# The Design of Stacking Yards Management of The Early Warning System Model: A case study in Jakarta International Container Terminal, Indonesia

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***Abstract*--As a part of the Indonesia-National Logistics System, Jakarta International Container Terminal (JITC), facing a long dwell time (DT) which impacts to high yard occupancy ratio (YOR). This is happened because of the long necessary documents of clearance processing time, the limited yard provided, and the owners preferring for storing their goods in the terminal for cost reasons, etc. The objectives of this research are to design an early warning system (EWS) model to avoid YOR above the normal by using adaptive neuro fuzzy inference system (ANFIS); be found that EWS Model can use for prediction and simulation YOR in the future therefore simplify to manage of stacking yards and avoid losses. Another finding from data and empirical fact be found that k as a constanta influence YOR beside throughput (container import total pass to the terminal) and dwell time. Designing the inter-agency institutional collaboration to apply the EWS model by using interpretive Structural Modeling (ISM) with eight elements; showing the main constrain in the implementation of EWS is slow coordination among departements and stakeholder affected by the EWS progran are JICT and customs and formulating YOR above normal mitigation strategy be found is easy to be done. The primary data used are collected through the in-depth interviews and the focus group discussions with the multi-discipline experts. The secondary data are collected from JITC daily operations and from other supporting agencies. The proposed model is validated, verified and tested. It shows the promising results.**

**Keywords:** dwell time, yard occupancy ratio, institution model, ANFIS, ISM.

## 1 Introduction

The national logistics system's performance currently was not in its good condition.
For instance as characterized by the high logistics costs, such as the research carried out, for 7 years the average reached 26.03 percent out of the gross domestic product. Another factor was the low logistics performance index [1], [2]. The main factor of the global competitiveness index (GCI) was also low, the main factors influenced the logistic is infrastructure condition like ports and highways [3], [4].

The issue regarding ports, particularly in Jakarta International Container Terminal (JICT) which recently became the national issue was the long duration of waiting time for containers, especially in the imports in the terminal, or called dwell time (DT), namely the time required ship unloading, heading to the stacking yard after getting through the licensing and payment process. The duration of DT affected the ratio of field application level or Yard Occupancy Ratio (YOR) that might inflict losses to all parties, such as queues, soaring costs, overdue goods, and others, whilst the problem solving was not properly coordinated and all of sudden, for instance, the firefighters and the parties put the blame on each other. That was why the research was needed to design an early warning system model, hence the problems could be addressed early, and even high YOR was avoidable.

The purposes of this research were to design the early warning system model for handling the problems of overcrowded import stacking yard in JICT and to design the institutional model for the application of the early warning system model for handling the problems of overcrowded import stacking yard in JICT, and to formulate mitigation strategy for overcoming YOR above normal situation.

This paper was structured as follow :: First, we introduced the background and described some reasons that's why we needed the research. Second, we reviewed earlier researches on the dwell time condition and on how to solve the problems and related concepts of early warning system, adaptive neuro-fuzzy inference system (ANFIS), interpretative structural modeling (ISM) and institution theory. Third, we described research method : data collection and processing procedure, application of ANFIS, application of ISM and institution model formulation. Fourth, we processed and analysed the data. Fifth, we discussed the finding and formulated the conclusions and the suggestions.

## 2 Literature review

### 2.1 Research already done in JICT

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The research identified and obtained the significant relationship between the throughput and DT [5]. That was, the higher number of incoming containers into the terminal the more DT increased, as recorded in 2012; the DT import value was 5.2 days in average. The development report on the goods flowing at Tanjung Priok pointed out that DT in 2012 [6], according to the World Bank, was 6.7 days, and the government asked for it to be pressed down until 4 days in January 2013. From January to August 2013, the average DT was 7.7 days with YOR condition of JICT's import stacking yard of 104 percent.

Pointing out that the long duration of DT in Tanjung Priok resulted from 24/7 working time in a week was not implemented [1]. There were many closed institutions when the customers needed them; hence they had to wait for a long time. In addition, there were delays in the notification of imported goods (PIB) from the importers to the customs. Indonesian National Single Window (INSW) did not optimally operate as expected in the one-stop import clearance.

## 2.2 Research in Iran, Australia, Singapore etc.

Not only in Indonesia, almost all over the world are also experiencing the DT problems. This can be seen in previous studies as follows: DT of some countries selected obtained that in Singapore average of 1.1 days, in Hong Kong two days, in France 3 days, in the United States 4 days while in Indonesia is still 6 days [7]. In Rotterdam the Netherlands and get a DT in Europe, the average 3 to 5 days [8], [9]. The work done in order to reduce DT, would likely reduce the cost and increase the capacity of the existing terminal infrastructure to improve competitiveness at the international level. Studies in Africa shows a circle bad happens in DT in the port sub-Saharan Africa, the bargaining process between the owner and the clerk, there is no pressure in the improvement of productivity and lack of ease in the reduction of DT causing DT cargo to an average of 16 days, this is not including the Durban terminal [10]. In Mauritius, found that DT in Mauritius container terminal (MCT) DT average is 4 to 6 days [11]. It is worth highlighting that the purpose ports such as PT. JICT have different management ports of transit or transshipment such as Singapore and Hong Kong. Transit port can be higher productivity because they only move containers from one ship to another ship. While the ports of destination will deliver the container to the owner or agent take care of it in large quantities.

Annual conference in Cyprus, presents techniques to optimize the capacity of the container terminal with storage costs in the field. Identify the factors that affect the capacity of container yard, stacking area and loading and unloading system, dwell time and stack height. Conducted a sensitivity analysis to determine the impact of reducing the DT at field capacity and develop a theoretical framework to optimize the use of the capacity of the terminal based on the length of DT [12]. It is the same with research mentioned above is about the capacity field associated with the fines imposed for the duration DT targets are to optimize the capacity of the field [13].

Research conducted in Iran by the terminal state, to reduce DT by improving the use of electronic systems, reducing paperwork and work parallel in the settlement document items. Utilizing as an intermodal road and rail transport, observe the working time customs operations, coordination and collaboration among organizations in the issuance of permits documents goods [14]. Although the principle is the same, that PT. JICT almost all operational activities and services already using the electronic system, but there is a difference with this study, which is to build a system that can prevent overcapacity and control DT for the better by involving stakeholders and can react quickly and coordinated.

Investigated the effects of computerization on reducing the processing time of cargo at port and stated that the use of computers play an important role in decreasing DT in the harbor. It shows that the research at that time the role of computers in the terminal operation does not stand out and most of the cargo operations are still done manually. The equation of this research is to reduce the time automation becomes an alternative solution in this research [15].

Examined the role of automation in reducing the time of cargo at the port of Australia and New Zealand. The author explains and presents a fully computerized system, namely CEDIFIT, which can be used for clearance of cargo in Australia and New Zealand, both in the port or airport. Given one port in Australia as a case study, it was concluded that this method has been effective in reducing the time of issuing the goods up to 50% [16].

The factors that influence the potential efficiency and productivity at the port executive Darussalam, field accumulation of goods, which is one of the factors that contribute to the efficiency and productivity of the port, were investigated in the study. The author examines the relationship between the goods yard and port capacity Darussalam. At the end of his article, suggest some factors to reduce the time DT. Utilizing high speed and efficient equipment, improve individual skills through training and specialization of those working in the field of container stacking. Improving port infrastructure and connecting routes concerned [17]. In this regard has been made by the management of PT. JICT about service improvements including increased productivity, but it does not adequately resolve the issue, especially in the management of container yard.

Studies on the selection of field operations need adequate loading and unloading equipment, to increase the flow of containers and capacity. In this study will be included in the time required for the operation, and the time in this section is not very long compared to the time that affect DT, such as processing documents, because only time load and unload containers from one part to another [18].

Research in Turkey, operational inefficiencies in the yard of container exports because they still manuals, created a model to improve the buildup and optimization yard [19]. In Korea conducted studies in the field density stacking export, their financing schemes can reduce queues of container [20].

Meanwhile research in Tin Can Lagos port showing before and after the reform there are differences in the situation that is before many broken tools and productivity is low, after the reform, repair tools and productivity rose. YOR and DT inverse relationship and different with JICT [21].

## 2.3 Early warning system

By far the best way to manage a crisis was to prevent it from happening in the first place, and the intelligent companies had the early warning system, thereby, in case the incidents affecting the companies or their industries occurred, it could be immediately communicated with the management. The hardest part lied here. The management should have the considerable discipline required to heed the warning as the people generally tended to ignore it [22].

Crisis might imply the unstable situation where the fundamental changes could occur. In Webster's dictionary, the crisis was defined as a turning point for better or worse, and a defining moment. Figure 1 Illustrated that based on the anatomy, there were four stages of crisis cycle: (1) Prodromal; (2) Acute; (3) Chronic; and (4) Resolution.

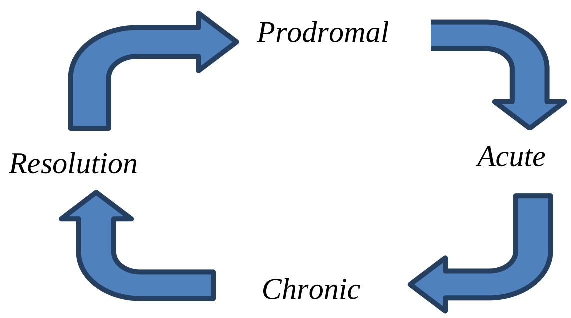



**Figure 1.** Crisis cycle

At this stage, the prodromal stage had shown the symptoms leading to the critical stage, but it was still difficult to identify. The introduction to crisis at this stage was highly essential in order to prevent the crisis at an initial stage and to perform actions towards the turning point to a normal state.

In the acute stage, the fact of crisis occurrence was already found, so it would be highly difficult to find a state as a turning point to return into a normal state, and typically considerable amount of losses or problems had happened. Therefore, the planning was required in handling of acute phase, and the entire action should be properly controlled, so that the intensity and duration of this stage could be controlled. The next stage was the chronic stage. It was also called the cleanup or treatment stage. At this stage, the decision-makers should apply the crisis management by analyzing the truth and the falsity of steps/ actions undertaken prior to the evaluation materials in taking the next best step.

The last stage of a critical cycle was the Resolution stage, namely the recovery stage. The handling performed at this stage should be related to that was previously done at the earlier stages. Nevertheless, the completion method at resolution stage was commonly easier than to those of the previous stages. There were two factors determining the success of handling in this resolution stage; firstly, identifying the prodromal phase and secondly, controlling the next handling. Given that the stage above was a cycle of crisis, then the final Resolution stage was deemed the initial stage of prodromal. It was difficult to determine when a crisis started or ended, given the crisis was a complication of reaction effects from one condition to another [23].

In the crisis management or control management, one tool was extremely needed to forecast the early condition, namely the early detection. The early detection was a forecasting activity for a future state by estimating various possibilities that occurred before undertaking the definite plans [24]. The early detection could be separated in two periods of forecast, i.e. long-term and short-term forecasts. The use of long-term forecast was more emphasized on the preparation of the strategy, while the detailed was obtained from the short-term forecast that was commonly used as a guideline for the preparation of implementation planning. Practically, the early detection system was highly needed in the scheduling field of usage or provision of the competitiveness resources to operate as efficiently as possible [25].

The successful implementation of the early warning system in the organization depended on two crucial things, namely the synthetic ability of the introduction to condition and the integrity of analysts to manage the early detection unit. One of simple model was using the technique of Issue Management Technology [26].

## 2.4 Adaptive Neuro-Fuzzy Inference System (ANFIS)

The early warning system model of which data were non-linear and complex required the appropriate analysis technique, i.e. the neuro-fuzzy technique which was an inference technique, consisting of fuzzy logic and neural network functions. The fuzzy logic was used as a counterfeit mindset, while the neural network functions determined the maximum approach value from the inference results [27]. Adaptive Neuro-Fuzzy Inference System (ANFIS) was one neuro-fuzzy technique. ANFIS basic idea was to build a system implementing an Artificial Neural Network (ANN) in the environment of Fuzzy Inference System (FIS). ANFIS used FIS structure, the type of Takagi-Sugeno and JST with the hybrid learning or the back propagation [28].

The soft computing method could be categorized into three main categories, namely: Fuzzy Logic (FL), Neural Network Theory (NN) and Probabilistic Reasoning (PR). In the concept of the soft computing, these methods resembled the pillars, supporting one another and working together to solve a problem. The soft computing applications were highly diverse and commonly found in the medicine, the geodesy, the economy, the agriculture, the meteorology and others [29]. ANFIS was proven to be able to be used to predict the chaotic time series and could be applied directly in the modeling, the decision-making, the signal processing, and the control [30]. One of the applications frequently used for forecasting was the application of the Adaptive Neuro-Fuzzy Inference System [31].

Fuzzy Inference System (FIS) was a process of formulating the mapping from the input to the output using the fuzzy logic [32]. Generally, FIS was comprised of five functions, among others:

1) Rule / Regulation = containing a set of fuzzy regulation of If - Then.
2) Database = defining the member function used.
3) Decision - Making Unit = indicating inference operation.
4) Fuzzyfication = the conversion of single input to the compatible linguistic value.
5) Defuzzyfication = the conversion fuzzy output to single-valued output (crisp).

The type of Sugeno FIS Model was first introduced in 1985's by Takagi, Sugeno and Kang. The model was more widely recognized as Takagi-Sugeno model [28]. The Fuzzy rules in Sugeno model took the form of:

"**IF X = A and Y = B thus Z = F(X,Y)"**

A and B were fuzzy clusters in the antecedent; Z = F (X, Y) was a crisp function in the consequent. F (X, Y) waspolynomials with the input variables X and Y, the output of Takagi-Sugeno model was linear or constant. In this research, ANFIS method would be used for the simulations in evaluating the risks in the Container Terminal of PT. JICT. The stages on ANFIS in this research were as follows:

1) Identifying the factors of inputs (opportunities and business) as EWS inputs.
2) Creating a rule base.
3) Preparing for the training data.
4) Creating FIS and ANFIS models corresponding to rule base and interface designs.
5) Creating a program code using computer software.
6) Preparing data for training data trials using ANFIS.

## 2.5 Institution theory

The institutions had consequences: first, it increased the routine activities, the orders or actions that did not require a complete and perfect selection. However, it could influence the individual behavior through the incentive and disincentive systems. Second, the institutions had influences for the creation of a stable interaction pattern that was internalized by each individual. It caused the regularity expectations in the future and, therefore, the institutions were able to reduce the uncertainty and to decrease the transaction rates in the economic activity [33]. The institutions had the fundamental characteristics that were consolidated, established, dynamic, constituted and vast in characteristics [34]. The institutions, according to economists, argued that the failure of economic development generally resulted from the institutional failure [35]. The difference between institutions and organizations was: the institutions were vast, whilst the organizations were tighter and resolute [36].

The summary of key elements of the institution included [35] :

- Institutions were the foundation for building the social behavior of the public.
- The behavior norms were rooted in the community and widely accepted to serve the common goals containing certain values and generating interaction among structured human beings.
- Regulation and enforcement of law/rules.
- Rules in society facilitating the coordination and the cooperation with the support of behavior, the rights and obligations of members.
- Code of Ethics.
- Contracts.
- Market.
- Property rights (property rights).
- Organizations.
- Incentives to yield the desired behavior.

## 2.6 Interpretive Structural Modeling (ISM)

Interpretive Structural Modeling (ISM) was first proposed to analyze the complexity of socio-economic system [37], [38]. ISM was a computer-assisted learning process allowing the individuals or groups to develop a complex map among many elements involved in a complex situation. The basic idea was to use an experienced expert practitioner and his knowledge to decipher a complicated system into several subsystems (elements) and to build multilevel structural models [38], [39]. By providing and highlighting which commanded that might be subjected to complex variables, the researchers had applied the ISM to analyze various systems [40], [41], [42].

The ISM was closely joined with the interpretation of an object or a representative system intact through the application of graphics theory systematically and iteratively. ISM was one of the computer-based methodologies assisting the group to identify the relationship between ideas and structures to stay on a complex issue [43].

ISM could be used to develop several types of structures, including the influence of structure (for example: supports or ignorance), the structure of priority (for example: 'more important than', or 'should be studied beforehand'), and the categories of ideas (for example: 'included in similar category with') [44]. ISM was an interactive methodology and implemented in a group setting. The methodology provided an extremely perfect environment to enrich and broaden the views in a considerably complex construction.

# 3 Research method

The study was conducted from November 2014 to September 2015. The study was carried out in PT. Jakarta International Container Terminal (JICT), at Sulawesi Ujung Street No. 1 Tanjung Priok Jakarta.

## 3.1 Data type and sources

Types of data used in the study were primary data and secondary data. Primary data obtained from the first sources of either individuals or groups such as the results of the questionnaire and the focus group discussions. Secondary data were data retrieved from the daily operational data of JICT namely throughput, DT and YOR. Primary data were obtained using the following data collection technique:

- Questionnaire and interview.

- Focus group discussion (FGD).
- In-depth interview.

The primary data collection in this study was using the survey method of experts representing stakeholders with the aim to justify a more objective and precise. The experts represented the management of JICT who understood the operational issue in the field and the management from Pelindo II Co., was the former commercial director, and had been the head of the port as a branch manager of the port area. Customs as an auditor of documents and physical goods, Katsushiro Co. (owner of goods), the former chairman of the Indonesia shipping association (INSA) as academia and practitioners who were well aware of the logistical problems of ports, and the representation of Shipping Line as the owner of the ships that all of which experienced a minimum of 16 years.

## 3.2 Method of model development

In designing a model of the early warning system in the management of container yard in JICT, it used two methods of analysis, namely Adaptive Neuro-Fuzzy Inference System (ANFIS) and Interpretative Structural Modeling (ISM**).** ANFIS was a model of prediction combining two techniques, namely soft computings, i.e. Fuzzy Inference System (FIS) and Artificial Neural Network (ANN). The capabilities of FIS in performing the reasoning and the excellence of ANN in carrying out learning would be collaborated, thus it was expected to be able to obtain a better model. Fuzzy logic was used as an imitation control of thinking flow, whereas the cells tissue functioned to determine the value of maximum approach from inference results [27]. ANFIS was one of the techniques of neuro-fuzzy.

Phases of ANFIS were as follows.

1). Determination of input variables and output, included throughput (TH) import, dwell time (DT) import, whereas the output variable was YOR.
2). Making the rule base (rule base) – IF....THEN....— with its criteria.
3). Data collection and data process with a computer software package.
4). Performing training 1 (training data and data of test).
5). The result of model 1.
6). Performing repetition process until it obtained the final model with a minimum error.

In this research, the flow diagram of the EWS with ANFIS development procedure was shown in Figure 2.

The development model of ISM contained 3 steps : 1). Determined the essential elements, 2). Outlined the elected element into more detailed sub elements, 3). Performed the matrix processing and continued with the grouping of sub elements based on the drive power (DP) and the dependence [45].

ISM helped in identifying the relationship between variables. The modeling techniques were suitable to analyze the effect of one variable to another variable, primarily intended as a group learning process [46]. This method was used to design the institutional model for the application of the early warning system model in handling issues of the density of import container yard JICT.

# 4 Result and discussion

## 4.1 Design a model of an early warning system with ANFIS

The research data taken were daily data from the Dwell Time, Throughput and YOR for Import Process from 2011 to September 2015. The daily data used consisted of 1734 records (days). After the preprocessing stage, the total numbers of valid data were 1699 records. These data were then used as the data set in this study. The division of the data was used to generate a model as well as to test the model. For the first model, the use of data was throughout the years of 2011-2013 as the training data, while the data in 2014 were used as the test data to validate the goodness of the model.

### 4.1.1 Training 1

ANFIS was a prediction model that combined two techniques of soft computings, namely Fuzzy Inference System (FIS) and Artificial Neural Network (ANN). The capabilities of FIS were in performing a learning, it would be collaborated thus it was expected to get a better model. Training process 1 performed with several experimental schemes. The scheme of experiments conducted at the training process 1 could be seen in Table 1.

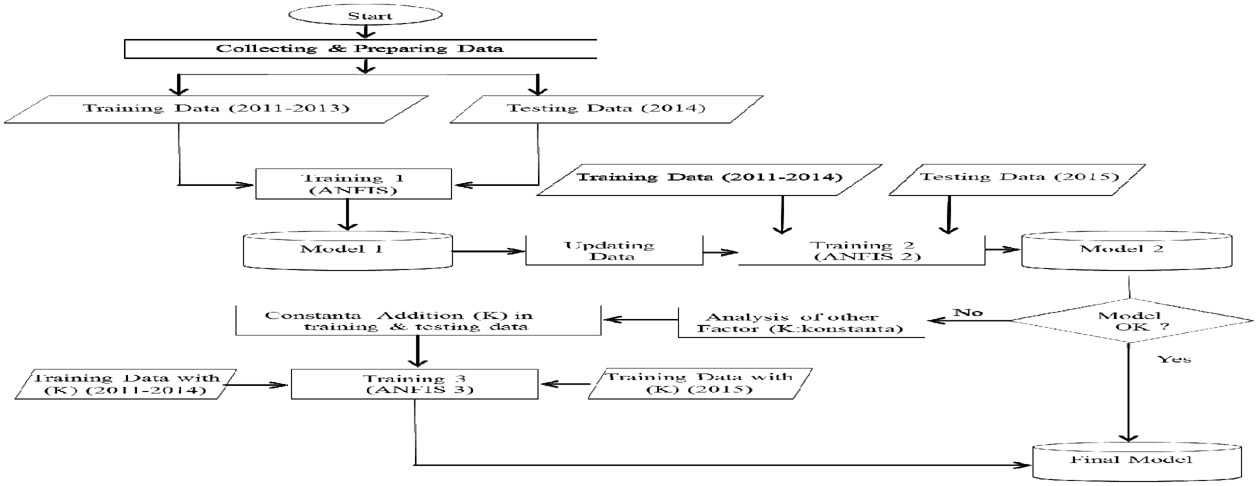



**Figure 2.** The ANFIS model development procedure

**Table 1.** The design of the training model 1

| No. of Anfis model | Total of input variables | Total of value sets | Total of rules | Membership function | Training method | Stopping criteria |
|---|---|---|---|---|---|---|
| 1 | 2 | 7 | 49 | Trimf | Hybrid | epoch:1000 error:0.1 |
| 2 | | | | Trapmf | | |
| 3 | | | | Gaussmf | | |
| 4 | 2 | 9 | 81 | Trimf | | |
| 5 | | | | Trapmf | | |
| 6 | | | | Gaussmf | | |
| 7 | 2 | 11 | 121 | Trimf | | |
| 8 | | | | Trapmf | | |
| 9 | | | | Gaussmf | | |
| 10 | 2 | 13 | 169 | Trimf | | |
| 11 | | | | Trapmf | | |
| 12 | | | | Gaussmf | | |

## 4.1.2 Training 2

For the computational simplicity, training 1 was limited to eleven models. ANFIS technical complexity would depend on the number of rules used. That rule was derived from the number of fuzzy set and determined for each data input. Table 1 showed that at most the number of rules designed was 169 with 13 fuzzy sets for each input. After the results of Training 1 had been completed, it was necessary to select a model with the lowest error rate when reaching to the prediction process. The model was the one which would be selected to undertake the retraining. Training 2 was a model that results Training 1 that had been selected and been improved by adding the training data starting in 2011-2014. To test the model, the data in 2015, were used.

After the process of training 1, it was known the value of error of the smallest then it designed a model of ANFIS for the training process 2. The scheme of the design of training model 2 could be seen in Table 2.
The design of this second model was to improve the accuracy by reducing the value of the error during the training process. Thus, the predictive value of YOR could be more accurate. The outcome of this process was a model of ANFIS 2.

Generally, ANFIS had 5 layers. The first layer was the input layer, namely the inputs used in the model. The second layer was a layer of fuzzy sets of each variable input used. The third layer was a layer of rules. Total numbers of rules were m and n (with m of fuzzy sets and n number of inputs). The fourth layer showed the firing strength of a rule while the fifth layer was the output layer. ANFIS structure visualization layer on training 1 and 2 could be seen in Figure 3 above. In essence, between ANFIS model 1 and 2 had the same input only that on ANFIS model 2 had been added with more additional training data to become more representative model.

## 4.1.3 Training 3

Basically, the determination of the percentage of YOR through throughput information and DT could be performed. Only the facts on the ground indicated

**Table 2.** The design of the training model 2

| No. of Anfis model | Total of input variables | Total of value sets | Total of rules | Membership function | Training method | Stopping criteria |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| 22 | 2 | 7 | 49 | Trapmf | Hybrid | epoch:1000<br>error: 0.05 |

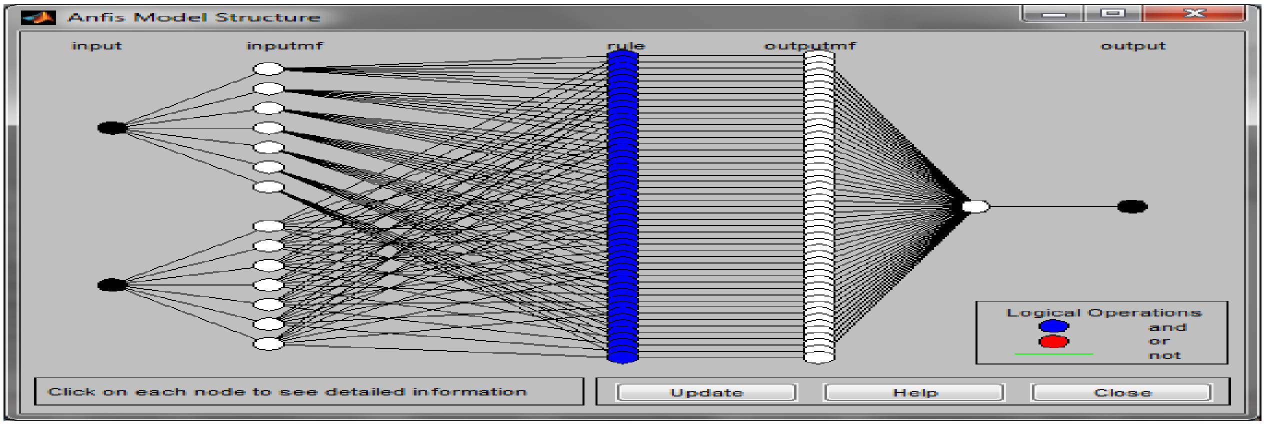



**Figure 3.** Structure of ANFIS in the process of training 1 and 2

that, sometimes there were other factors that also had a particular role to the value of YOR itself. Force majeure was a condition which we had no control, such as: floods, strikes, traffic jams, and others. In addition, the conditions such as lights off might cause the system not to work. From both of these conditions (data and empirical evidence) showed that there was one factor in this case (K = constant, a design parameter) that affected YOR in addition to the variable / attribute of TH and DT. High YOR conditions were caused by the height of TH and DT.

With the presence of value of K (constant), it meant that there was one particular becoming the new variable. Empirically, the more the intensity of the force majeure conditions, the higher the value of K. Or in other words, K was proportional to the intensity of interference (the force majeure conditions). In the model of ANFIS itself, the increasing value of K would have the implications on the input of ANFIS model to be created. The structure of ANFIS for training on model 3 could be seen in Figure 3. The experimental design in the training process model 3 could be seen in Table 3.

Stages of the testing process and the data analysis with ANFIS had been done through the stages of training of the first to the second, because the results had not been good, then were resumed to Training 3. Repeated tests to determine the best model had also been done, but in a different case [47]. Basically, the determination of the percentage of YOR through information throughput (TH) and dwell time (DT) could be performed. Only the facts on the ground indicated that, sometimes there were other factors that also had a particular role to the value of YOR itself. Force majeure was a condition that we could not control such as: floods, strikes, traffic jams, and others, in addition to other disorders such as the power outages might cause the system not to work, and the loading and unloading equipments were damaged.

Both of these conditions (data and empirical evidence) showed that there was one factor in this case the design parameter (K) that affected the conditions of YOR in addition to input variables of TH and DT. YOR conditions of import were high, due to the high factor of TH, DT and also the role of the value of k (constant), so there were new variables that were taken into account as the input. Empirically, the more the intensity of a fault condition, the higher the value of k. In Figure 4, it appeared that for the input layer would increase one, namely the value of K. This would have the implications on the number of rules used. K value was justified based on the information of the existing YOR value.

The time series data used were dwell time and YOR during 2011 to 2014 with the value of throughput was around 1000 to 8000 teus per day, with an average of 3292 teus. The maximum value once reached 8585 teus. The average DT of six days or more, there were some extreme events specific to problematic goods. The average YOR was around 85%, although the YOR range could reach 10-127%. The visualization of the results of the test data in 2015 could be shown in Figure 5.

Based on the distribution information of data above, it appeared that on the attributes of TH, with mean and standard deviation, it appeared that there was an overlap (there was a common trait), but categorized in different classes (indicated by color). Likewise for DT attribute, it appeared to be so, with the average and standard deviation of DT and TH which overlapped, it turned out that YOR was categorized in a different status. Empirically, in fact YOR conditions were also influenced by things such as: force majeure.

**Table 3.** The design of the training model 3

| No. of Anfis model | Total of input variables | Total of value sets | Total of rules | Membership function | Training method | Stopping criteria |
|---|---|---|---|---|---|---|
| 11 | 3 | 3 | 27 | Trimf | Hybrid | Error: 0.05<br>Epoch:500 |
| 12 | | | | Trapmf | | |
| 13 | | | | Gaussmf | | |
| 21 | 3 | 5 | 125 | Trimf | Hybrid | Error: 0.05<br>Epoch:500 |
| 22 | | | | Trapmf | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 23 | | | | Gaussmf | | |

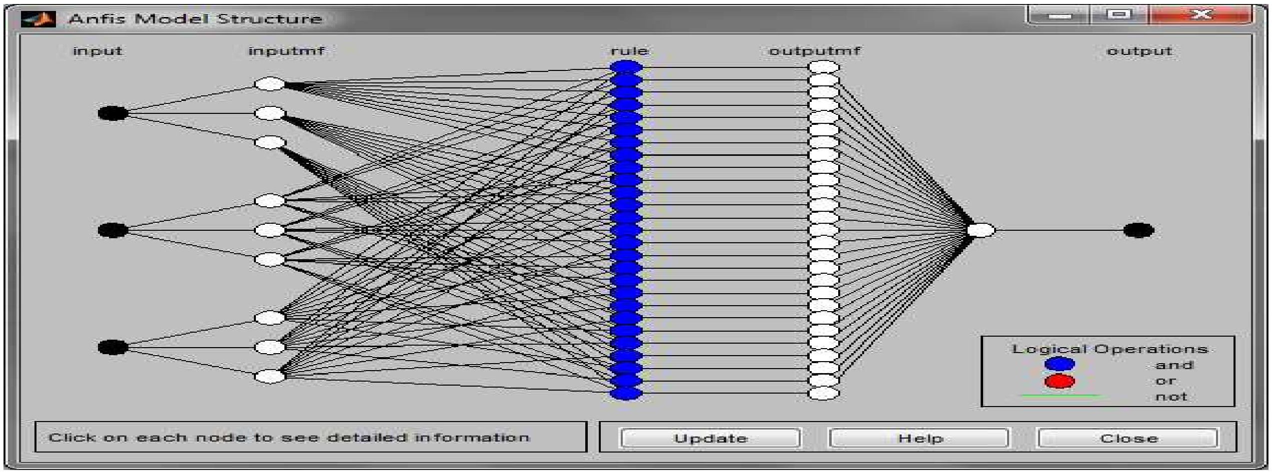


**Figure 4.** Structure of ANFIS after the addition of K value

When looking at the data of YOR for each condition, then there were three categories of YOR obtained from the experts, namely YOR <= 0.65, 0.65 <YOR <= 0.85 and YOR> 85, the average of 0.54, 0.76 and 0.98 consecutively. With a standard deviation obtained K value in a particular range was shown in Table 4.

Under these conditions, there were new training data by adding attribute of K. So the training data had three attributes, namely TH, DT and K. The ANFIS was then be retrained accordingly. The resulting error was decreased compared to the previous model, as shown in Figure 6. Thus, the parameter design K, was able to improve the accuracy of YOR prediction.

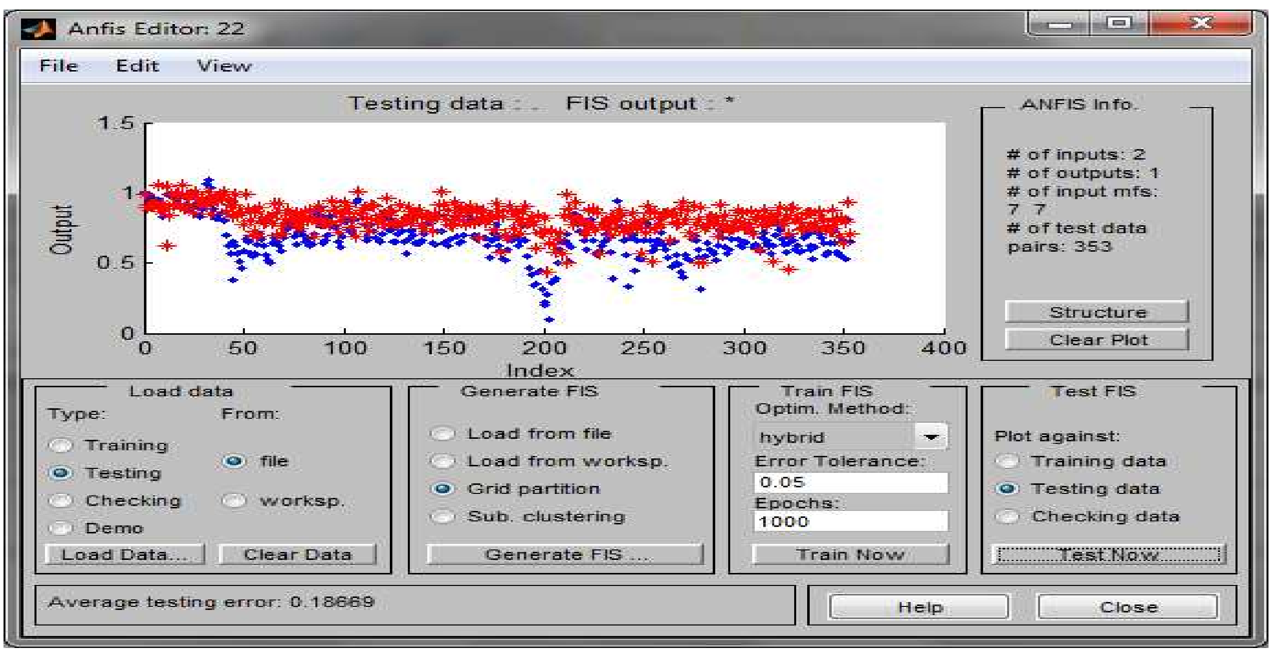


**Figure 5.** Visualization of test results

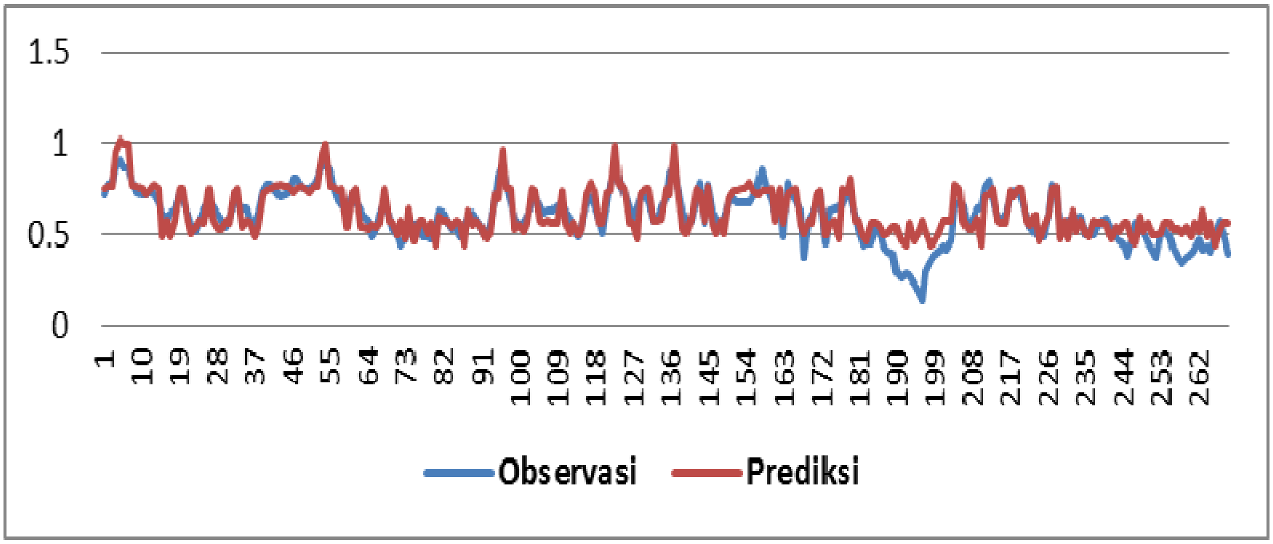



**Figure 6.** Results of prediction model compared with the real observation (RMSE : 0.08)

**Table 4.** Range of K value at difference YOR level

| | YOR | YOR | YOR |
|---|---|---|---|
| Mean | 0.54 | 0.76 | 0.99 |
| Range of K | [0.43-0.65] | [0.70-0.82] | [0.89-1.07] |
| N | 208 | 412 | 800 |

### 4.1.4 Validation and verification

Validation and verification were done through the testing of the model that had been generated while training. Good model generated a low RMSE value. The system also came with a predictive menu. Prediction of value for every month could be done in this menu. The prediction results could be seen in Figure 7. that explained the prediction for the throughput, the dwell time and the YOR.

Prediction of YOR through the resulting model could also be done with the predictions of throughput in a week ahead from the results of information in the field with the following stages:

1. Checking the planning of throughput for the month concerned.
2. Checking all the scheduled ships windows, and whether there was an additional ship (addhoc) or omitted (cancelled).
3. Viewing the trend throughput week to two weeks earlier.
4. Checking the noon reports whether there were changes again in the week both the ship's position and the forecasts of the number of vessels.

The results of these predictions were for the 25th until the end of the month, if until the 30th then the total of teus (teus = tons equivalent units of containers were counted in units of container sizes 20 feet = 1 teus, 40 feet = 2 teus) were ranging from 32000 to 35000 teus. If until 31, then it would be around 45000 until 47000 teus. Prediction value of throughput the total would be retrieved the throughput import to the predictive value of other variables such as DT and k, if entered into a model, then these values would generate the value of YOR. The value of YOR was the output model as the indicator of EWS. Three categories of the value of YOR for each conditions were as follows, YOR <= 0.65 (green), 0.65 <YOR < =0.85 (yellow) and YOR>85 (red) which was critical. This value would determine what sort of action to be taken.

## 4.2 Designing institutional model for the application of the EWS with ISM

As what had been explained before that the Early Warning System Model was formulated based on the result of the basic assumptions with the highest priority as a prerequisite that should be considered in the preparation of this policy model. The structural elements of the Early Warning System were analyzed by using ISM. The ISM inputs were based on interviews and FGD with 7 experts representing all stakeholders. There were suggested 8 elements that should be considered in policy making, namely 1) The aim of the EWS program, 2) The requirements of the EWS program, 3) The main obstacle in developing the EWS, 4) The main obstacle of the EWS implementation, 5) The possible changes through the EWS, 6) The sector of stakeholders affected by EWS program, 7) The activities needed to build the EWS program, and 8) The takeholders involved in the implementation of the EWS program.

Then, the questionnaire was designed and it was submitted to the respective experts to be filled and then it was processed by the ISM computer program. The classification was based on the ISM Cartesian diagram ratings, the value-Driver Power (DP) and the value of Dependence (D) to find out the classification of the elements. Broadly speaking, the classification of the element was classified into four sectors, namely [48].

From the eight elements, there were some that were relevant to be displayed in the ISM analysis technique i.e. the main constraints in the implementation of EWS as shown in Figure 8.

## 4.3 Designing institutional model for the application of the EWS with ISM

As what had been explained before that the Early Warning System Model was formulated based on the result of the basic assumptions with the highest priority as a prerequisite that should be considered in the preparation of this policy model. The structural elements of the Early Warning System were analyzed by using ISM. The ISM inputs were based on interviews and FGD with 7 experts representing all stakeholders. There were suggested 8 elements that should be considered in policy making, namely 1) The aim of the EWS program, 2) The requirements of the EWS program, 3) The main obstacle in developing the EWS, 4) The main obstacle of the EWS implementation, 5) The possible changes through the EWS, 6) The sector of stakeholders affected by EWS program, 7) The activities needed to build the EWS program, and 8) The takeholders involved in the implementation of the EWS program.

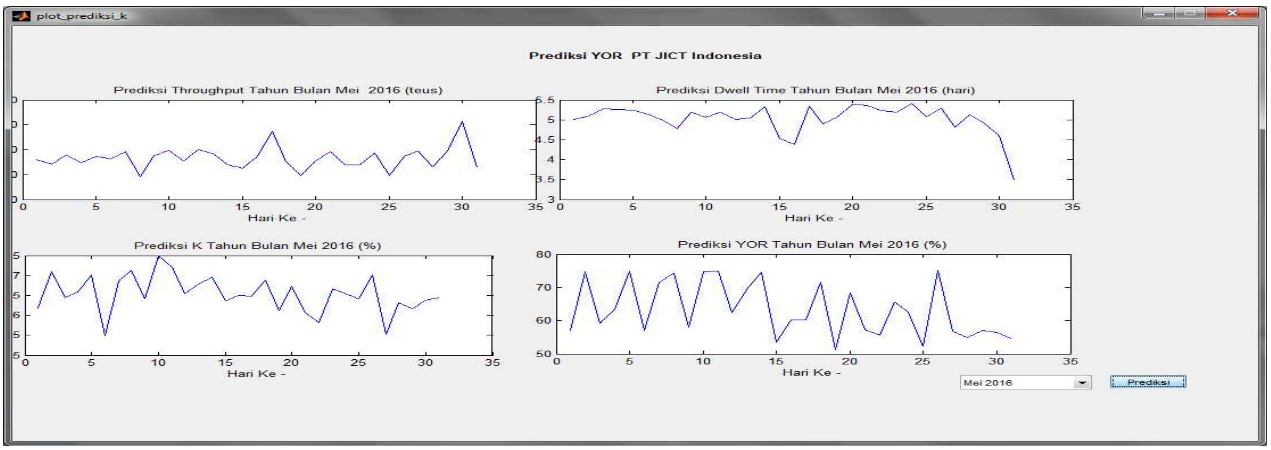
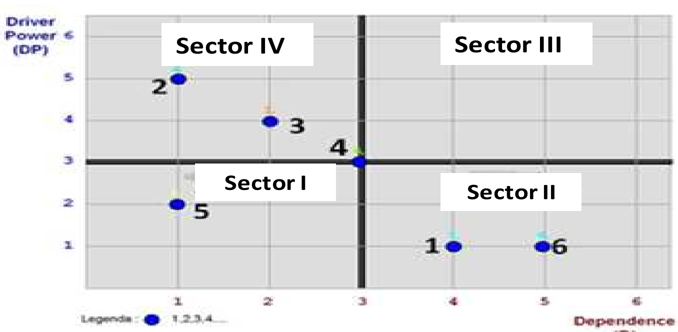



**Figure7.** Example of YOR prediction results in May 2016 (right below): X ordinat in % - Y ordinat day to

RM Matrix Final (Transitivity)

Elemen : MAJOR OBSTACLE OF EWS IMPLEMENTATION

| DM / Respondent : Expert | | 1 | 2 | 3 | 4 | 5 | 6 | DP | R |
|---|---|---|---|---|---|---|---|---|---|
| Sub Elemen Description(i-j) | | | | | | | | | |
| Slow handling or the present of bearucracy | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 5 |
| Slow coordination among parties | 2 | 1 | 1 | 1 | 1 | 0 | 1 | 5 | 1 |
| Lack of concern to the crisis happens | 3 | 1 | 0 | 1 | 1 | 0 | 1 | 4 | 2 |
| Lack of parties's commitment | 4 | 1 | 0 | 0 | 1 | 0 | 1 | 3 | 3 |
| There is the perception of decreasing the stacking yards income | 5 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 4 |
| Being additional works for employee who conduct the EWS control | 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 5 |
| DP : Driver Power D : Dependence L : Level R : Ranking | D | 4 | 1 | 2 | 3 | 1 | 5 | | |
| | L | 1 | 5 | 4 | 3 | 2 | 1 | | |



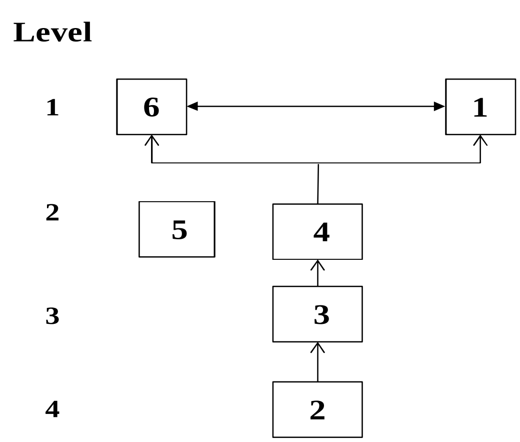




**Figure 8.** The major contraints on EWS implementation

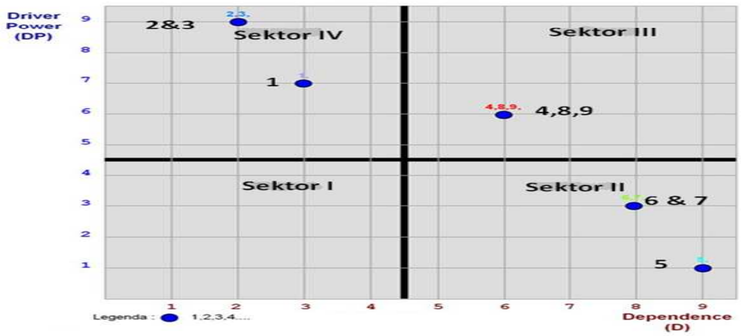
Notes: 1. Slow handling or the present of bureaucracy, 2. Slow coordination among parties, 3. Lack of concern to the crisis happens, 4. Lack of parties' commitment, 5. There is the perception of decreasing the stacking yards income, 6. Being additional works for employees who conduct the EWS control.

The stakeholders sectors affected by EWS program was shown in Figure 9.

RM Matrix Final (Transitivity)

Elemen : The Societal Sectors Affected of EWS PROGRAM

| DM / Respondent : Expert | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | DP | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sub Elemen Description(i-j) | | | | | | | | | | | | |
| Goods owner | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 7 | 2 |
| JICT | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 1 |
| Customs | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 1 |
| Trucking company | 4 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 6 | 3 |
| Customers/people | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 5 |
| Port Authority | 6 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 3 | 4 |
| IPC/Pelindo II | 7 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 3 | 4 |
| Shipping Line | 8 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 6 | 3 |
| Container depot outside | 9 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 6 | 3 |
| DP : Driver Power D : Dependence L : Level R : Ranking | D | 3 | 2 | 2 | 6 | 9 | 8 | 8 | 6 | 6 | | |
| | L | 4 | 5 | 5 | 3 | 1 | 2 | 2 | 3 | 3 | | |



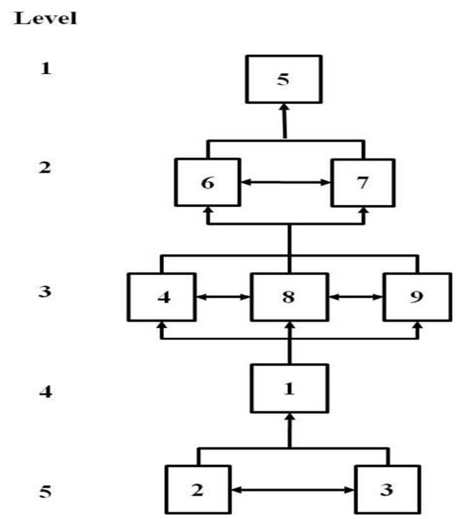




**Figure 9.** Stakeholders sectors affected by EWS Program

Notes:

1. Goods Owner, 2. PT. JICT 3. Customs & Excise, 4. Transportation companies, 5. Society around,
6. Port Authority, 7. IPC/Pelindo II, 8. Shipping line, 9. Container depot outside

Referring to problems of inter-institutional and institutional theory above, to be able to develop a model application of EWS among institutions, it could be summarized as follows: It took an understanding between the same institution and a change in attitude about the problems faced in this case of the increase of YOR above normal, therefore it was necessary to conduct the continuously socialization to all parties so that problems could be dealt together in advance. When there was a better interaction between institutions, EWS models produced could be applied and would be very useful and facilitated in controlling the YOR in the containers stacking yard.

The result of the design of the institutional model for the application of EWS in PT JICT with ISM method was summarized in the key sub-elements, linkage and its dependent for each element as described in Table 5.

**Table 5.** Matrix of elements synthesis resulting from ISM analysis

| Element | Key of sub elements | Linkage of sub elements | Affected dependent sub elements |
|---|---|---|---|
| The Aim of EWS Program | (1) Early knowing the increase of YOR | (2)Avoiding the impact of losses incurred as a result of high of YOR<br>(3) Facilitate the management of YOR stacking yard | |
| The Needs of EWS Program | Major : (5) Regulations supported by : (1) stakeholders Data and information support and (4) Ideas and Suggestions | | (2)Partnership management and stakeholder<br>(3)Evaluation and dissemination of stakeholders<br>(6)Implementation and follow-up |
| The Major Constraints on the Development of EWS | (2) Lack of information about the importance of EWS | (3) Unavailability of Information Systems which are connected between sections<br>(4) Inaccurate or differences in the data | (1)The parties tend to think of their own sector |
| The major constraints on the implementation of EWS | Major : (2) Slow coordination among parties Supported : (3) Lack of concern about the crisis | | (4) Lack of commitment all parties<br>(5) Perceptions of decreasing income<br>(1) Slow handling or their bureaucracy and (6) Creating additional work for employees |

| | | | |
|---|---|---|---|
| Possible Changes made by the EWS | Major :<br>(1) The ease of using system | (2) (Speed information to stakeholders and handling)<br>(3) The speed of handling | (4)Avoiding losses<br>(5)Increasing the operational process |
| Stakeholders sector who are affected in program EWS | Major :<br>(2) PT JICT<br>(3) Customs Supported by:(1) Goods owner | (4)Transportation companies<br>(8)Shipping Line<br>(9)containers depots near terminal | (6)Port authority<br>(7)IPC/Pelindo II<br>(5)Society around |
| Activities needed to build the program of EWS | Major: (2) Good Examining Procedure Supported by :<br>(1) The procedure of placing and delivering of containers<br>(3) The procedure of goods transfer to the outside of depot | (4)Stocking time data collection containers that long stay<br>(5)Secondary data collection of the container traffic last five years in order to estimate future conditions<br>(6)Current Operational information systems | (7) The last five years daily DT data (8) The last five years YOR data. |
| Stakeholders involved in the implementation of the program of EWS | (1) PT JICT and (2) Customs | (3) Goods Owners | (5) Shipping line<br>(4) Container transport companies |

Based on Table 5, Matrix of ISM synthesized method resulted above could be made of alternative applications for applying the EWS model that synergized the pattern of cooperation and institutional relations between the stakeholders involved in the management of the container terminals in the JICT as shown in the Figure 10. This model was expected to be a solution to overcome the problem of the management of the container yard.

The results of the ISM analysis of the EWS program aimed at finding out the increase of YOR earlier, then it was expected that the information was delivered to all parties beside JICT such as to Custom, the owner of the goods and shipping so if all parties knew or could easily see the condition of YOR, the anticipation would be better, the easy way in this joint observation was to connect a computer network JICT with the Customs and Excise as well as the access to information and help desk or display the monitor screen in the customer service. Moreover, this still needed to be socialized by JICT to all parties. It was based on the results of the analysis that there were the lack of understanding of the importance of EWS, the slow coordination between departments, the lack of concern for the crisis

In this case, the role of government namely the ministry of transportation was to make regulations in the control of container yard by all parties concerned so that there was a common view in acting and well-coordinated response in this regard that would be coordinated by the Port Authority (OP), representing the government to conduct meetings regularly and institutional oversight if there were things that needed to be resolved and IPC or IPC 2 as operator and regional authorities to help drive the parties to execute these regulations in order to control them more easily.

Procedure stacking by JICT and examination by the Customs were required in the control of this YOR, because both of these activities would affect the condition of YOR to come. Stacking container which was too high then the demolition would take a long time in the field of operations thus inhibiting or causing queues of trucks, although it was advantageous in terms of capacity addition and should be done when YOR was very high or in a state of red.

The examination could be conducted by observing the situation of YOR, if the YOR was high, it was better that the examination represented, because of the space, and the loading and unloading facilities had limited spot for checking, so that if too many things were checked especially the red line then there would be a queue at a later time.

The direct impact of YOR increased was all related to the institutions, while the indirect impact was the owner of Depot companies like Pelindo 2 and depots outside the port, as well as the company based on the trucking company it could be explained that after the capacity inadequate, the shipping containers would be removed from the terminal to the depots by trucks. The community would be affected indirectly, namely congestion and dirty environment, and would eventually hit the burden of the prices of goods to be expensive

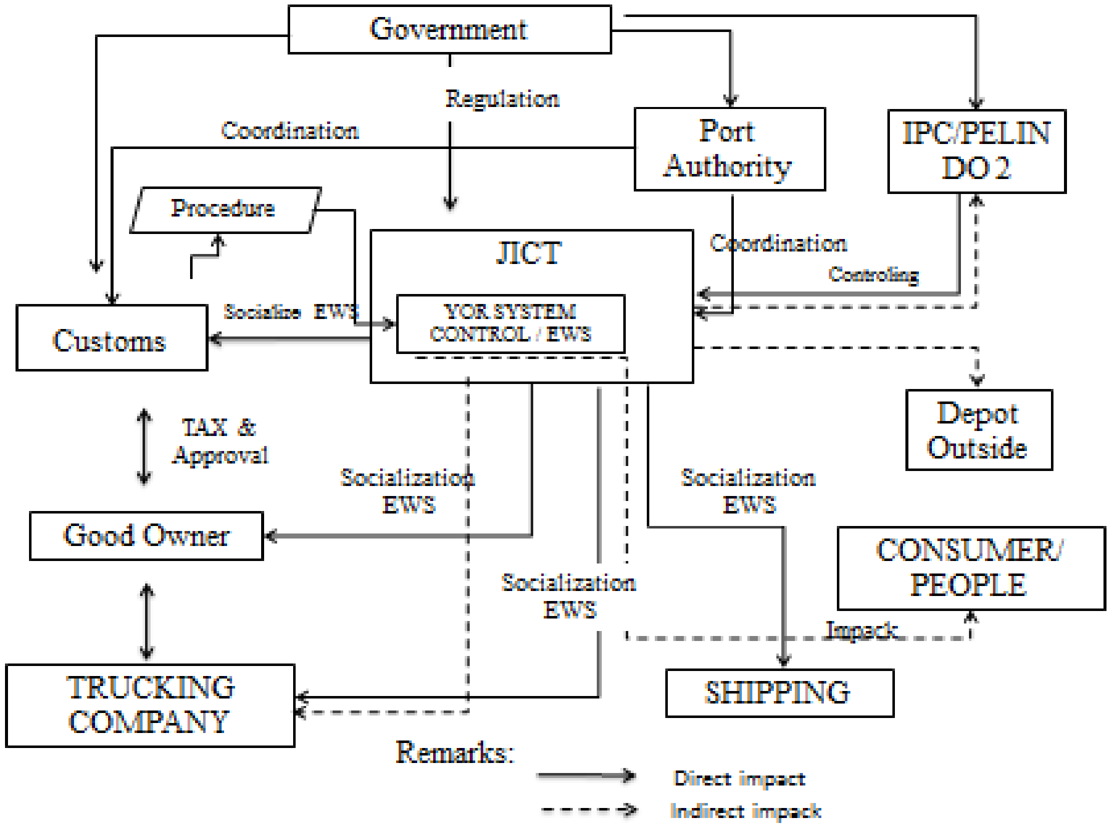



**Figure 10.** Institutional model for application of the stacking container yards EWS model

## 4.4 The YOR above normal mitigation

It was caused by a deviation from the normal condition or the force majeure and it often happened in sudden and there was no enough time to anticipate it, such as: flooding plus tidal sea water, poor weather in some oceans abroad, strikes, booming trade, riots or chaos and no incidence of accidents in the port area. Although it was not desirable, the things mentioned above had occurred and still potentially happened again in the days to come. Therefore, if there were more events, they should be sought in order to minimize the losses that would arise related to DT and YOR.

Mitigation in the short term was conducted by the decline of YOR which was relatively fast, there was agreement with the Customs for the emergency situations or acceleration permitted the transfer goods to the depot outside. Besides, the agreement with the cruise could be conducted if YOR had been already yellow, the goods imported temporarily suspended login first or set scheduling. For the long term, among others: the approval of the Customs agreement with the depot that was wide enough although it was a bit far from the terminal, because the depots which were close to the terminal, in peak conditions, were often get full, and the depots outside should be able to accommodate approximately 0:35 x 21 672 teus = 7585.2 teus (YOR maximum decreased from 100% to 65%), since the security condition was 65% of the terminal capacity.

The next mitigation should have the agreement with the trucking company on immediate needs when it required the trucks to take out the containers from the terminal, for example, for the trucks could be calculated from 7585.2 teus: 1.5 (the ratio of container was 20 feet less than 40 feet) = 5056.8 crib or it needed 5057 trucks. If a day, the company could only provide an additional 500 trucks, so it needed 5057: 500 or = 10.1 days or more time to take to return to normal.

## 5. Conclusions and suggesions

### 5.1 Conclusions

The YOR early warning system that has been developed, validated and verified can represent actual conditions of YOR so that it can be used to make YOR prediction and to suggest the mitigation accordingly.

Be found that k as a constanta influence YOR beside throughput (container import total pass to the terminal) and dwell time.

For the application of the early warning system, it has been developed an institutional model among agencies at JICT, where the roles of JICT and Custom are as the key implementing institution.

YOR above average mitigation can be conducted among the agencies involved through the institutional coordination.

### 5.2 Suggesions

- This models is possible to be implemented in another ports with small data modification according to the data availability and local port characteristics.
- For future work, the developed model can be expanded to also include sea transport, loading and unloading at the dock, the transportation time at terminals and on highways or depots outside and warehousing systems, and other infrastructures. Before implementing the model, it should be synchronized and adapted to the regulatory change, especially in the port management.

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