Development of a Container Terminal Educational Simulator

*Hyun Soo Kim, *Hyung Rim Choi, ***Jae Un Jung*, **Jae Young Park, **Hui Yun Kim
Department of Management Information Systems
College of Business Administration, Dong-A University,
840 Hadan2-dong, Saha-gu, Busan 604-714, Republic of Korea

Abstract: - In this paper, a study was conducted inquiring into the development of a simulator, which can be used as training material for the internal process of container terminal among various areas of habor distribution. For developing a simulator, a language called Powersim was used. It is a useful tool for causationally modelling the composition of a system. The advantage of designing the model of a container terminal by using the tool is that learners can causationally understand the internal process of the container terminal. On the other hand, the interface of the simulator has been designed as a form of digital dashboard, which faciliates the input and output of the senario (Value of environmental variables) so the learners can analyze the course of changes incurring during processing the traffic volume within the terminal depending on various technologies and how they are applied in the terminal. In the following studies, we are planning to develop a more dynamic training tool for operating container terminal by complementing the ommitted part of the simulation model developed up to the present and by concretly designing the parts that have been presented abstractly.

Key-Words: - Container Terminal, Educational Simulator

1 Introduction

The traffic volume of international marine transportation is continuously increasing. According to MOL (2005:15), world trading volume (based on value) is increasing by an average of 9.6% per year and marine transportation trading volume (based on traffic volume) has been increasing by an average of 4.8% per year. Especially, in marine transportation trading, the market for container machine transportation is increasing by 10% per year. Accordingly, each country is continuously making investments on the harbor distribution infrastructures. For the sake of the development of harbor distribution industry, professionals who can contribute in this regard have to be secured. However, in reality, supply for such professional is shorter than the demand. Now, measures to efficiently nurture harbor distribution professionals need be formulated. As one of the measures that can solve this problem, this study focused on container terminal among various areas of harbor distribution. We developed a simulator, which can be used as a training material for operating container terminal. This training simulator can help in increasing educational effects on the trainees learning about container terminal operation and productivity while training them to learn the dynamic internal processes of the container terminal and experiment many technical scenarios required in operating the terminal. The system used a language called Powersim which can present the causational concept of the dynamics of the model in a relatively easy and convenient way. Also, a dashboard was developed for supporting input and output of the data on the environmental variables of the terminal operation so the trainer can carry out computer experiments on the various applicable technologies for the container terminal.

2 Literature Review

2.1 Internal Process of Container Terminal

Container Terminal, which is the contact point of marine and overland transportation, is largely composed of 3 areas that are gate, yard and quay wall. The function and activity of each area is as follows. We conducted a survey by referencing to Ha et al. (2007), Yun et al. (2001), Yoo et al. (2007).

2.1.1 Gates

Gate area of a container terminal can be divided into an entrance gate and exit gate. Through the entrance gate, trucks loaded with containers enter into the yard inside the terminal for unloading the containers. The entrance gate is also for the empty trucks coming into the terminal for picking up cargo. On other hand, the exit gate is for the trucks to exit from the terminal after finishing their works. Normally, the entrance and exit gate are separately used for its own purpose but at times they are used differently depending on circumstances. It is the same reason as operating reversible lane on a drive way for smoothing the traffic flow.

Procedures for the contrainer trucks to pass through the gate are as follows. First, a truck arrives at a gate and the gate identifies the truck and the information of cargo loaded on the truck. Then the gate issues a slip through a slip machine installed at the gate. The slip contains the information such as where in the yard the truck can unload its containers or from which part of the yard the truck has to pick up cargo. The truck that has received this slip now drives into the yard and here, gate operating technologies/tool for identifying the information of vehicles are man, barcode, OCR(Optical Character Reader or Recognition), RFID(Radio Frequency Identification) and etc. For RFID, the information of the cargo stored in the RFID chip can be transmitted and processed wirelessly so it is used as a non-stop gate technology.

2.1.2 Quay

The quay area of terminal is a space where vessels can anchor in the harbor for loading or unloading cargos. When loading or unloading cargos, an equipment called QC (Quay Crane) or CC (Container Crane) is used. And these equipments can be divided into Single type, Tandem type etc., depending on their capacity (number of containers they can pick up at once). In order to move the cargos from the quay to the yard and from the yard to the quay, transportation equipment that moves back and forth is required. For example, SC (Straddle Carrier), SHC (Shuttle Carrier), YT (Yard Tractor) and AGV (Automated Guided Vehicle)

2.1.3 Yard

In order to unload / pick up containers, trucks enter in to the yard and drives to the assigned location, where TC (Transfer Crane) loads/unloads the cargos. This equipment also loads/unloads the cargos that are delivered by transportation from the quay.

There are different types of YT such as RTGC (Rubber Tired Gantry Crane) and RMGC (Rail-Mounted Gantry Crane).

On the other hand, in order to marshal the cargos stacked in the yard, equipments such as RS (Reach Stacker) and FL (Fork Lift) are used.

2.2 Simulation

Simulation is the only technique that can be used when it is difficult to constantly control the restraint environment of the study or when the scope of the study is too wide in such a way that the time and the cost required for the study is unbearable or when some test or analysis is required for future condition which is not likely the reality. The following is surveyed by referencing to Goldsman(2007); Sánchez(2007) .

2.1 Mental and physical model

For simulation, the person who conducts the study needs to understand and define the problem. Here, the defined model is called mental or soft model. And the model that has been defined as a form which is workable by computer is called a physical model. With the mental model, major variables and activities that compose the problem have to be defined. And with the physical model, a functional relation needs to be defined so those can be numerically calculated. In uncertain conditions, exceptions can be created by setting random numbers.

2.3 Simulation languages

There are various simulation languages. It includes Java, C and Visual Basic, which are professional programming languages and there are also Venism, Powersim and Witness that can program the causational concept in a graphic environment. In this study, Powersim Studio 2005 was used to design and develop the simulation model.

3 Development of Container Terminal Simulation Model

In order to develop and embody the educational simulation model for learning the operation process of container terminal, Powersim Studio 2005 was used. Its graphic-based design environment defines every relation of the constituent variables of the system (model) so it facilitates the understanding of ordinary people when they look at the drawing. Also, it features a digital dashboard through which the user can easily change the value of the variables for simulating various scenarios.

On the other hand, container terminals in different part of the world are adopting many different operating technology and method so it is difficult to consider all of them. Therefore the simulation was designed and embodied as follows so the trainees can learn the basic process of container terminal.

3.1 Gate Area

Among the 3 areas (gate, yard and quay) of container terminal, the environment of gate was designed as following. (Fig. 1) First, total number of the gates is 5 and the structure is designed in such a way that the user can set the number of the entrances and exits.

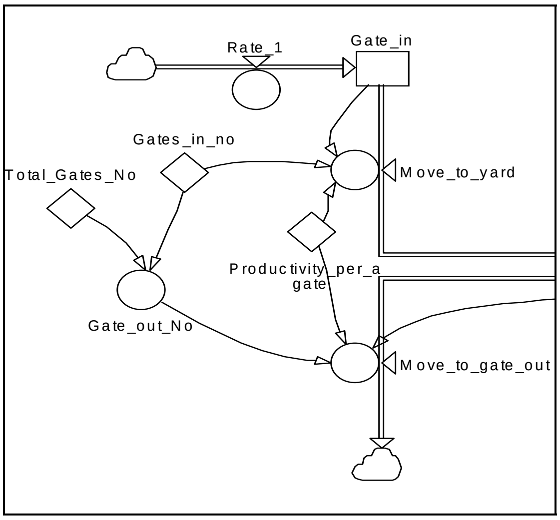


Figure 1. Model of Entrance and Exit Gates

Second, the applicable technologies for operating the gates are defined as man, barcode and RFID. This can also be changed by the user when conducting experiment. Third, the number of the trucks entering through the gates is to be generated through random generator (variables) between 0 and the maximum value that the user allows.

3.2 Quay Area

The quay of terminal was designed as following with making consideration into the entry and departure schedule of vessels. (Fig. 2) First, the vessel anchoring in the quay is one and the scenario for handling cargos of several vessels can be made possible by adjusting the amount of the loaded cargo. However, multi-threaded vessel cannot be used. Second, the structure was designed in such a way that the user can set the amount of cargos to be loaded and unloaded.

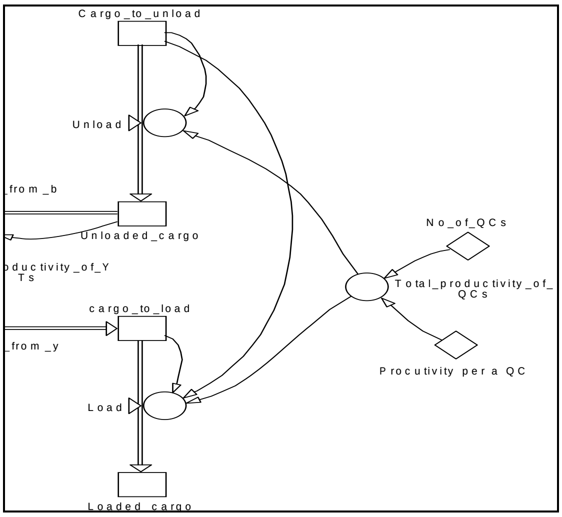


Figure 2 Model of quay loading and unloading

Third, QC in charge of loading and unloading at the quay was defined as 3.

Fourth, the orders of QC operation were defined in such a way that the cargo is to be unloaded from vessel first before loading the cargo from the yard.

3.3 Yard Area

For the yard connected to the quay, the number of YT coming from and going to the quay and yard was defined as 4. Such setting was made because there are various types of YT and the driving speed of YT in the terminal is much lower than its actual maximum driving speed. With such setting, the user can conduct various experiments according to the operation condition of the terminal

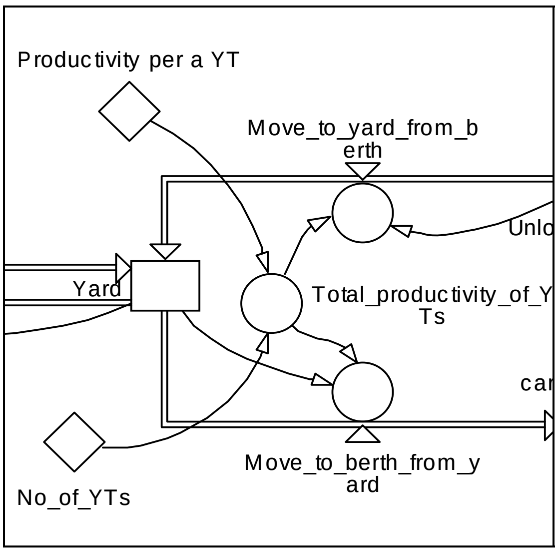
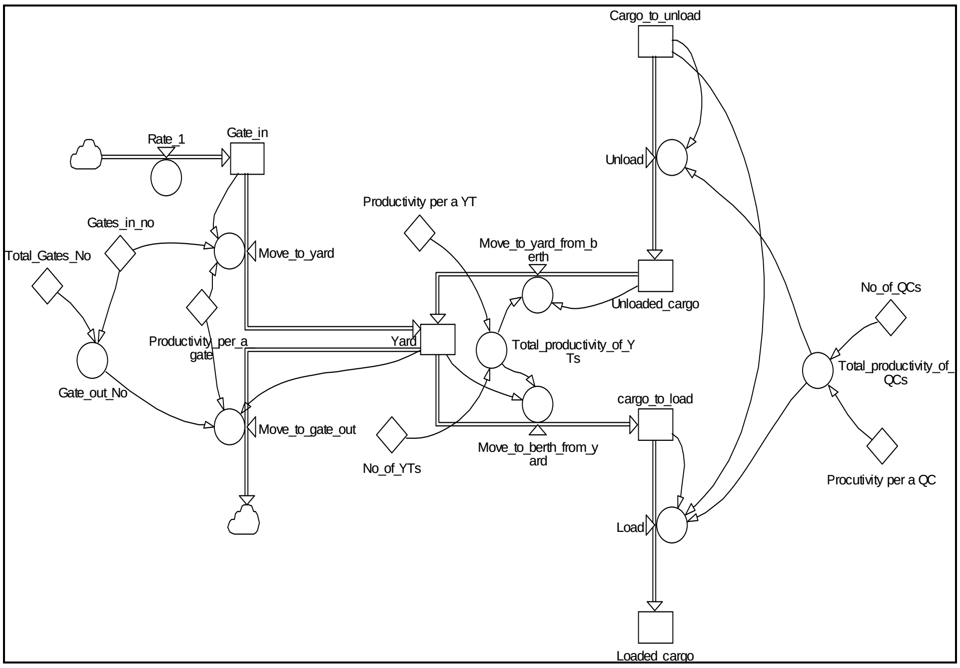


Figure 3 Model of yard arrival and Delivery

3.3 Integration and Embodiment of Terminal Model

Fig. 4 is an integrated model of the each 3 areas – gate, yard and quay. And Fig. 5 shows a simulator screen which enables creation of various scenarios so the user can learn the dynamic internal process of container terminal with the developed model [Fig. 4]. In the screen, the user can compare and analyze the internal dynamics of the terminal that changes according to the changes made to the operation environment (type of device and initial amount of cargos). The features have been designed in such a way that various scenario can be created by changing the type and number of YT (the type can be changed by changing the capacity), gate operating technology (man, barcode and RFID), the number of the trucks entering through the gate, initial amount of cargos stacked in the yard and the initial amount of loaded and unloaded cargos. (Container terminal environment control, upper side of the screen) Other than this, an additional feature is provided enabling the user to compare and analyze the result value of the test conducted through various scenarios using this simulator (Operating analysis of container terminal, lower part of the screen).



Figuer 4. Integrated model of internal process of container terminal

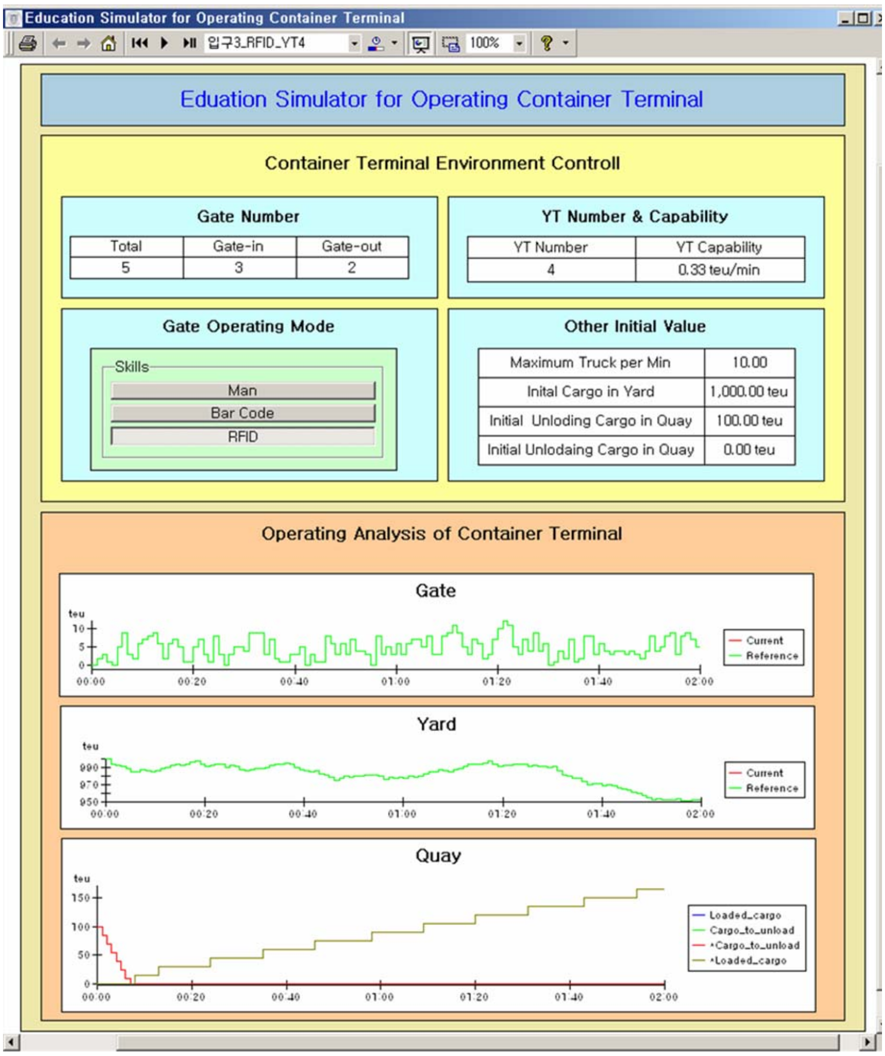


Figure 2 Screenshot of Education Simulator for Operating Container Terminal

4 Conclusion

A study was conducted to develop a simulator enabling users to learn the operation process of container terminal and to observe and learn about the dynamic internal changes of the terminal depending on different environments of terminal operation (technology, initial amount of cargo and etc).The internal process of the container terminal was designed as causational model to facilitate the understanding of the learners. However, this model was developed for the level of the users who are learning about the internal process of the terminal. Therefore, in the following study, the model should be improved by concreting the existing model and adding more technologies for the container operation to make it more realistic. Also, we are planning to carry out performance evaluations in order to improve and complement the problems found in the developed simulator.

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