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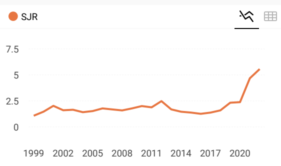

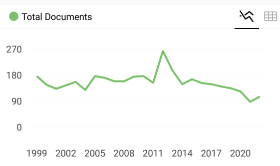

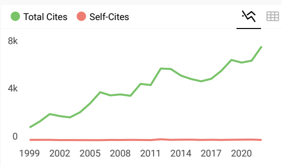

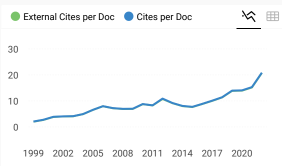

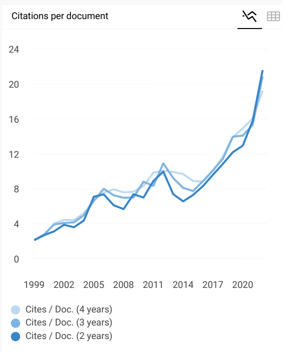

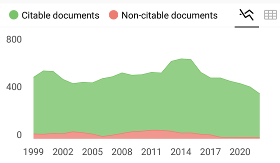

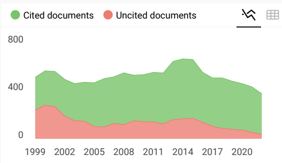

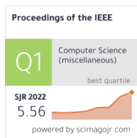

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Truck Management Integrated Information System in a Shipping Line Company

An Integrated System to Manage Truck Dispatching

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***Abstract*—The study has been done to maximize the capacity of transporting container (called: ritase) that can be done in truck management at a shipping line company. Currently, truck dispatching for transporting container is done decentralized. Drivers will decide by themselves who will transport the container. The study approaches the integration of the information system in a shipping line company and the GPS information system which already installed in each truck. This will enable centralization of truck dispatching that helps internal truck's ritase capacity improvement. The suggestion then simulated using simulation software AnyLogic. The simulation proves that the suggestion could improve internal truck's ritase and could reduce vendor usage. Current ritase is 5,3 ritase per shift. The suggestion's ritase is 9,74 ritase per shift. The suggestion can lead to 137.599.099 IDR savings per month.**

Keywords—Business process reengineering; integrated system information; truck dispatching; simulation.

I. INTRODUCTION

The company studied in this paper is a shipping line company. Container shifts that occur in the process of loading and unloading, of course, produce costs. The process of truck management of trucks in shifting container will determine the performance of the company. The performance of company's truck management has an impact on efforts to reduce the cost of container shifts and efforts to move containers on time.

Yard Operation Foreman orders the truck when they want to shift the container from container deposit to the terminal and reposition the container to another container deposit. Ship Operation Foreman orders the truck when there is a company's container loaded on the ship and will be shifted to company's container deposit. Yard Operation Foreman and Ship Operation Foreman will order according to the number of required trucks via handy talky. This communication method connected to every truck driver, truck administrator, ship operation foreman, ship operation supervisor, yard operation foreman and yard operation supervisor.

Driver revenue depends on the amount of "ritase" he takes, i.e. how many 2x20' container shifting he is able to make. However, the distribution of trucks to shift the container is still unorganized. The truck management procedure is now still ambiguous and there is no definite person in charge in deciding the best truck to dispatch. Truck drivers can decide for themselves who takes delivery orders if the driver's feel his position is close to the pickup location. The driver who takes the order depends on how quick the driver can confirm the order. This truck dispatching procedure sometimes creates miss coordination and has a wide impact.

Failure in truck dispatching leads to the low truck productivity. The average ritase per truck is 5 ritase. The average ritase per truck is considered very low because the company's target is 8 ritase per truck. In organizing their trucks, this company actually has a subscription information system, ie GPS service by PT.Z. Through the technology owned, truck managers can monitor the position and status of the truck. In addition, this technology also uploads trailer data records such as truck speed, truck movement, fuel, etc along with the timing of occurrence.

Unfortunately, this GPS technology is not fully utilized so the truck management does not utilize this technology in truck management and utilization. GPS technology that is not utilized optimally also causes this GPS technology is not updated in order to facilitate the truck management and data analysis. A lot of data are recorded by systems that are doubtful and the information stored is not enough for further analysis.

Vendor truck is a third party that this company uses when all of the internal trucks are busy. Current vendor usage is about 13% of all containers that need to be moved. However, when calculated on a cost basis, this vendor usage expenditure is 37% of all expenditure for container shifting. Increasing the productivity of this company's internal truck can reduce this cost.

Unregulated truck dispatching resulted in a very wide variation for the ritase completed between trucks. The result of 8-month data recapitulation in 2016, found ritase gap between the truck with the least is 174 ritase and the most is

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1656 ritase. This enormous ritase difference needs to be reduced by organizing the truck dispatching.

Clear truck coordination and utilization of existing technology need to be applied to improve the process of truck management in this company. Improvements in truck coordination and utilization of existing technologies in truck management can be done with Business Process Reengineering (BPR). Improvement is done by BPR method because to get maximum benefit from applied technology requires a business process that can be integrated with the technology itself. BPR will simplify the existing process for the purpose of optimal output. BPR is able to optimize the existing processes by integrating processes on emerging technologies. The application of the BPR to the truck management process will maximize the objective with the utilization of existing technologies.

II. Methods

This part examines the methodology that will be used to solve the problems to be covered in this paper. Business Process Reengineering (BPR) is the main method to remodel the business process. Simulation on AnyLogic software will be used to see the new model's outcome.

A. Business Process Reengineering

Business Process Reengineering (BPR) is in essence a performance improvement philosophy that aims to achieve quantum improvements by primarily rethinking and redesigning the way that business processes are carried out [1]. BPR pursues a massive increase rather than a gradual increase. The definition of business process reengineering has 4 keywords, that are [2]:

- Fundamentals: Reengineering is performed on fundamental operations in the process and must be in line with the strategy resulting in added value for the company.
- Radical: Redesigning from the root of one of these problems by overriding all existing structures and procedures and creating entirely new ways of getting things done.
- Massive: Reengineering makes changes that give a massive leap in company performance.
- Process: Reengineering is done in the process. The process consists of a set of activities consisting of one or more inputs and generating high-value output for consumers.

B. Ten Principles in Business Process Reengineering

In applying BPR, there are 10 principles that must be considered to optimize the process [1]:

- Principal #0 : Streamline
- Principal #1 : Lose Wait
- Principal #2 : Orchestrate
- Principal #3 : Mass-Customize
- Principal #4 : Synchronize
- Principal #5 : Digitize and Propagate
- Principal #6 : Vitrify
- Principal #7 : Sensitize
- Principal #8 : Analyze and Synthesize
- Principal #9 : Connect, Collect and Create
- Principal #10: Personalize

C. Simulation

Simulation can imitate existing processes in the system [3]. This simulation uses the help of a computer device. Here are the advantages in the simulation:

- The randomized ability that can simulate random events of possible probabilities.
- Anticipate possible risks that may occur caused by new system.
- The new system can be tested without interrupting the existing system.
- Can evaluate the new system before doing the implementation.

D. Simulation Stages

There are ten stages to perform the simulation [4]:

1) Formulation of the problem: the problems and objectives of the study are clearly stated.

2) Data collection and model design: to know the distribution of occurence probabilities and know the process of the system works.

3) Model Validation: the prescribed assumptions are rechecked and involve an expert who understands the system well.

4) Preparation of computer programs and verification: choose a simulation software that matches the problem.

5) Trial program: the program is tested for the validation of the next stage.

6) Validation: the test results are re-examined if there are errors in the model.

7) Experimental design: decide the best experiment design alternatives.

8) Program execution: run the program according to the experiment designed.

9) Simulation output analysis: the simulation output that becomes the performance criteria of the system is examined.

10) Documentation, presentation, and implementation: results are documented and implemented.

E. AnyLogic Simulation Software

AnyLogic is a simulation tool developed by The Anylogic Company [5]. This software can simulate agent-based, discrete event, and system dynamics simulations. AnyLogic is a simulation software that can be operated with drag and drop method, but can be expanded with Java programming language. Personal Learning Edition (PLE) from AnyLogic is a non-paid edition with a limit of 50,000 generable agents.

III. Results and Discussions

A. Current Business Process

The current business process applied on container unloading process illustrated by Fig. 1. The process of unloading containers from vessels is preceded by ordering truck needed by ship ops unit through Handy Talkie (HT). Which truck will the take order is through the driver's own considerations. The considerations are whether the truck is idle, the location of the pickup point is near and whether the number of trucks requested has not been met. If he takes the order, he will confirm it through the HT. The truck that receives the order then heads to the pickup location of containers.

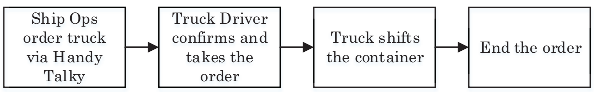

Figure 1. Current business process (unloading)

Upon the truck arrival, the container that needs to be removed will be unloaded from the vessel and placed on the truck chassis. A reference letter according to the number of containers will be handed over to the driver as a document for shifting containers. The driver will shift the container according to the destination stated in the reference letter.

Upon arrival of the driver at the destination location, the driver will submit the reference letter to the yard unit ops and will be directed to the unloading area at that location. After loading the container, the driver will ask the yard ops if there is any container that can be shifted for the condition named combination.

B. *Proposed Business Process*

The current truck dispatching system is reviewed for its effectiveness by referring the theory of Business Process Reengineering (BPR). Like principle #1 in 10 BPR principles, that is, to create a closed loop team in the activity for all of the involved parties in the same system. The information provided by GPS technology turns out to be in a discontinuous system that is not directly able to communicate with all of the involved parties within the truck management system. This may result in the information provided not being used quickly and appropriately. Improvements can be made by integrating the information available from the GPS system and the company Haulage system. Haulage System of this company is an information system related to container shifting. The information integration between the two systems will provide more useful and more accurate information.

The next principle, principle #4 in 10 principles of BPR. This principle improves the system by tracking physical goods electronically. Currently, each truck order status and the position of each container along with the truck cannot be traced directly. Improvements can be made by providing additional information about the containers transported by each truck on a GPS system.

Another principle that can be applied is principle # 5, which is to digitize information. The current information is in the form of a request via HT. This may cause the information cannot be processed directly for decision making. Improvement can be done by customizing GPS technology that enables truck order duties. This will remove the physical reference letter that slows the performance of the shifting assignment and also remove the reference letter recapitulation activity each day.

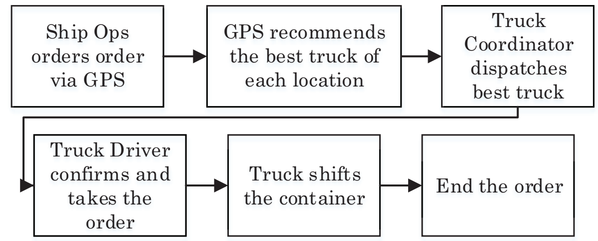

Figure 2. Proposed business process (unloading)

In general, the proposed and current business process are similar, but truck dispatching is done online on the GPS system interface. Fig. 2 illustrates the proposed business process. Ship ops will order the truck by inputting the number of containers that need to be unloaded from the vessel. The GPS system will update the ordering information and will notify the truck management. The truck coordinator then checks which best truck will be dispatched for this task. This process will run the recommended truck algorithm performed by the GPS system. This process requires truck status and truck route information from the company Haulage system. This algorithm considers the position of the truck, truck ritase status and truck conditions (previous job completion). This recommendation algorithm will put the truck with the best value at the top of the recommendation list, the second highest recommendation truck underneath it, and so on.

The truck coordinator will be in charge to select the truck as per the recommendations and situation of the truck according to the information displayed. The truck selected for dispatching will be notified by the GPS system to confirm the task and head to the pickup point.

Upon arrival at the loading point, the container will be moved from the ship to the truck chassis. This second also, ship ops will input the relevant information to the company Haulage system. Such information is the number of containers and truck identity that carries it. This information will be processed into a truck route according to container destinations that are stored on the company Haulage system. The driver then proceeds to the destination and shifts the container.

Upon arrival at the destination, yard ops will check the container carried and the identity of the truck according to the information provided by the company Haulage system. The Haulage System will provide relevant information regarding container destinations and other matters that determine the loading and unloading locations of containers. Yard ops will direct the driver to the deposit area and input the shifted container information at the company Haulage system. This Haulage system will update information regarding the status of trucks and containers. This information will also be updated to the GPS system. If the truck coordinator dispatches the truck further, then the driver will know where to go and perform the task.

C. *Proposed Business Process Simulation*

The proposed business process simulation using AnyLogic simulation software. Units in the system that involved in the simulation called agent. There are four agents used in the simulation:

- Location : The pickup or destination location of the container, consists of 14 locations.
- Trucks : Units that carry containers, consists of 40 trucks.
- Input: The assignment will then be broken into agent order, generated by the probability distribution.
- Order : The assignment that the truck will take, generated by probability distribution.

D. *Process in The Simulation System*

The whole process of the truck dispatching then translated into AnyLogic simulation language. There are 5 main processes in the system.

1) First Stage

The simulation of this truck dispatching simulation begins with generating the input agent of each location with the probability distribution interarrival obtained from the historical data.

2) Second Stage

Input agent that has been created will then continue into the process of each location. This second stage will divide the input agent into several agent orders according to probability distribution from the historical data. Order agent will be divided into different destinations, and group the order type

3) Third Stage

The third stage is truck dispatching stage. Order agent will be attached to the recommended truck which is the truck with the best value. This process is actually just trying to make a list of the best truck recommendations from the results of calculations. However, since the truck coordinator's manual input is not possible in the simulation, it is assumed that the best truck will immediately get the task as if the truck coordinator has been selected. The calculation in this simulation is divided into two, namely truck recommendation and orders prioritization. The algorithm used to choose the best truck and the best order done with these stages:

- Stage 1: besttruckvalue = 0; i = 0
- Stage 2: calculate the truck's value (i) by the formula (1) and calculate the value of the truck (i) by the formula (2)
- Stage 3: prevordervalue is the value of the order order previously belonging to the truck (i). If no previous order, skip to stage 5. If the prevordervalue is not zero, then bestordervalue = prevordervalue, otherwise bestordervalue = 0
- Stage 4: if truckvalue > besttruckvalue and valueorder > bestordervalue, then besttruckvalue = truckvalue; besttruck = truck (i); Set order has a truck. Go to stage 6.
- Stage 5: if truckvalue > besttruckvalue, then besttruckvalue = truckvalue; besttruck = truck (i); Set order has a truck.
- Stage 6: i = i + 1. If i < truck population, go back to stage 2, otherwise go to Stage 7
- Stage 7: if the order has a truck go to stage 8, otherwise the algorithm is complete
- Stage 8: check if this previous order has a truck, if yes reset the previous truck parameters
- Stage 9: check if besttruck has the previous order and in the status, has not been transported, if yes reset the previous order parameter
- Stage 10: set nextorder of besttruck is this order; prevordervalue besttruck = the value of this order against besttruck

First, all trucks will be calculated in value based on the origin location of the order, the calculation of the value of this truck using mathematical calculations as follows:

$$\text{Truck value} = \frac{truck\ status}{\left(A * \frac{travel\ time}{3600}\right) + \left(B * \left(\frac{Truck\ Ritase}{Ritase\ Total + 1}\right)\right)} \quad (1)$$

Truck status is the overall weight of the value depending on the condition of the truck, the more the truck will complete the previous task, the value will be closer to 1. Another consideration is the truck's travel time to the pickup location and ritase that he has done. The closer the initial location of the container, the greater the value of the truck. The smaller the ritase he completes, the greater the truck's value.

"A" value is a weighting parameter used for the priority weight of the truck's travel time. The greater the value of "A", the more frequent the combination (trucks coming and going carrying containers). This is because the combination container is a container that has a distance of 0 or close to the truck. Parameter "A" will use the parameter "ParDist" in AnyLogic Software.

The "B" value is the weight of the truck ritase multiplier. The greater the "B" value, the less the ritase difference between trucks. This is because trucks with a lot of ritase tend to have small truck value. The value of "B" uses the parameter "ParRit" in this simulation. Both values of A and B will be assumed to be equal to 50 so that no condition is prioritized.

Order agent will queue up if the truck is doing the previous order and recommended by the algorithm. Order agent queuing will be compared to another order agent according to order value parameter. Here's the mathematical calculation of order value:

$$\text{Order value} = \frac{1}{\left(A * \frac{indexorder}{totalqueueorder}\right) + \left(B * \left(\frac{traveltime}{3600}\right)\right)} \quad (2)$$

The order value calculation considers two things, namely how early the order was requested and how far the pickup location. The earlier the order is requested, the greater the order value. The closer the order is to the truck, the greater the order value.

Value "A" is the multiplier weight on the order queue. The greater the value of A, the prioritized order is the earlier requested order. Thus, the likelihood of the combination will decrease. A value will use parameter "ParOrderIndex" in this simulation. The “B” value is the multiplier weight the time needed for the truck to pick up the order. The greater the value of B, the greater the likelihood that combinations will occur. This is because the far order will have a small order value. The value of “B” will use the parameter "ParOrderTravel" in this simulation. Both values of A and B will be assumed to be equal to 50 so that no condition is prioritized.

Once the value of all trucks has been calculated, it will be compared to each other. The truck will be selected if it has the largest truck value and also the order to be assigned has a value greater than the order that is queuing. If there is no order queue, then consideration only exists on the truck’s value with each other.

4) Fourth Stage

When the truck is already idle, it will go into loading container stage. Time needed to travel to each location obtained from probability distribution according to historical data. The order agent attaches to chosen truck and simulates container loading condition. The truck then heads to the destination that already determined by the system.

5) Fifth Stage

Upon the truck arrives, the agent order attached to the truck is released and container unloading is simulated. After this stage, the released truck can handle new order agent.

E. *Verification Phase*

There are two verification methods used to verify the simulation. First by verifying the model whole logic and second by verifying the algorithm used in the simulation.

The first verification result method described by Table I. The initial "multiply" parameter is 0, so the number of existing orders is normal. Verification is done by changing the value of parameter "mulitply" to 0.5, so total order agent 50% more generated. The result of the number of ritase that completed in the initial experiment is 12,926 ritase. The result of the number of ritase that arrived at the verification experiment is 16,052.5 ritase. This result is in line with expectations; thus, the first verification states that the model has been verified.

Table II describes the second verification method result. ParDist and ParRit values in the initial model are both 50. Verification is done by changing these two parameters value to 100 and 1 respectively. The initial combination value is 3,153.5 ritase while the model verification combination value is 3,368 ritase. Large variations of truck ritase with each other in the initial model is smaller than 42 ritase, while the model verification value is smaller than 93 ritase. This result is in line with expectations, that the greater the value of ParDist, the more frequent combinations and will increase the variation of the trucks’ ritase. The second result of this verification states that the model has been verified.

TABLE I. FIRST VERIFICATION METHOD

	Initial	Verification
“multiply” value	0	0.5
Total Ritase Completed	12,926 ritase	16,052.5 ritase

TABLE II. SECOND VERIFICATION METHOD

	Initial			Verification		
	Value	Combination	Variation	Value	Combination	Variation
ParDist	50	3,153.5	<42	100	3,368	<93
ParRit	50			1		

F. *Validation Phase*

TABLE III. VALIDATION METHOD

Period	Current	Simulation
1.	11,051	11,297
2.	11,740	12,498
3.	12,786	12,608
4.	12,206	12,740
5.	11,586	12,576
6.	12,554	11,558
7.	9,388	13,025
8.	12,425	13,245
9.	12,366	12,745
10.	13,430	11,784
11.	12,611	11,818
12.	13,104	12,395
13.		11,973
14.		12,693
15.		13,483
16.		11,241
17.		13,100
18.		11,248
19.		12,971
20.		12,236
21.		12,362

Each period on Table III illustrates total ritase completed for a month. Both of the current total ritase and simulation total ritase result compared with two sample t test. The test result is that both data set are identical. This validation test states that the model has been valid.

The multiply value then is used to increase the overall agent order. This is done to maximize the trucks’ ritase capacity. This simulation is done for 20 days in simulation since the AnyLogic PLE limitation.

Order agent increased up to twice the normal (multiply value = 1) gives truck capacity up to 9.75 ritase per shift. The result can be seen on Table IV.

TABLE IV. MAXIMUM TRUCKS’ RITASE CAPACITY

Multiply Value	Ritase Completed	Ritase/shift.truck
0	7,750.5	5.38
1	14,035	9.75
1.1	12,621	8.76
1.2	13,973	9.70

G. *Proposed Model’s Benefit and Savings*

Improvement of business process of truck duty distribution through information system integration of this company can increase the capacity of ritase up to 9.75 ritase / shift.truk. In addition, many benefits can be gained by