Designing a Proposed Scheduling Model in Logistics Company

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***Abstract*—X. Corp. is a company engaged in the logistics industry that provides their clients with every logistics need, including land transport. The company has received many complaints regarding their on-time delivery. A new model of scheduling must be implemented to provide and maintain good on time delivery and truck cycle. A model of scheduling with EDD method will be compared to the actual scheduling results by random sample. Then, a program will be made by Excel VBA to automate the scheduling process. The output of the program will then be compared to the actual scheduling for the past 2 months. Results show that EDD method is the most optimal method for scheduling a model that is based on a due date. Compared to the actual scheduling model, the scheduling program could improve truck cycle by 15%. A better truck cycle means faster delivery and more truck utility.**

Keywords—scheduling, earliest due date, programming, excel VBA, logistics, land transport.

I. INTRODUCTION

In today's competitive business landscape, on-time delivery can serve as a significant differentiator. Businesses that consistently deliver on time gain a competitive edge over their competitors. Customers are more likely to choose a company that can meet their deadlines reliably, especially when time-sensitive factors are involved in their decision-making process. Therefore, currently many companies are in dire need of a logistics company that can be relied on in timely delivery. X. Corp. is a company engaged in the logistics industry. As a logistics company, one of the most difficult issues in the business is to provide and maintain good on-time delivery and truck cycle.

In 2022, the company's on-time delivery rate is only 78%. If we explore deeper, it is caused by several factors. In Fig. 1, the biggest cause of delays is because trucks are not available as much as 56%. There are many factors that can cause unavailable trucks, such as truck damage, poor scheduling, or unexpected order handling times. Besides that, it is known from data that cycle rate of 0.77 (truck route per day). This is caused by their low usage of trucks and a bad scheduling process.

Branke et. al stated that scheduling is concerned with the allocation of limited resources to tasks over time, with the basic aim to ensure an effective and efficient use of the available resources [1]. Kerzner said that effective scheduling allows us to perform what-if exercises, develop contingency plans, determine the risks in the schedule, perform trade-offs, and minimize paperwork during customer review meetings [2].

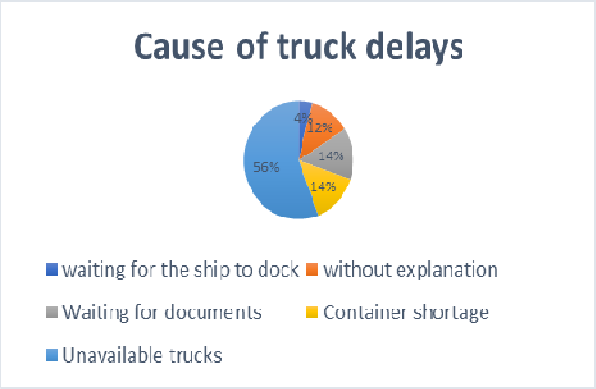

Fig. 1. Cause of truck delays

Many research papers have been published in the scheduling management area. Zhu et. al mentioned that mathematical programming and heuristics are frequently applied in the complex linear and combinatorial optimization problems [3]. Gahm et al. developed a research framework for energy-efficient scheduling [4]. Khodaei presented a model for microgrid optimal scheduling considering multi-period islanding constraints to minimize the microgrid total operation cost [5]. In the field of transportation, Niu et. al computed and adjusted train timetables for a rail corridor with given time-varying origin-to-destination passenger demand matrices [6]. Lam et. al proposed a new public transportation system based on autonomous vehicles [7]. Palacios et al develop an integer linear model and then a decomposition procedure, combining relaxed integer models and heuristic algorithms in order to determine the minimum number of trucks in container loading [8]. While Banyai determined the optimal assignment and scheduling of last mile logistics to minimize energy consumption, which allows to improve energy efficiency [9]. Guo et al proposed a two-level scheduling method to improve a low-cost transportation scheme and satisfactory path tracking results for Unnamed Surface Vehicles (USVs) scheduling to transport containers between different berths (exclusively for USVs) in the seaport.[10]

To help this company to maximize their truck cycle to meet their customers satisfaction on on-time delivery, this study

suggests using EDD method of scheduling, which is a scheduling method that uses due date as a priority. A proper scheduling method is needed by the company to handle the problem. In this study, analysis and proposals will be made regarding the design of the scheduling system for X. Corp.

II. METHODS

To be able to manage the truck cycle well, the company must be able to predict when the most optimal time is for the truck to depart and when is the estimated time for the truck to return based on the data from the past. Finding the ideal schedule with the highest truck cycle while still meeting the due date is the purpose of the scheduling management. There are many methods to improve a schedule, and one of them is the EDD method (Earliest Due Date). It is a method that manages a schedule based on the due date of each order. The calculation in this method is done by simulation.

III. RESEARCH METHODOLOGY

The first step in this research project is problem identification. The concern of on-time delivery by land transport are discussed verbally with X. Corp. The interview concluded that the company was having issues with completing on-time delivery by truck. Then, supporting data was collected to support the claim. The data used to validate the claim was taken from the year before.

The scheduling method that will be proposed will be simulated with the EDD (Earliest Due Date) method. This method will be effective for the situation, because on-time delivery is measured by how well a truck can arrive at a given location before the appointed time. The data used as a comparison will be taken by random sampling. The result of the proposed method will be compared to the current scheduling method.

After proving that the proposed method could give better results, an automated program will be designed with Visual Basic for Applications in Microsoft Excel Software. The program for IFF division order and DFF division order will be separated. The design of the truck scheduling system will be carried out in the scheduling process of LT division. After the program is completed, the program will then be used again to schedule trucks for the past 2 months and will be compared to the actual scheduling results. The analysis and conclusions will be drawn regarding the overall research and will become suggestions for future research for the company.

IV. RESULTS AND DISCUSSIONS

A. EDD Scheduling

Land Transport Division (LT) is one of the many divisions of the company. It's responsible for managing and providing its customers with delivery services by land transport, such as truck. The LT division has 2 internal customers: International Freight Forwarding Division (IFF) and Domestic Freight Forwarding Division (DFF). Each customer has their own characteristics. IFF division will mostly submit their truck requirements a day before the requested day. DFF division on the other hand, could still submit their truck requirements on the requested day.

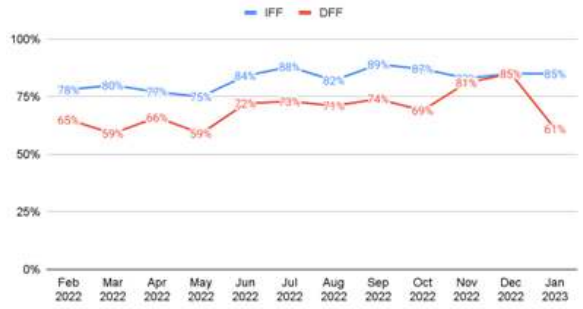

Fig. 2. On-Time Trucking Delivery

Figure 2 shows a chart of on-time truck delivery targets for the IFF and DFF departments. Timely delivery starts from the time the truck arrives at the customer's warehouse at the promised time. Based on data for the last 1 year, the LT department still has a low percentage of on-time deliveries. The average delivery time for IFF trucking orders is 83% and DFF is 70%, which means that the percentage of delivery delays from the LT department is 17% for the IFF department and 30% for the DFF department.

LT division has two means of completing their order. First is by using their own truck. Currently, the LT division has 42 trucks ready to be deployed. The second one is by using other trucking vendor's services. The LT division will prioritize the usage of their own truck and will use other trucking vendor's services if the LT division is out of capacity. For outbound transactions, the most common route for the truck is to pick the empty container from the assigned container depot, stuffing process at the customer warehouse, then full container stack at the port. For inbound transactions, the route started by picking full container at the port, delivering it to the customer warehouse for the stripping process, then returning the empty container to the assigned container depot.

In general, the LT department will share a portion of the orders received with the vendor. The purpose of setting this target is to maintain good relations with X Corp. with vendors providing other land transportation services. On the other hand, sharing a percentage of orders that are too large for the vendor can result in losses for the LT department as well. This is because the more trucks owned by the LT department that do not travel, the greater the additional cost that the company needs to incur. The ideal percentage of using vendor services is around 30%.

Figure 3 shows the percentage of vendor service usage in the last 1 year. The lowest percentage of using vendor services is at 28%, which is a reasonable number. However, the highest percentage of using vendor services is 48%, which is quite high. The percentage of vendor services that is too high can increase in additional costs for unused trucks from the LT department.

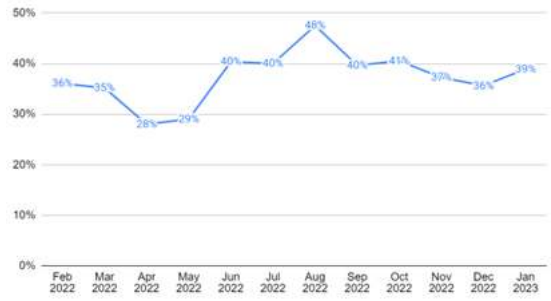

Fig. 3. Percentage of Monthly Vendor Service Usage

These are some of information used in the proposed scheduling method:

- The truck will arrive at the designated location 2 hours before the appointed time.
- The scheduling process will be centered around the law of Indonesia that requires a minimum of 30 minutes rest for every 4 hours of driving.
- The estimated pickup time for all containers is 1 hour.
- The estimated stuffing or stripping time for standard cargos is 3 hours and 5 hours for flexibags and isotanks. There are some exceptions for a few customers, with the estimated stuffing or stripping time 18 hours.
- The business hours of the container depot are from 9.00 AM to 9.00 PM and the port operates for 24 hours.
- Inbound trucks returning outside of the container depot business hour will be assumed to come back at 11.00 AM on the next day.
- Outbound trucks departing outside of the container depot business hour will be assumed to depart while already carrying the container. The container will be picked the day before from the container depot in business hours and will be parked at the company's garage.
- This scheduling method will ignore traffics condition.
- The estimated pickup time for domestic and export containers is 30 minutes and the estimated pickup time for import containers is 1 hour.
- The time interval used in this scheduling method is 30 minutes.
- The estimated truck speed is around 40 km/h, and around 50km/h while on highway.
- The proposed scheduling method will assume that LT division has a dedicated unit for each IFF and DFF. The number of units for each division will be based on the percentage of total order from both divisions. In this case. In this case, the IFF division will have 27 units of truck and the DFF division will have 15 units of truck.

TABLE I. ACTUAL SCHEDULING AND PROPOSED SCHEDULING FOR IFF AND DFF COMPARISON

Day	LT Truck Used		Vendor Truck Used		Truck Cycle	
	Actual	*Proposed*	*Actual*	*Proposed*	*Actual*	*Proposed*
1	48	55	35	28	1.14	1.31
2	37	52	33	18	0.88	1.24
3	31	32	10	9	0.74	0.76

Based on Table 1, the proposed method of scheduling with EDD method could give better overall results. The truck cycle is calculated by dividing the total order completed by LT with the number of days and the number of trucks used. In all 3 days, the proposed scheduling method has better overall results compared to the actual scheduling results. This proves that scheduling with EDD method is more effective.

B. Programming the Model

The results of the calculation from the EDD method are then recreated into the Visual Basic for Application in Microsoft Excel Software. The function of this recreation is to automate the scheduling process so that the process can be done faster, more efficiently, more accurately, and could be done by anyone while still maximizing the truck cycle. There are 3 worksheets in Microsoft Excel software: Schedule sheet, Calculator sheet, and Database sheet.

The Schedule sheet is the main worksheet of this program. This is the sheet where the user will input the data needed for the calculation, which are: order type, container content, truck type, customer and location, pickup location, stack location, due date, and due time. Order type will inform whether the order is for import, export, or domestic. Container content will inform if the content of the container is standard or liquid.

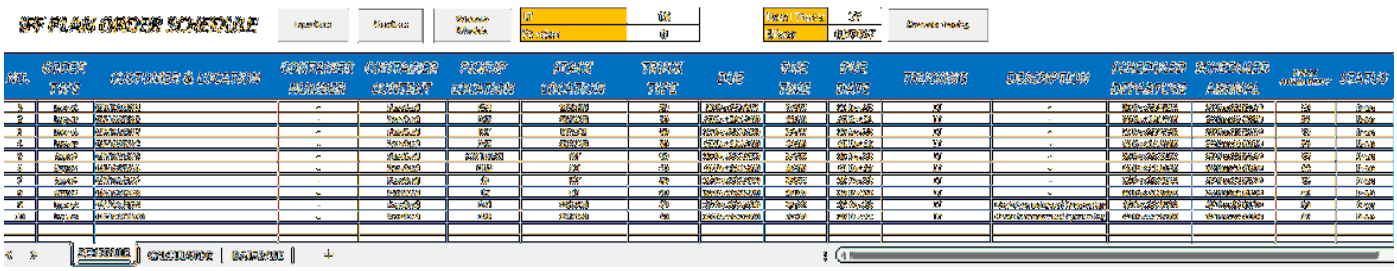

Fig. 4. Schedule Sheet

Truck type will inform about the truck required for the order, which is 20 feet, 40 feet, or reefer. If the order requires a reefer truck, the order will then be given to the vendors to handle. Customer and location will inform the customer requesting this order and where should the order be delivered. Pickup and stack locations will inform the port or the container depot where the truck will pick the container from. Due time and due time will inform the due date of the order. The Schedule sheet and customer input can be seen in Fig. 4 and Fig. 5, respectively.

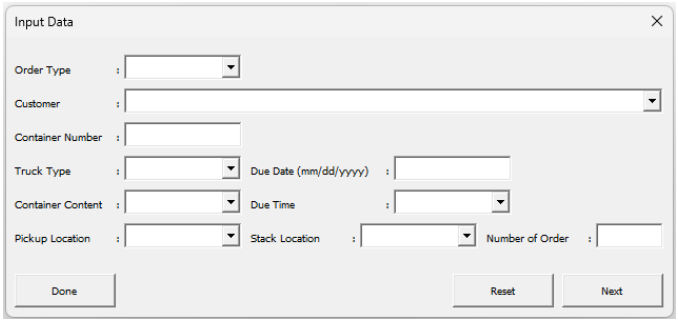

Fig. 5. Customer Input data

The output of this program will also be displayed on the Schedule sheet. The outputs are scheduled departure, scheduled arrival, description, and trucking. Scheduled Departure and arrival will inform when the truck should depart and the estimation of truck return time. Description will be the place where information about whether the container must be picked up the day before or be returned the day after is written. Trucking is the place where the means of completing the order will be written, either by LT or by other trucking vendor services.

TABLE II. ACTUAL SCHEDULING AND PROGRAMMED SCHEDULING FOR IFF AND DFF COMPARISON

Week	LT Truck Used		Vendor Truck Used		Truck Cycle	
	Actual	*Proposed*	*Actual*	*Proposed*	*Actual*	*Proposed*
1	261	275	128	114	0.89	0.94
2	263	287	198	174	0.89	0.98
3	244	277	133	100	0.83	0.94
4	208	238	127	97	0.71	0.81
5	251	255	105	101	0.85	0.87
6	243	306	193	130	0.83	1.04
7	237	301	200	136	0.81	1.02
8	234	277	144	101	0.80	0.94

The Calculator sheet is where the calculation required for displaying the schedule is documented. This sheet is used to calculate the scheduled departure and scheduled arrival outputs. The Database sheet is used to store all the data required in this scheduling process. The data included in the sheets are customers and their addresses list, container depots and ports list, and the distances for each location.

C. *Program Validation*

The scheduling program created with Visual Basic for Application in Microsoft Excel software is implemented to calculate the schedule for trucks for the past 2 months. Then, the proposed schedule is compared to the actual schedule.

Based on Table 2, the proposed scheduling method could give a better overall result compared to the actual scheduling method. The proposed one has more LT usage, less vendor usage, and could improve truck cycle by 15%. This proves that the program is valid and can give improvement to the company.

V. CONCLUSION

X. Corp. is a accompany engaged in the field of logistics. To be able to compete with the industry, companies need to implement effective supply chain management to ensure optimal performance and can meet customer satisfaction. Based on the calculation of the proposed scheduling by using the EDD method, it is proven that the proposed scheduling could improve the company's truck cycle by 15%. A good truck cycle is achieved when the usage of LT division's truck is high and when the usage of other trucking vendor's services is low. With a better truck cycle score, the company will be able to manage the flow of trucks better and a higher on-time rate will be achieved. To work with more efficiency, effectively, and precisely, companies need to implement computerization or digitalization to improve the performance of their truck management. The results of the most optimal truck management are then implemented to the scheduling process via the program that has been made.

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