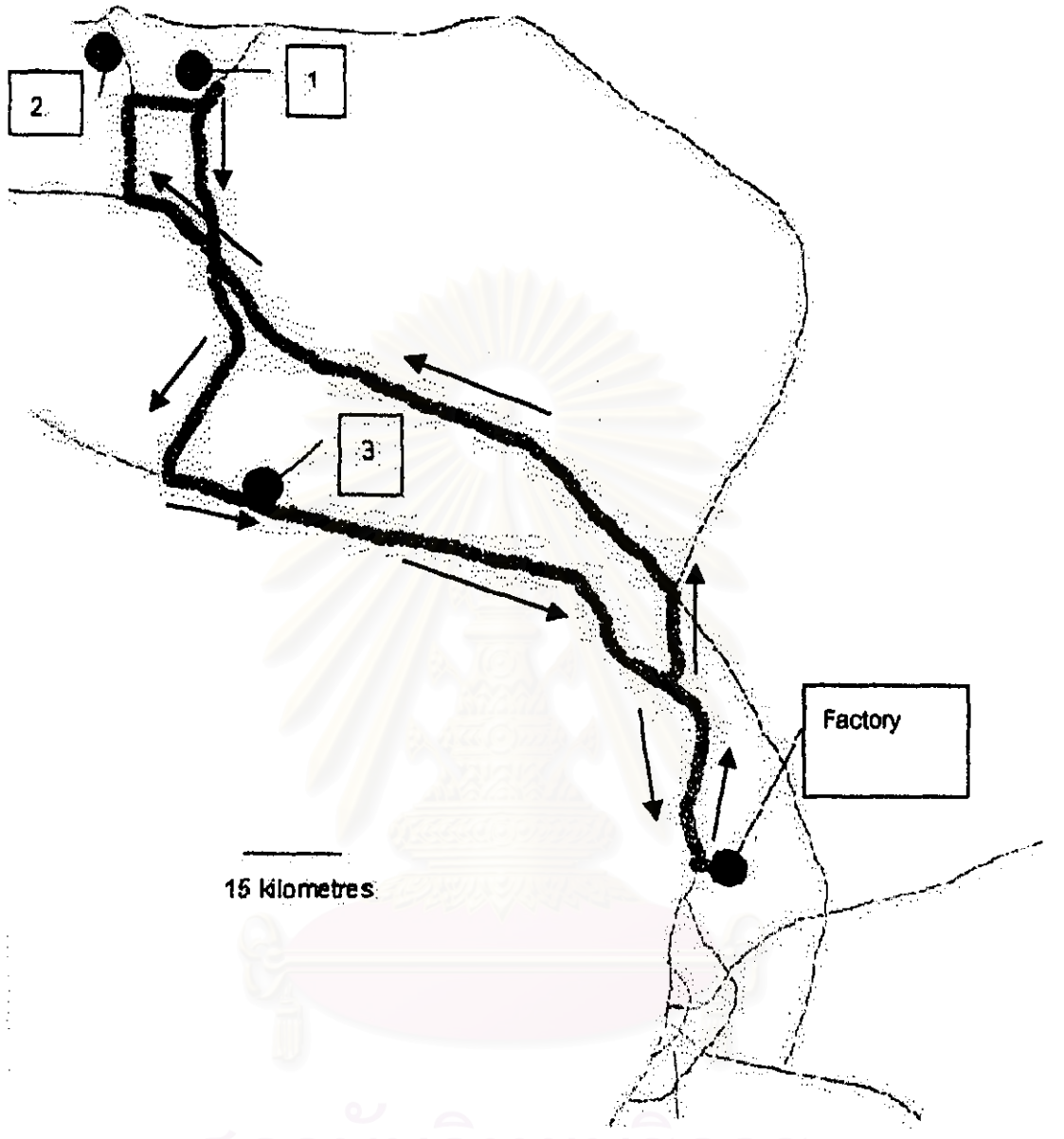


Fig. 5.6 : The proposed route via the Motorway for the outbound direction.

There are some constraints in both routes. Table 5.2 shows the differences between an existing route and the proposed route.

Table 5.2: Differences between an existing route and the proposed route for a six wheels truck.

Route	Distance (km.)	Estimate Time (min.)	Fee (Baht)	Quality of the road surface
Existing route	144	171	0	Moderate
Proposed route	122	110	50	Good

Our proposed route can help saving sixty minutes but the cost is fifty baht extra for a six wheels truck. The distance is shortened for about twenty two kilometres. The new route has better road's surface that can decrease the maintenance cost for the truck in a long run.

5.4.2.2 Small Truck Route

For a small truck, it is used to deliver finished products to only the cutomer no. 2. The existing route is as follows in Fig. 5.7.

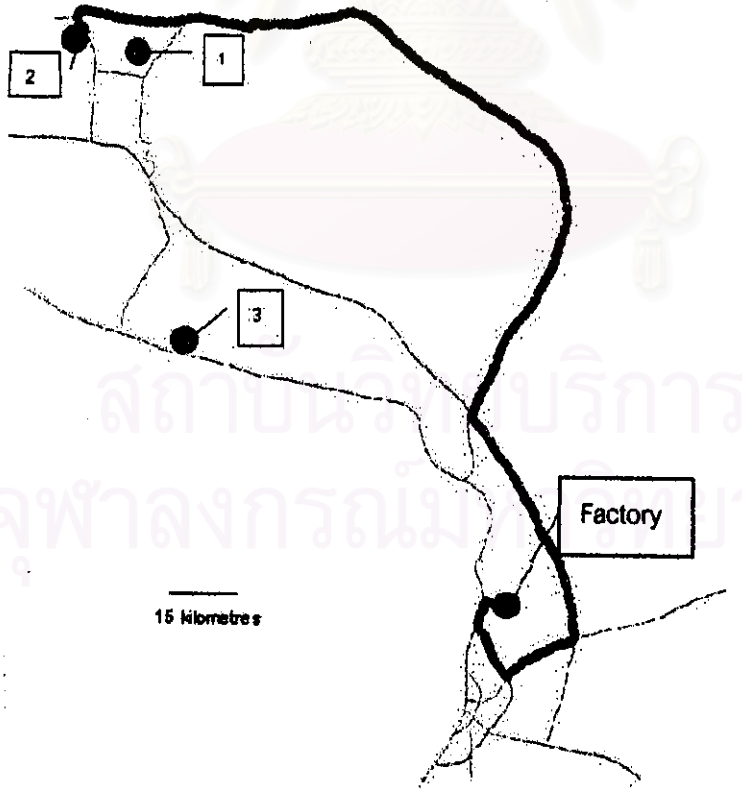


Fig. 5.7 : An existing route to the customer no. 2.

The same route is used for both the outbound and inbound directions. However, the other route is via the Motorway. Fig. 5.8 shows the new route to the customer number 2.

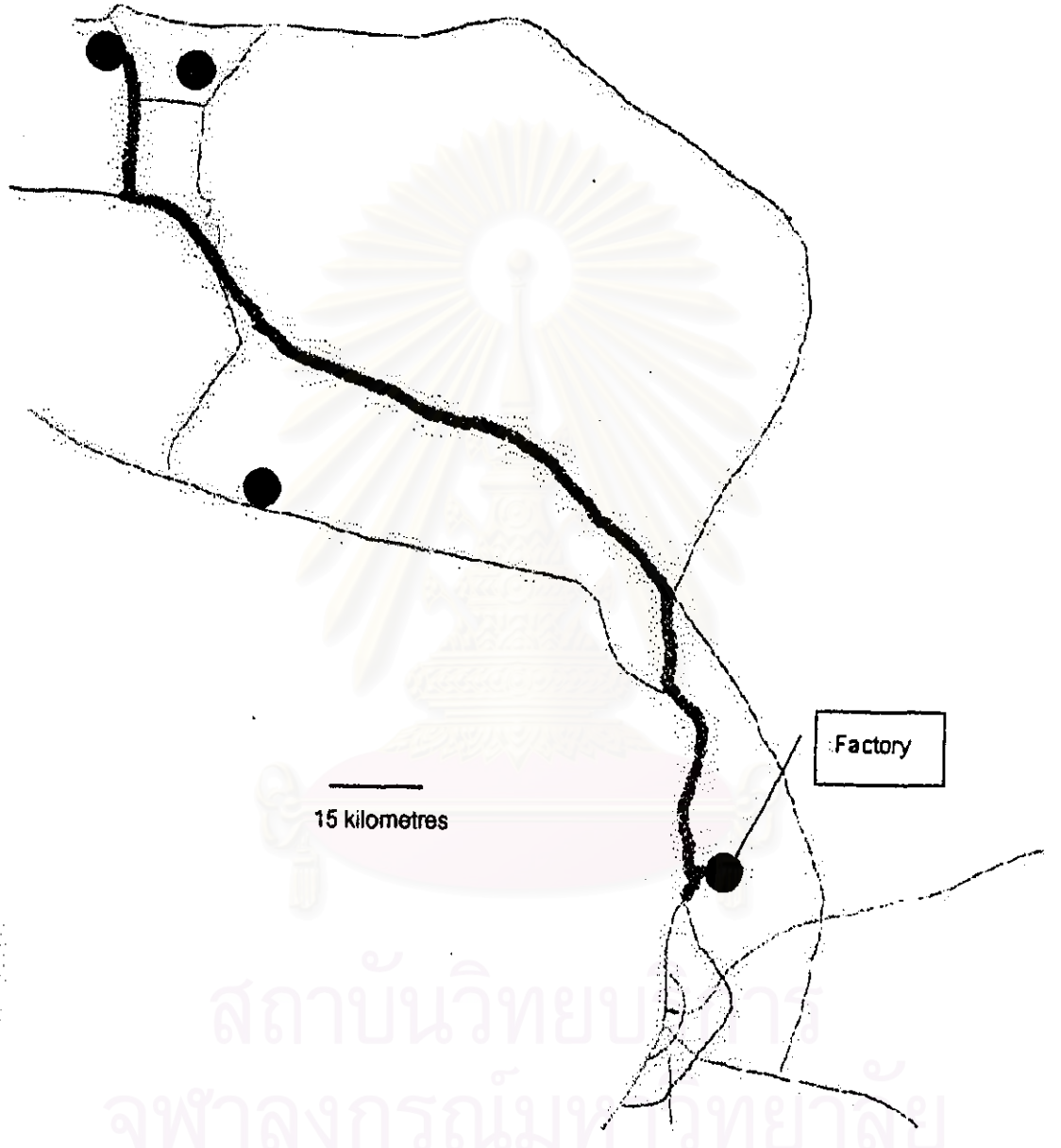


Fig. 5.8 : The proposed route to the customer no. 2 via the Motorway.

For this route, the Motorway is used in both directions which added extra cost of 60 baht. The comparison for the proposed route and the existing route are shown in Table 5.3 below.

Table 5.3 : Comparison between an existing route and the proposed route for a small truck.

Route	Distance (km.)	Estimate Time (min.)	Fee (Baht)	Quality of the road surface
Existing route	168	168	0	Moderate
Proposed route	105	100	60	Good

The newly proposed route can help shortening the distance from 168 km. to 105 km. However, an extra cost of 60 baht for the Motorway fee (2 times x 30 baht for 4 wheel vehicle). The road surface in the new route is better than the existing route. In addition, an estimated time for the new route is shorter than for the existing route about one hour. The company can deliver to this customer twice a day, in the morning and in the afternoon if the driver use the Motorway.

5.4.2.3 Combined Route

The main criteria for this tour is based on the fact that the amount of finished products for the customer no. 2 are not many. The company may combine the products for the customer no.2 into the six wheels truck which delivers to the customer no. 1 and no.3. Since the customer no. 2 requires products delivery about twice a week, the six wheels truck will be loaded to its full capacity only 2 days per week. The route for this tour is shown in Fig. 5.9 below.

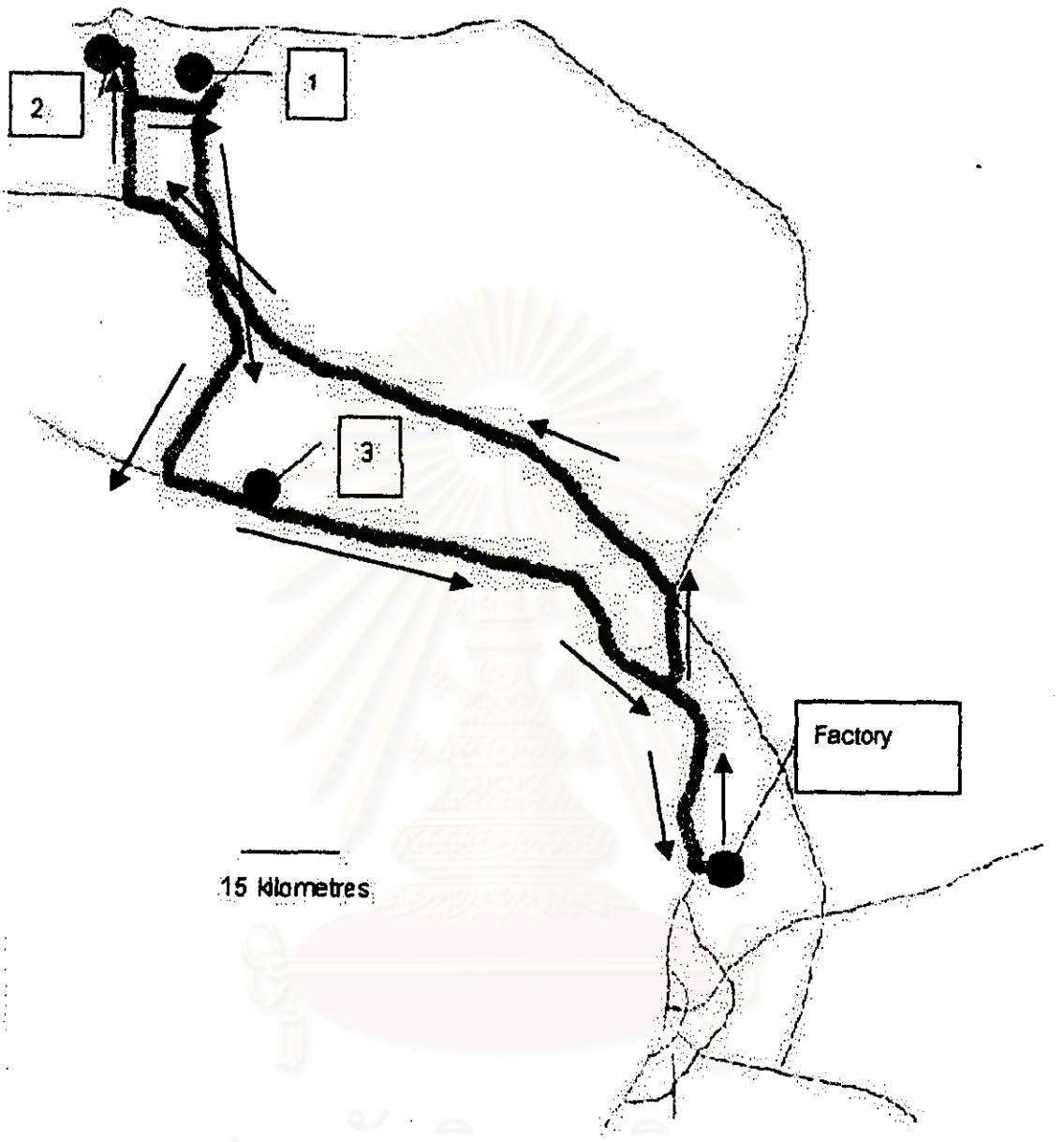


Fig. 5.9 : The combined route for the customer nos. 1,2, and 3.

For this combined route, the six wheels truck travels about 132 kilometres. The Motorway is used in one direction therefore, an extra cost of 50 baht is added (50 baht for a six wheels truck/trip). The total distance for an existing route is that of the six wheels truck plus the small truck. On the other hand, if only one six wheels truck is used to deliver to three customers, the total distance is that of the six wheels truck plus the route from the customer no. 2 to customer no.1. The distance reduction is apparent

from the fact that the small truck route is no longer needed. As a result, the fuel consumption and working time decrease.

Assuming that the distance between the two customers are equal that is

$$d_{ij} = d_{ji}$$

where d_{01} = distance between the factory and the customer no.1,
d_{02} = distance between the factory and the customer no.2, and
d_{12} = distance between the customer no.1and the customer no.2.

The existing route = $2d_{01} + 2d_{02}$
the combining route = $d_{01} + d_{12} + d_{02}$

Therefore, the distance reduction is equal to $(d_{01} + d_{02} - d_{12})$

The distance for the six wheels truck to deliver to the customer nos.1 and 3 is 122 kilometres. The distance for the small truck to deliver to the customer no.2 is 105 kilometres. Therefore,

the distance reduction = 122 + 105 - 132
= 95 kilometres

5.4.3 The Tour Number 3

In this tour, two groups of customers are grouped together. They are called Area B and Area C as our delivery code. Customers in both areas require the finished products delivery everyday. Therefore, the company has to deliver daily. In Area B, a six wheels truck is needed to deliver the products because of high capacity requirement. After the six wheels truck delivers products to Area B, this truck is used for any delivery for some other chained companies in the afternoon. In addition, the route to this area is now optimal because there is only one appropriate route. For Area C, the customers require the finished products everyday but for a small amount. Hence, a small truck is used. Fig.5.10 shows the existing routes to Area B and Area C.

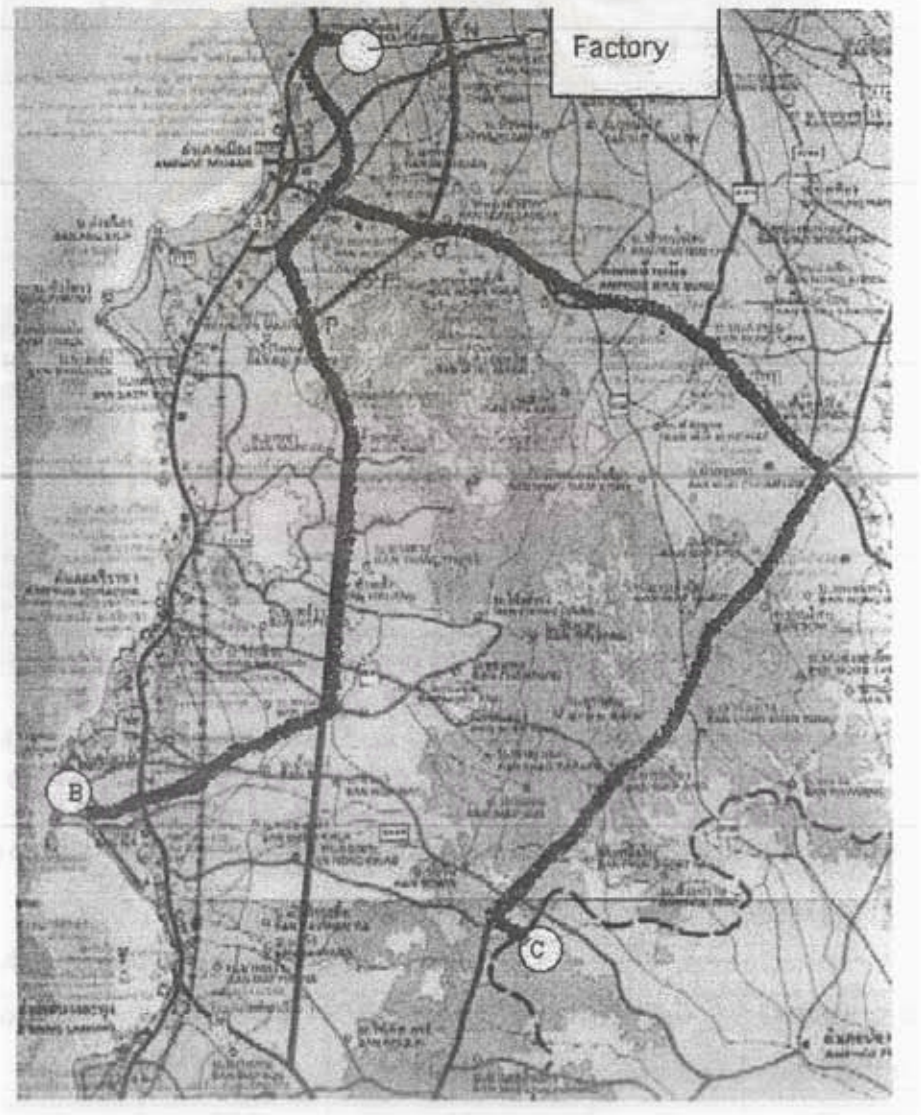


Fig. 5.10 : Existing routes to customers in Area B and Area C.

When the highway map has been investigated, there are some possible routes to Area C. The possible route is displayed in Fig. 5.11 as follows.

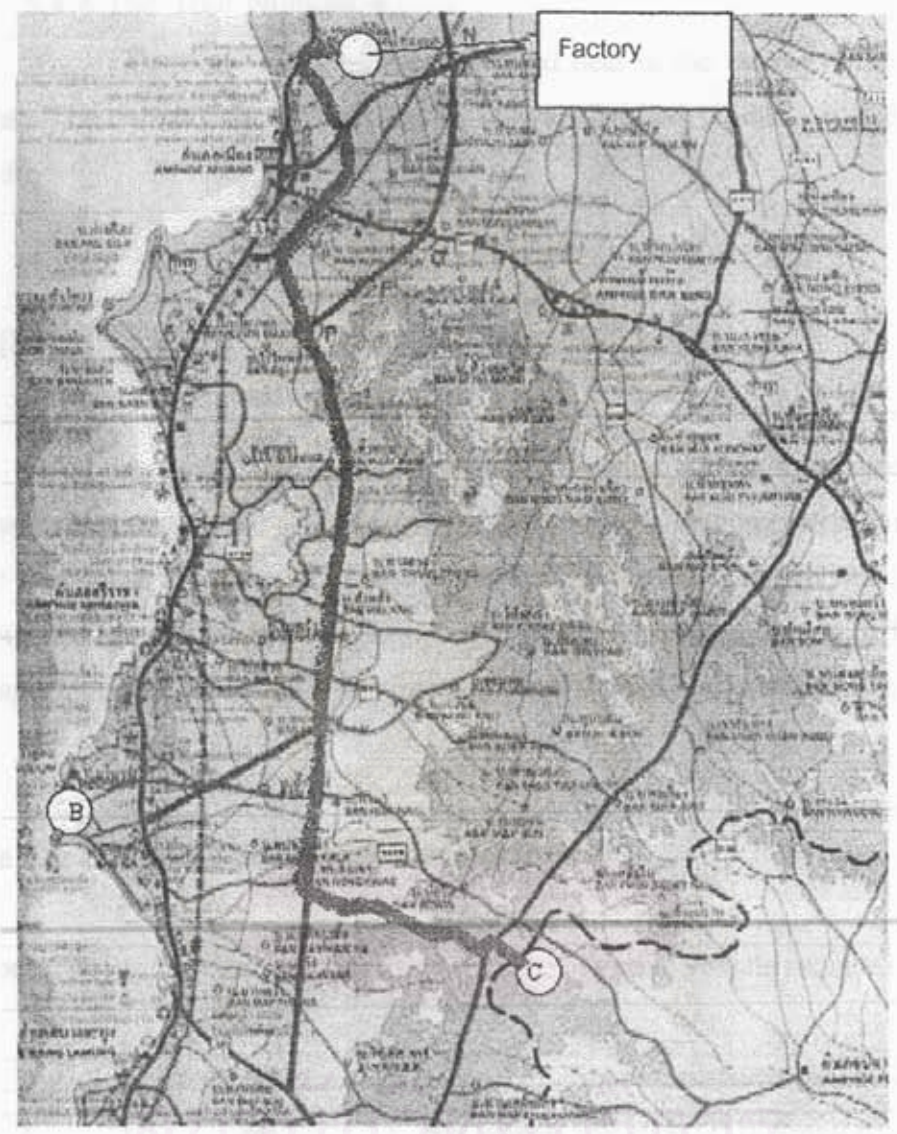


Fig. 5.11 : A proposed route to Area C.

The details of our proposed route and the existing route are shown in Table 5.4.

Table 5.4: Comparison of routes to Area C.

Route	Distance (Km.)	Estimated Time (Min)	Fee (Baht)	Quality of the road surface
Existing route	136	90	0	Good
New route	108	70	0	Moderate

The new route to Area C is shorter than the existing route. However, this proposed route has not been surveyed. The road could be narrow in some parts.

5.4.4 The Tour Number 4

There are two customers situated near to the factory. This route is now optimal. The delivery department has to deliver finished products to these customers everyday.

5.5 Routing Plan and Scheduling of Vehicles

After the routes have been investigated, the other criteria to be determined is the time spending at each customer before the schedule can be completed. Firstly, workers at our warehouse are assumed to load all the finished products onto a vehicle within half an hour. An amount of products and size of vehicles would make no difference in our assumption. Table 5.5 exhibits the time to unload finished products at each customer.

Table 5.5: Unloading time for various customers.

Customer no.	Unloading time (min.)	Type of vehicle required
1	60	Six wheels truck(ISUZU)
2	60	Six wheels truck(ISUZU), Small truck (ISUZU)
3	60	Six wheels truck
4	45	Small truck
5	90	Small truck
6	45	Six wheels truck
Area B	90	Six wheels truck
Area C	90	Small truck

There are two six wheels trucks and two small trucks at our factory. There are two ISUZU trucks: one six wheels truck and one small truck. When all the time in each tour is determined, the basic schedules should be as follows:

- The six wheels ISUZU truck serves the customer nos. 1 and 3 in the morning and then serve the customer no. 6 in the afternoon everyday.
- The six wheels MITSUBISHI truck serves customers in Area B everyday in the morning.

From the above table, the customer nos. 2 and 4 do not require the finished products everyday. Therefore, the scheduling process depends on them. There are four possibilities as shown in Table 5.6 below.

Table 5.6: Possibilities for customer requirements.

Case	Customer no. 2	Customer no. 4
1	YES	NO
2	NO	YES
3	YES	YES
4	NO	NO

As a result, there are four schedule possibilities for the two small trucks based on the requirements of the customer nos. 2 and 4 from cases 1-4.

Case 1: the small ISUZU truck delivers finished products to the customer nos. 2 and 5. The small TOYOTA truck serves customers in Area C.

Case 2: the small ISUZU truck serves customers in Area C and customer no. 5 while the small TOYOTA truck serves the customer no. 4.

Case 3: the small ISUZU truck delivers finished products to the customer no. 2 using the Motorway in the morning and then serves customers in Area C in the afternoon. The small TOYOTA truck serves the customer no. 4. For the customer no. 5, the company has to use a subcontracted truck.

Case 4: the small ISUZU truck delivers finished products to the customer no. 5 and customers in Area C.

5.6 Summary

When all the routes and schedules have been determined, the new schedules and routes are proposed to improve the transport operations in this company. The new routes are proposed in the tour numbers 2 and 3. When all the routes are changed according to our proposed routes and schedules, some schedules can be adjusted to be appropriate for delivery in the morning and in the afternoon. This can reduce the cost of subcontracted trucks to be necessary only in the case 3. In addition, the combination of the customer no 2 into the tour no. 2 strategy is proposed to reduce the travel distance. Nevertheless, the company may need to change a six wheels truck to a larger size vehicle such as a ten-wheel truck that requires rather high investment. The evaluation of the new routes and schedules are investigated in Chapter 6.