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Truck Scheduling Analysis using Cross Docking System with Simple Iteration Mutation Algorithm

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Abstract:- Cross Docking is one of the modern distribution systems with products from various types of suppliers accepted in one warehouse facility which is then combined for the same shipping destination, then departed at the soonest possible time. Cross Docking has operational problems, one of which is scheduling trucks that enter and exit the cross-dock terminal. Good truck scheduling results in a minimum total processing time and production costs. Truck scheduling has many alternative final results making it difficult to solve with exact calculations. Simple Iteration Algorithm Mutations are developed from a Cross Entropy hybridization algorithm and Genetic Algorithm with regard to the advantages and disadvantages of each algorithm. Using the Simple Iteration Algorithm Mutations for truck scheduling with maximum daily data produce a sequence of trucks with a faster total processing time of 6.156 hours compared to the actual situation. This calculation requires a computation time of 349 seconds which is a fairly short time considering truck scheduling is an operational problem.

Keywords:- *Cross Docking, Iteration Mutation.*

I. INTRODUCTION

The distribution system is one of the important factors in supporting the success of Supply Chain Management. With the right distribution system, companies can meet customer demands with minimum production costs. At present many companies are entrusting the distribution of goods to third-party companies or commonly known as Third Party Logistics (3PL). During this time Third Party Logistics use has reduced the logistics costs of the company (Frost and Sullivan, 2007). The distribution strategy that is widely applied by 3PL is one of them is Cross Docking.

Cross docking is a new strategy in the field of logistics that is currently widely used by companies in many industries (Van Belle et al., 2012). Although there may be some differences between cross cross docking and traditional distribution centers, what is more highlighted is that there is no storage or at least there is a significant reduction in storage (Kinnear, 1997). Cross docking is designed to meet a small number of customer needs at the same time. The implementation of the cross docking system has its own problems in the operation process, one of which is scheduling trucks coming and exiting the cross-dock to get an efficient cross docking system.

Truck scheduling is included in the cross docking system operational problems, so these problems must be solved every day. This problem arises when docking can only serve one truck entering or exiting the cross-dock. The service of more than one truck on a dock door will result in errors in receipt or delivery of goods. There are several important elements that must be considered to be considered such as goods must be sent with a short lead time, the time of arrival and departure of the truck must be known in detail, and the software and hardware systems must be well prepared. At large cross docking with the receipt and delivery of large quantities of goods, truck scheduling requires a long computing time. With good truck scheduling, the total duration of the truck delay or delay in distributing goods can be minimized, so that operating costs (inventory and material handling) can be reduced.

II. Literature Review

A. Optimization

Optimization is a systematic effort to choose the best elements from a collection of elements that are manifest. In a mathematical context, this optimization can be expressed as a systematic experiment to find the minimum or maximum function value. Optimization is used in almost all fields of science including engineering, science, social sciences, economics and commerce. Many problems in the field of engineering, science and economics may be expressed as optimization problems such as reducing costs, shortening periods, minimizing risks and maximizing profit and quality. Optimization is often the main focus in making decisions, for example to improve product competitiveness, so companies must be able to maximize product quality by minimizing expenses. Make a decision to make a few steps:

- *Formulate Problems*

The first thing that needs to be done in this ranking is to know the exact problems that need to be resolved. Factors that influence the problem and objective function of the problem need to be carefully recorded.

- *Model the Problem*

At this level, the problem is modeled systematically. True problems can be very complicated and difficult, so there needs to be simplification so that they can be expressed systematically.

- *Optimization*

After the problem is modeled systematically, optimization is used to get a solution that can be accepted (a solution that can be accepted). Always the problem model that is created cannot represent the real problem, so the accuracy in the modeling problem greatly influences the decisions obtained. Settlement obtained can be an optimum solution or not optimum.

- *Problem Solving*

The resolution obtained later is used to determine whether there is a settlement that may be accepted or not. If the settlement is not acceptable, the problem model and optimization method need to be corrected and the process repeated again.

The method in completing optimization problems can be done by exact completion and approach completion (approximation). Exact solutions can be done using dynamic programming, branch algorithms and constraint programming. Completion of using dynamic programming is done by breaking complex functions into simpler functions. This solution is done recursively. This method applies a trimming of the order of decisions that does not lead to the optimal solution. This is done to avoid enumeration (testing each solution in the search space). In the branch algorithm, finding a solution is done by building a decision tree. Solution solutions are sought by cutting off branches that do not lead to optimal solutions. Basically, programming constraints use the concept of search trees and the logic implications.

Approach optimization solutions can be divided into two approximation algorithms and heuristic algorithms. Approximation algorithm can provide a solution that can be proven quality within the specified time limit. For example, within a certain time limit, the solution to be solved by the approximation algorithm is at a distance of 5% of the optimal solution. While the heuristic algorithm places more emphasis on achieving a resolution solution that can be received quickly.

B. *Supply Chain Management*

The Supply Chain Management (SCM) is the integration of competent commercial sources inside and outside the company to obtain a competitive supply system and provide support for synchronization of product flow and information to create high customer value. Integrated trade sources include suppliers (suppliers), suppliers, warehouses, transporters, dealers, retailers and users who work with stress so that the products produced and circulated meet the exact number, quality, period and location. Concept of Supply Chain Management including:

- Integrate and synchronize suppliers, refiners and dealers.

  - Products produced and circulated meet the quality, quantity, time and Scope.
  - Optimizing boarding and increasing customer competitiveness and solemnity.

- Subtracting supplier numbers.

  - Subtracting inequality, additional fees, negotiations and the period of detection (detection)
  - Trend change rather than the double supplier concept to a single supplier.

- Affiliation (strategic partnership / partnership).

  - Supplier stocking is a partnership that can guarantee the smooth flow of goods.
  - Carrying out continuous development and the cost of space and quality

C. *Supply Chain Management Scope*

Supply Chain Management carrying out new activities which encompasses the design, acquisition, expenditure, storage, transportation and distribution, starting from the starting point of raw material (upstream) to the point of use (downstream). Management of acquisition is part of the activity SCM has the function of designing and carrying out the acquisition of goods and services. Logistics management is part of the SCM activity which builds on transportation, warehousing and distribution activities. Material management is the object of implementing the flow of goods, including SCM, acquisition and logistics. Management of assets is a property asset due to acquisition activities, in the form of assets (ease of expenditure, official building, and equipment).

SCM Link (SCM series) consists of 7 (seven) rainbow SCM links, namely Suppliers, Refiners, Warehouses, Transportation, Distributors, Retailers and Customers. The elements of SCM support consist of 9 (nine) management elements that play a very important role in the success of the activities of the flow of goods, namely the elements which include acquisition, logistics (transportation, warehousing, distribution), inventory (Inventory), demand forecast, Supplier, Expenditure, Quality and Customers.

D. *Cross Docking*

Cross Docking is a warehouse management concept in which the product is delivered to the warehouse by truck and then compiled, prepared at the customer's request, delivered to the dock of the shipping vessel and loaded into the truck to be delivered to customers without products stored in the warehouse (Yu and Egbelu, 2008) In practice, before the tracks are assigned, temporary storage areas are needed because many items from reception docks are different and need to be arranged and combined before being transferred to the delivery dock.

Pier is a terminal used for Cross Connection process which has several reception entrances where incoming tracts are assigned to cargo loads and several delivery doors where the tract is given for loading for delivered products. The aim in implementing Cross Docking shows the advantages of implementing Cross Docking compared to traditional warehousing systems, such as: increasing the maintenance stage, reducing the cost of storage, reducing the cost of controlling goods, and so on. In terms of equipment, the use of computers that they can specifically form a system of equipment to implement different Cross Docking configurations is very minimal, thus disrupting Cross Docking applications. Information technology provides the right information to ensure the Cross Docking order.

Problems with the Cross Dock system are shared with 3 stages, which include:

- Operation phase

The problems that arise are related to short-term decisions (daily or weekly). This stage consists of 5 problems: scheduling, transfer, door dock designation, vehicle route selection, and product designation.

- Tactical stage

Tactical ranking decisions are simple term decisions. The problem that arises at this stage is the arrangement layout.

- Strategic stage

The strategic stage involves long-term decisions. This ranking problem determines the location and number of terminals, as well as vehicle routes in the Supply Chain Management series.

E. Simple Iteration Algorithm Mutations

The Mutation Flowing Algorithm is easily built from the Entropy Algorithm Hybrid Algorithm and Genetic Algorithm which is known as the Cross Entropy-Genetic Algorithm (CEGA) Algorithm. This algorithm was researched byBudiman (2010) to solve the problem of scheduling workshops without waiting for time with a numbered machine. The CEGA algorithm uses crossover and mutation in broadcasts, while the SIM algorithm uses only mutations. The reason for using a mutation rather than a crossover is a traffic scheduling problem that was awakened by Budiman (2012) which shows that the sample produced in each run has a large percentage to leave the optimum location and requires a shorter period than the CEGA algorithm.

III. DISCUSSION

A. Truck Turnover Time

The truck turnover time (D) is obtained from the average turnover time of the incoming truck. The truck turnover time (D) is expressed in seconds. Table 1 shows data on truck turnover times in minutes and seconds.

Truk No	Truck Turnover Time (minute)	Truck Turnover Time (second)
1	18	1080
2	20	1200
3	20	1200
4	41	2460
5	14	840
6	24	1440
7	31	1860
8	28	1680

Table 1:- Truck Turnover Time

$$\text{Truck turnover time (D)} = \frac{1080+1200+1200+2460+840+1440+1860+1680}{8}$$

$$= \frac{11760}{8} = 1470 \text{ second}$$

B. Product Loading and Unloading Time

The product loading and unloading time (t) in this research is assumed to be the same, that is taken from the average product loading time (r) and product loading time (s) with number of products (k) as shown in table 2 and table 3.

Truck No	Numbers of Product	Loading time (minute)	Loading Time (second)
1	880	15	900
2	310	5	300
3	900	14	840
4	440	9	540
5	2116	39	2340
6	2047	37	2220
7	1600	36	2160
8	1319	27	1620
9	2136	36	2160
Total	**11748**	**218**	**13080**

Table 2:- Product Loading and Unloading Time

No. Truck	Numbers of Product	Loading Time (minute)	Loading Time (second)
1	444	16	960
2	329	10	600
3	382	14	840
4	766	24	1440
5	454	13	780
6	898	29	1740
7	405	13	780
8	839	23	1380
9	685	25	1500
10	370	12	720
11	410	13	780
12	1121	37	2220
13	291	12	720
14	639	25	1500
15	453	23	1380
16	303	10	600
17	905	30	1800
18	720	24	1440
19	547	14	840
20	548	14	840
21	239	5	300
Total	**11748**	**386**	**23160**

Table 3:- Product Loading Time

$$\text{Loading and Unloading Time } (t) = \frac{\sum r + \sum s}{\sum k + \sum k}$$

$$= \frac{13080 + 23160}{11748 + 11748} = \frac{36240}{23496} = 1{,}54\ second$$

C. Outbound Truck Scheduling

Outbound truck scheduling is carried out using the Simple Mutation Iteration algorithm built in Delphi 5.0 with input data from truck 1 to truck 9 and planning 21 trucks out. This scheduling is completed in 349 seconds and gets the sequence of outbound trucks which are L 13 - 1 - 2 - 3 - 4 - 6 - 5 - 7 - 8 - 10 - 19 - 9 - 11 - 12 - 14 - 15-16-16-17-18 - 20-21.

Calculation of the truck inbounds (F) and outbound (L) based on the equation on the objective function. Calculation of truck inbound schedule (F) and truck outbound (L) in seconds are presented in table 4 and table 5.

Inbound	Loading Time (t)	Numbers of Product	Total t	Product Movement (V)	Truck Turnover	F(i)	P(1)
Truck 1	1,54	880	1355,2	28800		1355,2	
Truck 2	1,54	310	477,4	28800	1470	3302,6	
Truck 3	1,54	900	1386	28800	1470	6158,6	
Truck 4	1,54	440	677,6	28800	1470	8306,2	
Truck 5	1,54	2116	3258,64	28800	1470	13034,84	42518,6
Truck 6	1,54	2047	3152,38	28800	1470	17657,22	46963,9
Truck 7	1,54	1600	2464	28800	1470	21591,22	51570,9
Truck 8	1,54	1319	2031,26	28800	1470	25092,48	54516,2
Truck 9	1,54	2136	3289,44	28800	1470	29851,92	60378,3

Table 4:- Inbound Truck Schedule Calculation

Calculation of truck schedules is entered in table 4 using equations (i), equation (ii), and equation (iii).

Outbound	Loading Time (t)	Numbes of Product	Total t	Truck Turnover	P(2)	L
Truck 13	1,54	444	683,76		683,76	42518,6
Truck 1	1,54	329	506,66	1470	44495,26	46963,88
Truck 2	1,54	382	588,28	1470	49022,16	49022,16
Truck 3	1,54	766	1179,64	1470	51671,8	51671,8
Truck 4	1,54	454	699,16	1470	53840,96	53840,96
Truck 6	1,54	898	1382,92	1470	56693,88	56693,88
Truck 5	1,54	405	623,7	1470	58787,58	58787,58
Truck 7	1,54	839	1292,06	1470	61549,64	61549,64
Truck 8	1,54	685	1054,9	1470	64074,54	64074,54
Truck 10	1,54	370	569,8	1470	66114,34	66114,34
Truck 19	1,54	410	631,4	1470	68215,74	68215,74
Truck 9	1,54	1121	1726,34	1470	71412,08	71412,08
Truck 11	1,54	291	448,14	1470	73330,22	73330,22
Truck 12	1,54	639	984,06	1470	75784,28	75784,28
Truck 14	1,54	453	697,62	1470	77951,9	77951,9
Truck 15	1,54	303	466,62	1470	79888,52	79888,52
Truck 16	1,54	905	1393,7	1470	82752,22	82752,22
Truck 17	1,54	720	1108,8	1470	85331,02	85331,02
Truck 18	1,54	547	842,38	1470	87643,4	87643,4
Truck 20	1,54	548	843,92	1470	89957,32	89957,32
Truck 21	1,54	239	368,06	1470	91795,38	91795,38

Table 5:- Outbound Truck Schedule Calculation

The outbound table calculations in table 5 using equation (iv) and equation (v), which are related to Outbound truck scheduling (L). The process time (M) is calculated by the equation(vi) $M = \max\{L_{(j)}\}, for\ 1 \leq j \leq S$ which is the maximum value of L or the last truck outbound time in table 5 with a value of 91795.38 seconds = 1529,923 minutes = 25,498 hours. When compared with the actual data of Truck inbound time at 1:20, the total processing time for loading and unloading is 31,333 hours with the calculation of the company's operational time is 2 x 8 hours, starting from 7:00 to 2:00 with 3 hours of rest namely at 12:00 - 13:00, 18:00 - 19:00, and 24:00 - 01:00. The total processing time with the SIM Algorithm shows a shortening of the total processing time by 25,498 - 31,333 = 6.156 hours.

IV. CONCLUSION

By using Simple Iteration Mutation Iteration Algorithm (SIM), the sequence of Truck scheduling at PT. Agility International for outbound trucks are :13 - 1 - 2 - 3 - 4 - 6 - 5 - 7 - 8 - 10 - 19 - 9 - 11 - 12 - 14 - 15 - 16 - 17 - 18 - 20 - 21. Outbound trucks are noted by L in table 5 in seconds. The total loading and unloading time in this sequence is 25,496 hours. When compared with the actual time with a total loading time of 31,333 hours, this sequence shortens the total processing time by 6,156 hours. Truck scheduling calculations in this case use 24 types of products, 9 inbound trucks, and 21 outbound trucks. This scheduling takes 349 seconds. The completion is the shortest time to schedule truck inbound and outbound . Short scheduling time is needed because Truck scheduling includes company operations

REFERENCES

[1]. Belle, Van,Valckenaers, J., andP., Cattrysse D., 2012, *Cross-docking: State of the art*, Omega, Vol.40; pp.827- 846.
[2]. Budiman, Muhammad Arif, 2012, *Simple Iterative Mutation Algorithm For The Truck s Scheduling Problem In A Cross Docking Environment*, Master Thesis.
[3]. Boysen, Fliedner M, and Scholl A, 2010, *Scheduling inbound and outbound trucks at cross docking terminals*, OR Spectrum, Vol. 32; pp 135-161.
[4]. Chen, F. and Lee, C., 2009, *Minimizing the makespan in a two-machine cross-docking flow shop problem*, European Journal of Operational Research, *193*(1),59-72.
[5]. Frost & Sullivan.2007. U.S Enterprise's Choice – An Evaluation of 3rd Party Logistics Service Providers.http://www.frost.com/
[6]. Gunawan, Herry, 2014, *PengantarTransportasidanLogistik*, RajawaliPers, Jakarta.
[7]. Kinnear, E. (1997). *Is There Any Magic in Cross-Docking?Supply Chain Management*, 2, 48-52
[8]. Lee, K., Kim, B. S., and Joo, C. M., 2012, *Genetic algorithms for door-assigning and sequencing of trucks at distribution centers for the improvement of operational performance*, Expert Systems with Applications, Vol.39; pp.12975-12983.
[9]. Santosa, Budi dan Paul Willy, 2011, *MetodaMetaheuristikKonsepdanImplementasi*, GunaWidya, Surabaya.
[10]. Siahaya, Willem, 2013, *Sukses Supply Chain Management Akses Demand Chain Mangement*. Jakarta: In Media.
[11]. Tsui, L. Y. and Chang, C. H., 1992,*An optimal solution to a dock door assignment problem*, Computers and Industrial Engineering, Vol.23; pp.283-286.
[12]. Yu, W., Egbelu P. J., 2008, *Scheduling of inbound and outbound trucks in cross docking systems with temporary storage* , European Journal of Operational Research, Vol.184; pp.377-396.