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Research Article

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Dwelling Time Analysis Using Dynamic System Model in the Implementation of National Logistics Ecosystem at Port Jakarta International Container Terminal

Ridho Hans Gurning* and Achmad Riadi

Department of Mechanical Engineering, Universitas Indonesia, Kampus UI Depok, Depok 16424, Indonesia

**Corresponding author: gurningridhohans@gmail.com*

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ABSTRACT

Efficient dwelling time loading and unloading at the port has been widely done. Behind this research was carried out the implementation of the National Logistics Ecosystem (NLE) by using a dynamic system to reduce dwelling loading and unloading time at the Port of Jakarta International Container Terminal. The purpose of research were to find out the development of dynamic system models and the impact of NLE implementation in reducing dwelling time. This research method used dynamic system models and validation tests with behavior pattern tests. The validation results of the dynamic system model were obtained dwelling time between 2.79 - 4.56 days, mean error by 3% and standard deviation error by 11% and the implementation of NLE caused a decrease in dwelling time between 0.96 - 2.30 days, resulting in a decrease in dwelling time by 70%. The results of simulated container flows between 120,909 - 195,212 containers, mean error by 0% and standard deviation error by 19% with the application of NLE container flows between 132,952 - 200,077 containers. The results of the simulation of unloading quantity of 67,295 – 103,342 TEU's, mean error by 1% and standard deviation error by 24% with the application of NLE between 86,169 – 108,032 TEU's, average – average of 96,712 TEU's / month, there was an increase in the quantity of unloading by 130 TEU's / month. The implementation of NLE can be applied to port operations

Keywords: Dwelling Time, Port, National Logistic Ecosystem, Dynamic System Model

ABSTRAK

Mengefisiensikan *dwelling time* atau bongkar muat di Pelabuhan telah banyak dilakukan. Melatarbelakangi penelitian ini dilakukan penerapan Nasional Logistik Ekosistem (NLE) dengan menggunakan sistem dinamik untuk mengurangi *dwelling time* bongkar muat di Pelabuhan Jakarta International Container Terminal. Tujuan penelitian untuk mengetahui pengembangan model sistem dinamik dan dampak penerapan NLE dalam mengurangi *dwelling time*. Metode penelitian ini menggunakan model sistem dinamik dan uji validasi dengan *behavior pattern test*. Hasil validasi model sistem dinamik didapatkan *dwelling time* antara 2,79 – 4,56 hari, *mean error* sebesar 3% dan *standard deviation error* sebesar 11% dan penerapan NLE menyebabkan penurunan *dwelling time* antara 0,96 – 2,30 hari, sehingga penurunan *dwelling time* sebesar 70%. Hasil simulasi arus kontainer antara 120.909 – 195.212 kontainer, *mean error* sebesar 0% dan *standard deviation error* sebesar 19% dengan penerapan NLE arus container antara 132.952 – 200.077 kontainer. Hasil simulasi kuantitas bongkar sebesar 67.295 – 103.342 TEU’s, *mean error* sebesar 1% dan *standard deviation error* sebesar 24% dengan penerapan NLE antara 86.169 – 108.032 TEU’s, rata – rata 96.712 TEU’s /bulan, terjadi peningkatan kuantitas bongkar sebesar 130 TEU’s/bulan. Penerapan NLE dapat diterapkan pada operasional Pelabuhan.

Kata kunci: Dwelling Time, Pelabuhan, Nasional Logistik Ekosistem, Model Sistem Dinamik

1. Introduction

Indonesia is one of the largest island countries where two-thirds are ocean areas. This is seen as an advantage or strength for Indonesia in the perspective of the ocean as a link to the mainland or islands in Indonesia, so That Indonesia is as a unit (Widodo. 2018). As an archipelago, Indonesia has many of the best ports that operate in contributing and supporting national and international trade activities. The role of the port is very vital in improving the economy of the Indonesian nation and one of the

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important means in trade, both inter-island (national) and international trade (Ruwantono, 2016).

The usual problems faced in the port area are in the problem of national logistics transportation systems such as customs mechanisms, infrastructure, costs and efficiency which are the main concerns in this will have implications for the aspect of punctuality (Rafi, 2016). This problem will have an impact on dwelling time, where dwelling time is the time calculated from a container when unloaded (unloading) from the ship until the container leaves the terminal through the main door (World Bank, 2011).

Dwelling time has 3 stages, namely pre clearance, customs clearance, and post clearance. There are several factors that affect the length of dwelling time, namely the capacity of the stacking land, loading and unloading facilities used by each container terminal operator, the density level of the flow of other container loading and unloading and so on (Narindra, 2016). The role of the government in reducing dwelling time is carried out to improve the performance of the national logistics system, improve the investment climate, and improve the competitiveness of the national economy, it is necessary to clarify the power of the manifest of arrival and departure of the means of holding in the implementation of the National Logistics Ecosystem.

The Port of PT Jakarta International Container Terminal is one of the largest and best ports engaged in container loading and unloading services with the best and busiest operational performance in Indonesia. Based on the current conditions JICT has grown very rapidly, which has partners of more than 30 shipping companies that ship containers in more than 25 countries in the world. Container loading and unloading management is controlled by JICT which is more than 50% and is expected to continue to grow in the future (Simamora, 2017). By looking at the busy condition of the port of PT Jakarta International Container Terminal, it can allow dwelling time in the field of buildup. If the problem is not immediately given remedial steps, it will greatly impact the smooth activities in the port environment (Kemenhub, 2016).

In this study will focus on finding out the influence of pre-clearance, customs clearance, and post clearance that occurs at the Port of Jakarta International Container Terminal. Dwelling time reduction will be done by analysis based on dynamic system models, where modeling will be done first to describe the real condition of container stacking fields. After getting a model of field conditions in real terms, the implementation of the National Logistics Ecosystem will be carried out in the modeling so that there is expected to be a reduction in dwelling time. The implementation of National Ecosystem Logistics based on Presidential Instruction of the Republic of Indonesia Number 5 of 2020 on National Arrangement of Ecosystem Logistics.

2. Materials and Methods

2.1 Research materials

This study used dwelling time data from January 2016 - December 2021, container flows from January 2016 - December 2021, unloading quantity data from January 2016 - December 2021, as well as data on facilities at the Port of PT Jakarta International Container Terminal. The proposing of the data and information needed in this study can also be done with depth interview or observation (Oktavia, 2020). In addition, supporting data is also needed in the implementation of the National Logistics Ecosystem such as ship arrival data, container movement data when coming out (gate out).

2.2 Research methods

Research methods are carried out to solve the problem. The data that is embraced is dwelling time data, container flow data and unloading quantity data during January 2016 - December 2021 and facilities at the Port of PT Jakarta International Container Terminal used for modeling simulation with dynamic system models. Dynamic system model is a method that helps in designing for better and considering complex and structured systems in decision making (Andhika, 2019).

2.3 Analysis data

In this study, analyzing dwelling time problems at the Port of PT Jakarta Internasional Container Terminal was arranged in a dynamic system model that needs to be considered to describe the condition of field phenomena. Dynamic system models can build causality relationships required in decision formulation

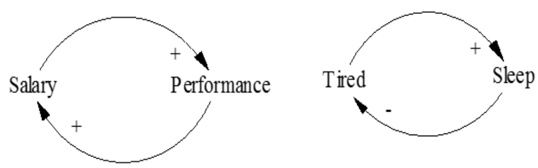
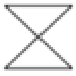
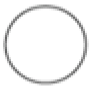


Figure 1. Example of a caustic diagram

Table 1. Use of variables in causal loop diagrams

Variabel	Symbol	Description
Level		It is a variable that states the accumulation of an object over time. It can be human, stuff, or something else. Accumulated rate can change its value
Rate		It is an activity or movement or flow that moves to the change of time. This rate can change the state from level to next level.
Auxiliary		It is a variable that represents a formulation that can affect the rate or other variables.
Source/Sink		Source is a variable that defines the system outside

processes, and also include major relationships in causality effects (figure 1) (Andhika, 2019).

Each variable is determined by the parameters, then all variables and parameters are spelled out sitematically which then becomes an input at the stage of preparing the causal loop diagram (table 1). Causal loop diagrams make it easy to understand causal relationships which is one of the tools to represent the feedback structure of the system (Sterman,2000). At the causal loop stage the diagram can show cause tree dwelling time and simulated in the stock flows diagram (Richardson.2013).

After simulation and modeling, it is continued with verification and validation of model results with field results using behavior pattern tests. Behavior pattern test is a form of validation test of the simulation model to assess how accurate the output of the model's behavior pattern with the behavior pattern of the actual system. The process is to compare the mean comparison and the comparison of amplitude variations, the formula shown in figure 2.

Average comparison (*Mean comparison*)

$$E1 = \frac{|S - A|}{A}$$

Description:
S = average value of simulation results
A = average data
The model is considered valid when E1 ≤ 5%

Comparison of amplitude variations *(% Error Variance*

$$E2 = \frac{|Ss - Sa|}{Sa}$$

Description:
Ss = Standard deviation model
Sa = Standard deviation data
The model is considered valid when E2 ≤ 3Sta

Figure 2. Average comparison formula (Mean comparison) and Amplitude variation comparison formula (% Error Variance)

3. Results and Discussions

Simulation refers to a collection of methods and applications for mimicking an actual system without the need to create an original system that can drain large resources, usually done using a particular computer and software (Ekoanindiyo, 2011). Computer simulation refers to a method for studying a wide variety of models of real-world systems by numerical evaluation using software designed to mimic the actual operation and characteristics of the system (Firmansyah, 2017). Regarding the stages included in the design and implementation of the research conducted include several stages such as data collection, the design of casual loop diagrams and stock flow diagrams, and model validation. Data collection is carried out to take data from the field and make observations at the Port of PT. Jakarta International Container Terminal so that the results of simulations and results of the National Logistics Ecosystem based on dwelling time value, container flow and unloading quantity.

3.1 Dwelling Time

Actual field results, dynamic system simulation results, and the results of the implementation of the National Logistics Ecosystem are obtained dwelling time values during January 2016 - December 2020 that can be seen in figure 3.

Based on the actual results of the field obtained dwelling time values ranging from 2.72 – 4.74 days with an average of 3.52 days and results from simulation processing then obtained dwelling time values ranging from 2.79 - 4.56 days with an average of 3.61 days. After a validation test of the simulation model and actual field based on the behavior pattern test, the mean error below 5% was obtained by 3% and the standard deviation error was below 30% which was 11%. So that the results of the simulation can be continued by adding the national logistics ecosystem implementation factor that causes a decrease in dwelling time. The decrease in dwelling time based on the implementation of the National Logistics Ecosystem ranged from 0.96 - 2.30 days with an average of 1.5 days, where the decrease in dwelling time by 70%.

3.2 Container flow

Data processing in the container current section in the dynamic system obtained actual field results, the results of simulation of dynamic systems, and the results of the implementation of the National Logistics Ecosystem. To see container flow results during January 2016 – December 2020 can be seen in figure 4. Container flow data included in the dynamic system model is obtained directly from field data taken over 5 years, so that simulation results are obtained and included in the national application of ecosystem logistics that causes changes in the number of containers/ month in the results of simulations and national logistics ecosystems.

Based on the actual results of the field, the movement of container flows ranged from 67,921 – 208,895 containers with an average of 161,722 containers / month and the results of simulation processing were obtained shifting container flows ranging from 120,909 - 195,212 containers with an average of 161,656 containers / month. After a validation test of the

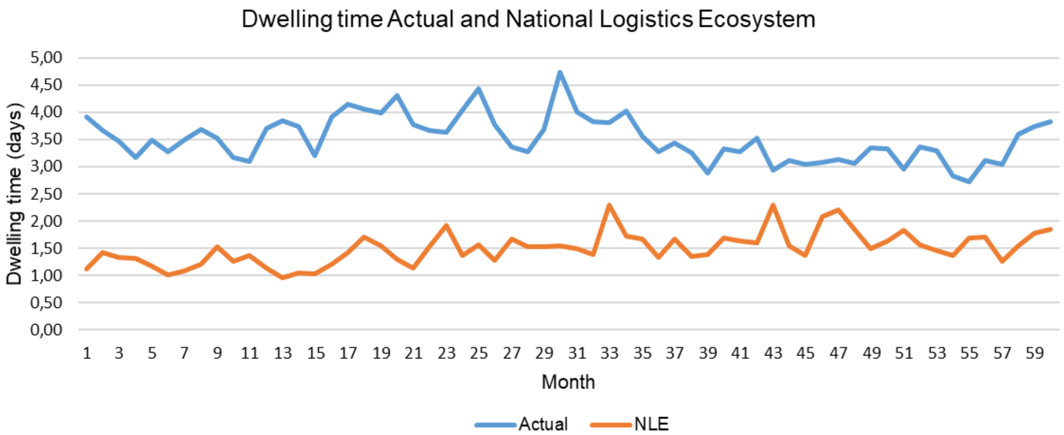


Figure 3. Difference in dwelling time based on actual field and National Logistics Ecosystem

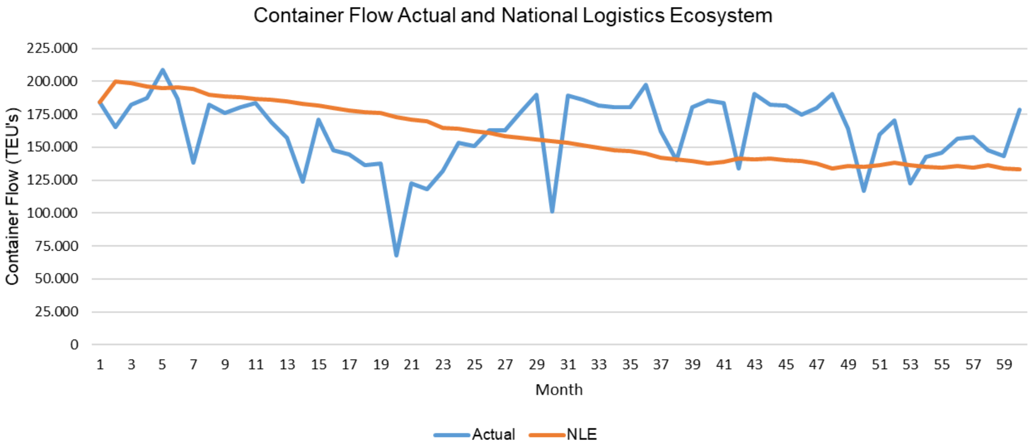


Figure 4. Differences in container flows based on actual field and National Logistics Ecosystem

simulation model and actual field based on the behavior pattern test, the mean error below 5% was obtained by 0% and the standard deviation error was below 30% which was 19%. So that the results of the simulation can be continued by adding the implementation factor of the National Logistics Ecosystem. Based on the implementation of the National Logistics Ecosystem, container flows ranged from 132,952 - 200,077 containers with an average of 159,018 containers / month.

3.3 Unloading quantity

Actual field results, dynamic system simulation results, and results of the implementation of the National Logistics Ecosystem obtained the quantity of unloading during January 2016 - December 2020 which can be seen in figure 5.

Based on the actual results of the field obtained the movement of unloading quantity ranged from 42,889 – 113,832 TEU's with an average of 88,878 TEU's / month and the results of simulation processing then obtained a shift in container flows ranging from 67,295 - 103,342 TEU's with an average of 87,882 TEU's / month. After a validation test of the simulation model and actual field based on the behavior pattern test, the mean error below 5% was obtained by 1% and the standard deviation error was below 30% which was 24%. So that the results of the simulation can be continued by adding the implementation factor of the National Logistics Ecosystem. Based on the implementation of the National Logistics Ecosystem, the quantity of

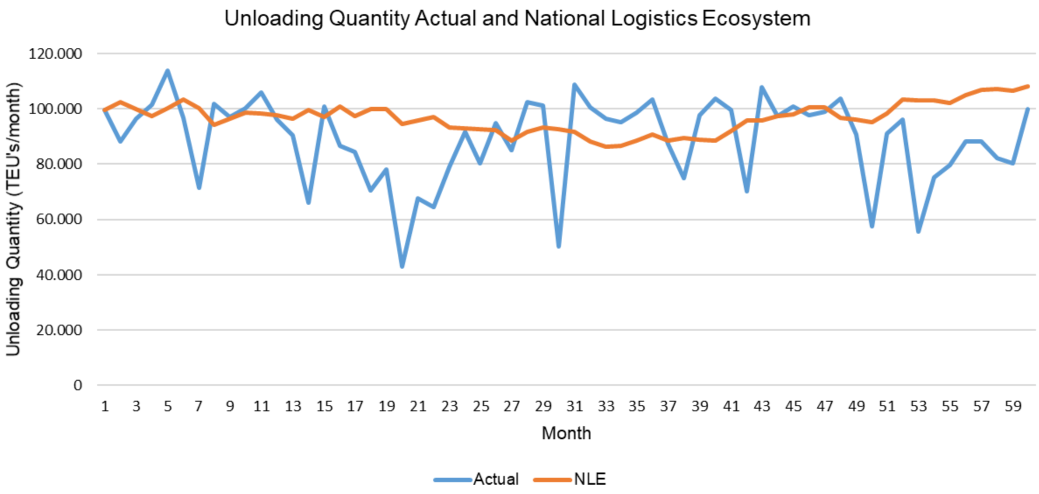


Figure 5. Difference in unloading quantity based on actual field and National Logistics Ecosystem

unloading ranges from 86,169 – 108,032 TEU's with an average of 96,712 TEU's / month.

4. Conclusion

Based on the results of the study, it was concluded that in the development of a dynamic system model with the implementation of national logistics ecosystem experienced a decrease in dwelling time and an increase in the quantity of existing unloading on the aspect of port and customs at the Port of PT Jakarta International Container Terminal. The model used is valid that meets the mean error value requirement of less than 5% and the standard deviation error is less than 30% for all data that has been tested validation. The results of processing based on simulation of dynamic system models with the national application of ecosystem logistics decreased from 3.52 days to 1.50 days or about 70% and an increase in the quantity of unloading by 7834 TEU's / month with a total percentage of 8.1%. So it can be concluded that the implementation of national logistics ecosystem at the Port of PT Jakarta International Container Terminal has a very important role and can be implemented in the field.

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