CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

In this thesis, an improvement in materials handling routing in the warehouse and transportation operations have been focused on. The company used as a case study manufactures automotive parts. The materials handling routing and vehicles routing and scheduling have not received as much attention from the company as in other operation sectors. For the warehouse, the location of each item is assigned without taking into account about the frequent of use. Some high turn over items are located far from the shipping and receiving station. For the transportation part, drivers use their experience to plan the routes to customers. In addition, some new route is now open for public. Therefore, a research study of the warehouse systems, transportation routing and scheduling have been carried out. All the information has been analysed based on the related literatures and knowledge in industrial engineering. Finally, the new warehouse layout which can help improving the materials handling routing, and the Nearest Neighbor Heuristic technique which can assist in the routing generation in picking and shelf-filling operations have been proposed. In addition, the vehicle routing and transportation schedule for eleven major customers have been proposed. The optimal schedule was also proposed for comparison with the proposed schedule and the existing schedule.

In this case study company, the existing warehouse layout takes into account only the models of items and space utilisation. However, the frequency of ordering those items have not been considered. Some high turn over items are located far from the shipping and receiving station. Furthermore, the materials handling operations are operated manually by the warehouse's workers. Their picking route and shelf-filling route may not be optimal.

For the transportation operations, the scheduling process is determined only from experience of the drivers and some existing guidelines. There are many ways to some customers and the routes were not compared. The drivers still use the existing route which may not suitable.

From the aforementioned problems, the warehouse layout, ordered items and the distance in the warehouse have been analysed. Every item in the warehouse has been determined such that the storing location based on their frequent of use and model has been considered.

The methodology in the warehouse are as follows.

1. The data of each item is collected. Then the items are groupped based on their model.
2. The frequent of ordering for each item is determined and sorted from high to low.
3. The most frequently ordered items are assigned to the new locations where they are located near to the receiving and shipping station.
4. The picking tours and shelf-filling tours for each order are generated by the Nearest Neighbor Heuristic technique to measure the tour distance.

After the new locations have been proposed to the company, the frequency in ordering items in November 1999 was collected to assist in evaluating the materials handling route. As a result, the travel distance of the materials handling route for each operation is as follows.

1. Order picking from the machining department

The existing distance	=	11,945.28 m.
The proposed distance	=	1,609.56 m.
Therefore, the distance reduction	=	10,335.72 m.

2. Order picking from the assembly department

The existing distance	=	12,422.44 m.
The proposed distance	=	10,816.96 m.
Therefore, the distance reduction	=	1,605.48 m.

3. Shelf-filling

The existing distance	=	2,165.92 m.
The proposed distance	=	1,755.64 m.
Therefore, the distance reduction	=	410.28 m.

The proposed warehouse layout can reduce 46.55% in distance for the materials handling operations.

When the problems in transportation operation are determined, the methodology in transportation operation are as follows.

1. The existing schedule and the route are collected and determined.
2. The new routes are generated from the map.
3. The distance, highway fee and surface of the road are examined.
4. The suitable routes are selected.
5. The proposed schedule is presented.
6. The cost analysis has been conducted to evaluate each schedule.

When the possible route to each customer has been analysed, the schedule in transportation is proposed to improve the transportation operations. In addition, the optimal schedule is proposed to compare with the proposed schedule. The overall cost for each schedule is calculated for a period of one year and the result of the direct cost is as follows.

- Existing Schedule 326,077.44 baht per year
- Proposed Schedule 291,024.24 baht per year
- Optimal Schedule 264,201.60 baht per year

In this thesis, the proposed warehouse layout can save up to 46.55% in distance in the materials handling routing in the warehouse. The proposed schedule and route in transportation operations can save up to 35,000 baht per year. To summarise all the aforementioned results, they are as follows.

1. The new warehouse layout can provide better efficiency in the warehouse. The travel distance in materials handling is reduced. The important variable is the frequency of moving.

2. The new vehicle schedule and route can reduce the cost of transportation. The evaluation result depends on the scope of expenses whether the driver's cost, fuel cost and maintenance cost are included or not.
3. The Nearest Neighbor Heuristic technique can be applied in the warehouse operation and in the transportation operation. This technique is used in planning schedules.
4. For the proposed materials handling routing, it may not be useful when compare with the workers' experience. The proposed technique requires more processes to plan the routes. In addition, some routes may not be optimal if there is a change such as amount of products to be delivered and new customers in the transportation operation, and amount of raw materials and products between the machining and assembly departments, locations of dock, tools in materials handling in the warehouse operation. All these constraints influence the route planning process that the existing routes have to be revised.

7.2 Suggestions

The exercise carried out in this thesis is a case study of a warehouse and transportation operations. The main processes are problems analysis, systems development, and new systems evaluation. To further improve the warehouse and transportation operations, some suggestions are proposed as follows.

1. The materials handling routing should be optimised in every department.
2. All the routes to every customer must be determined to help in reducing the overall transportation cost.
3. The data should be collected in greater details to provide the more accurate results.
4. Some information should be collected in reality such as the travel time for a truck and the travel time of the materials handling process.

7.3 Comments for Future Work

A computation analysis can be used to generate the optimal route in the warehouse. In addition, the materials handling routing may be considered in the overall process (from suppliers to the processing units in the company and to customers) to achieve the minimum cost of moving. Information Technology (IT) can be applied to the management of the space utilisation. The dynamic location strategy can be used when the control of all the transaction is computerised. As a result, the most frequently ordered items must be located at the optimal locations.

The replacement of the trucks presently used at the company should be studied to achieve the optimal schedule. The optimal schedule can further reduce the overall cost.