「한국 시스템다이내믹스 연구」 제5권 제1호(2004.5): 111-126

The Eligibility of Busan Port as A Hub Port in North East Asia

Hong, Eui*

Abstract

Many countries in theNorth East Asia are competing with each other in order to become a centre of international logistics activities.

The competition to become a hub port in Far East region is now fierce. The anticipated investments on improving port facilities and attracting the mega carriers are immense for all the ports in the region and the extent of the effort could cripple the local ports and region's economy given the limited financial resources. It is, however, impossible to avoid the disastrous possibility that the massive investments could be channeled into the port, which will never become a hub port, as no port is ready to currently admit defeat and settle as a small regional port. In an attempt to minimise such disastrous waste of resources, ports need to verify the eligibility of their own.

This paper tests a system dynamics model using the Port of Busan to understand and illustrate the principle guideline of investment decision making for ports.

Keywords: hub port in north east Asia, port of Busan

* Judge Institute of Management Studies University of Cambridge (hongdalcom@hotmail.com)

Ⅰ. Introduction

Ports are important economic catalysts for the countries that they serve. Many ports have traditionally practised what has been termed a "ports business"philosophy, in which the primary focus is on handling goods for ocean carriers.

As the size of vessels carrying shipments between countries has been increasing, two indirect results of this trend have been drawn: investment needed at ports to handle larger-sized vessels and the increased competition between ports to attract carriers making fewer calls (Lyons, 1996). A common belief from industry members as well as researchers is that, with the increase in vessel size, the desire has come for carriers to create hub ports (Hayut, 1981; Foggin and Dicer, 1985). A hub port would serve as the primary intermediary point for shipments being moved across the country's borders. Shipments would be sent to or from other locations by feeder vessels or, more likely, inland transportation services such as rail or road.

In order to become a hub port and attracting more traffic, ports need to realise what are the key factors that affect the port choice behaviour among shippers and carriers. Bagchi (1989) used an analytic hierarchy process to analyse the non-quantifiable factors that affect the selection of carriers, while Tongzon (1995) used quantitative measurements to figure out the competitive factors among ports.

The regional economy and trade development are also crucial point to affect port selection. These provide the basis for a port city to evolve into a hub port, and it is impossible for a hub port to survive fierce competition without securing more volumes of transshipment traffic. The globalisation of production has been triggered by the rapid industrialisation of the Northeast Asia economic region including China, and sustained by substantial capital inflows. This led to a demand from producers for an integrated global multi-modal transportation service to handle rapidly increasing containerised cargoes moving door-to-door to and from the Northeast Asia, and thus, the volume of containerised traffic in this region has increased 11.3% annually (KMI, 2003).

At this point, we present a research model using Port of Busan as an example, which is the geographically centre of the trade and logistics of Northeast Asia. It is located within 1,000km of the port of Osaka in Japan and the port of Shanghai in China, and within 2,000km of Tokyo, Beijing, Hong Kong and Manila. Besides the geographical advantage, the Port of Busan provides excellent services at comparatively low cost in the region. This paper usesa system dynamics methodology, and illustrates the model to test aneligibility of Busan port as a hub port in Far East.

II. Components of Port Selection

We propose three factors that can affect the relative attractiveness of the Port of Busan: (1) the revenue of the Port of Busan, (2) the amount of investment in the Port of Busan, and (3) the amount of investment in competitive ports. Accordingly, this study addresses how to increase the relative attractiveness of Port of Busan.

In Tongzon's study (1995) of port competition performance, he used quantitative measurements such as number of TEU, number of ship visits, number of TEU per ship visit, number of container berths and number of gantry cranes of ports in order to divide 23ports into more competitive and less competitive groups. Based on his measurements, we can suggest that the total volume handled in a port, which implies the revenue of a port can affect relative port attractiveness through the level of investment in the port.

Fleming and Baird (1999) explained why certain ports inevitably develop an edge over their adversaries with 6 factors. They chose the port productivity as one of those factors, and pointed out that the productivity of container ports can be affectedby the amount of land available for stacking and quay length for berthing vessels. Extending the infrastructure of container ports requires a huge investment, and therefore we can propose that a port with a large investment on its infrastructure has more opportunity to become more attractive than its competitors.

According to the globalisation of shipping industry, the customers of ports, i.e. carriers and shippers are showing less loyalty to specific ports in what has become a borderless world as far as commerce is concerned. They move their traffic over routes which offer best outcomes in terms of overall service provision, and this results in altering the destined ports of call (Fleming and Baird, 1999). We can, therefore, forecast that the relative attractiveness of one port is changeable relative to the attractiveness of its competitors. Introduction of new and much larger container vessels can be another reason, which has resulted in changing port preferences, as the required infrastructure may not be available at all ports (i.e. channel depth, gantry crane reach, quay length).

Ⅲ. Methodology

System dynamics modeling is based on the work of Forrester (1968) and formalised more recently by Coyle (1996), Sterman(2000) and Maani and Cavana (2000). By simulating real-world behaviour that may be difficult to capture in static models, the system dynamics approach focuses on how processes evolve over time and how policies might be changed to improve the performance (Garcia et al., 2003).

System dynamics have contributed to decision science by focusing on the notion of a continuous stream of decisions being made by perhaps many actors over time. It is this stress on continuity that may set it apart from the main stream of decision theory that has had a long history of emphasizing how to make the best decision or the best set of decisions under various circumstances. One of the main attributes of system dynamics is its ability to model complex systems in a straightforward and agreeable way, without the extreme mathematical complexity of other forms of simulation.

In the system dynamics modeling, the first step is descriptive. It emphasises policy capturing, based on qualitative and quantitative sources of data. The distinct design stage may entail finding ways to shorten delays and develop new sources of information not initially modeled, but indicated by the model to be effective in dealing with the ongoing problem.

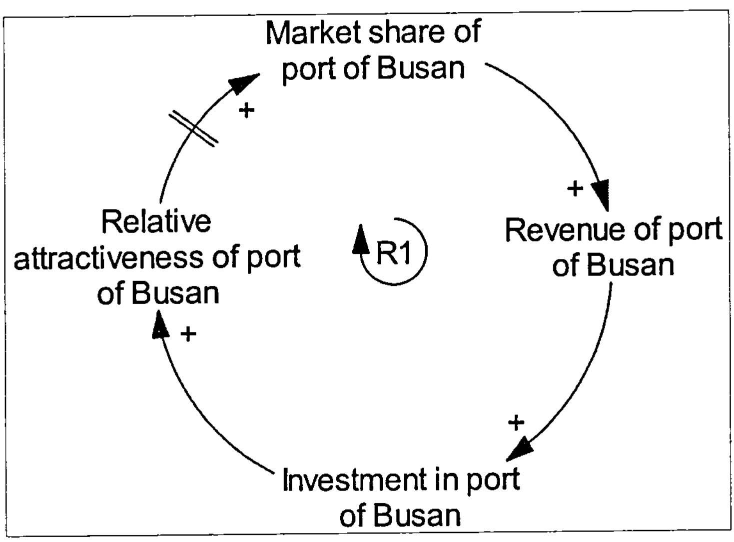
For this study, Vensim programming package (Bentana Systems) was used to build the model of approximate differential equations that represent the dynamic changes occurring in port selection behaviours over time.

The unit of analysis is the relative attractiveness of the Port of Busan. The time unit of analysis is 0.125 year. A 10-year analysis, or 80 times of analysis was entered for the simulation.

The next stage is introducing the model and formalising the relationships between constructs. It would be fair to say that in the initial model-building process, system dynamicists emphasise capturing the policies used in the situation (Morecroft and Sterman, 1994). Policies in the model are reflected by equations and table functions, both of which may represent nonlinear relationships. Decisions for actions and adjustments to changing conditions are based onthose policies. Decisions, when made, are concrete applications of those policies or decision rules. To ensure that variables are meaningful and relationships are observable, real-world observations should be reflected in the modeling as much as possible (Sterman, 2000). Accordingly, the model in this paper is based on real figures from the validated annual statistics.

Ⅳ. The Model

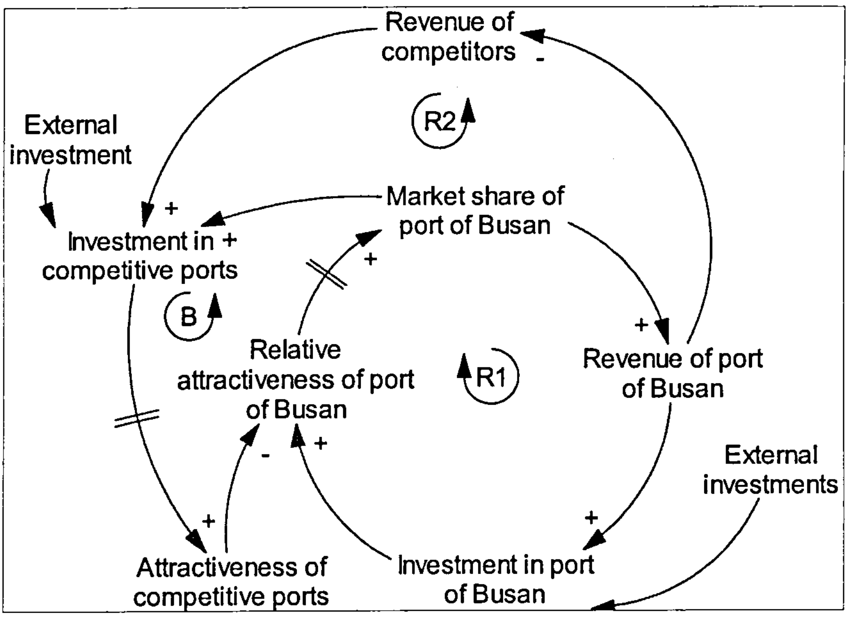
Figure 1 shows the basic premises of the model. The plus or minus notations on the arrow indicate the direction of the relationship between constructs in the model. The plus signs shows that the two variables move in the same direction; that is, if the first becomes bigger, then the second one will also become bigger and vice versa. A minus sign (see Figure 2) indicates that thetwo variables move in different directions; that is, if the first variable becomes bigger then the second variable will become smaller and vice versa. The number of plus and minus signs around a loop indicates the polarity of the loop. An even numbers indicates a positive or reinforcing loop while an odd number indicates a negative or balancing loop. The arrow with double line in the diagram means time delays between taking a decision and its effects on the state of the system are common and particularly troublesome. Delays in feedback loops create instability and increase the tendency of systems to oscillate. As a result, decision makers often continue to intervene to correct apparent discrepancies between the



[Figure 1] General casual model

desired and actual state of the system long after sufficient corrective actions have been taken to restore the system to equilibrium.

The first feedback loop is reinforcing (R1) and positive. This loop shows how it is possible to raise the attractiveness of Port of Busan over time. According to this diagram, the attractiveness of Port of Busan expands the market share of the port since more traffic volume comes to the port to enjoy its attractiveness such as better service or low charges. The bigger market share brings the higher revenue than competitive ports. As revenue increases, the likelihood of investment in the port becomes bigger. With sufficient investments, Busan can supplement the port facilities and achieve the higher service level and result in becoming a more attractive port, but it takes some time.



[Figure 2] Expanded model with competition

Figure 2 illustrates an expanded model with 2 more feedback loops included. Determining the polarity of a loop is important in order to trace the effect of a small change in a variable as it propagates around the loop. Starting from any variable, if the feedback effect reinforces the original change, it is a positive loop; if it opposes the original change, it is a negative loop.

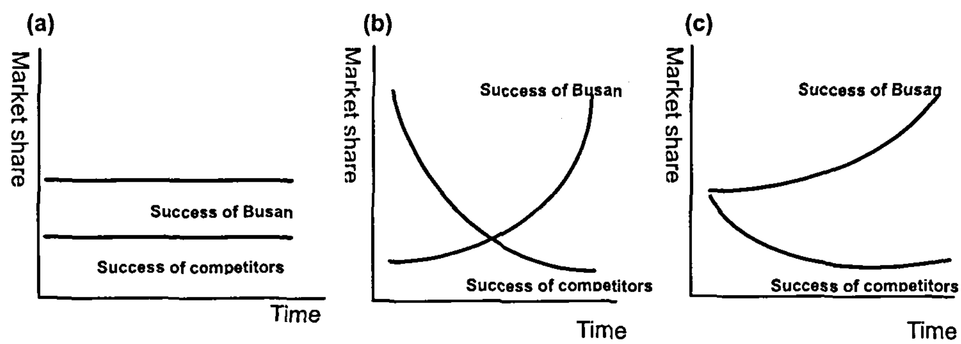
The second reinforcing loop, R2, is positive, includes the revenue of competitive ports that influences on the level of investment in them. In this loop, the revenue of competitive ports feeds back to attractiveness of them with the external investment.

The balancing (or negative) loop is labelled B. Negative feedback loops are characterised by goal-directed behaviour. "Such terms as self-governing, self-regulating, self-equilibrating, homeostatic, or adaptive, all imply the presence of a goal, define negative feedback systems" (Goodman, 1974, p.37). In the system modelled here, an increase in the market share of the Port of Busan is likely to spur competitors to increase the level of investment in their ports. Greater investment in other ports with external investment makes their ports more attractive after a time, thus reducing the relative attractiveness of Port of Busan.

Similar to the "Success to the successful archetype" (Senge, 1990), the archetype in *Figure 2* can produce the three types of behaviour like in figure 3(a), (b) and (c).

The first behaviour, (a) shows the attractiveness of Port of Busan and its competitors remain stable and are not changed in the long term. It happens very unlikely in the real world and it requires the same investment and conditions either for Busan and other competitive ports for a long period to come true.

The second and third behaviours, (b) and (c) explain the attractiveness of Busan goes up while the competitors' decline as time goes by. We can cite the "first-mover's advantage" as one reason why the port needs to start the reinforcing loop (Figure 1) sooner than its *competitive ports with the investment. By doing so, the port can deprive the competitors of* its advantage and thus, it becomes a more attractive port.



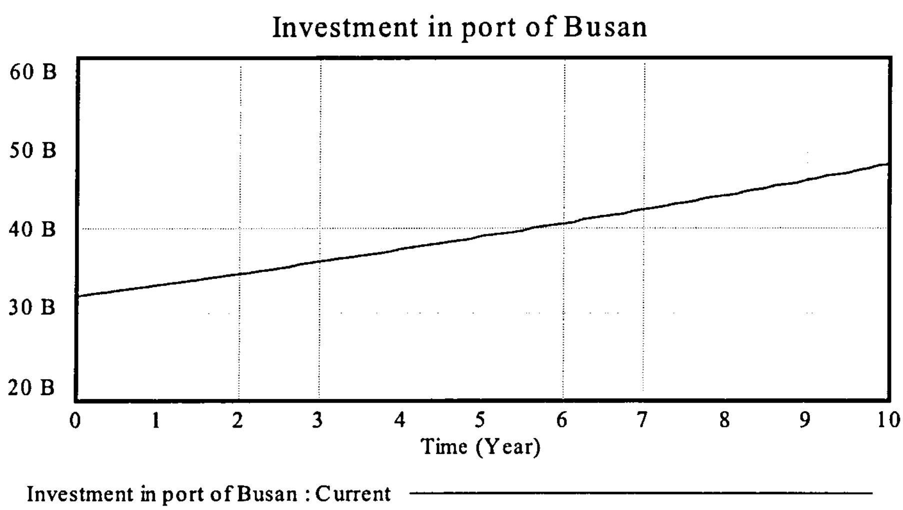
[Figure 3] The dynamics behaviours of port of Busan and competitive ports

The simulation model of this study in the form of a stock and flow diagram is added as an appendix. Stocks and flows the accumulation and dispersal of resources- are central to the dynamics of complex systems (e.g. A population is increased by births and decreased by deaths). However, research shows that people's intuitive understanding of stocks and flows is poor. In the stock-flow problems, many people drew trajectories that violated basic laws of physics such as conservation of matter (Sweenery and Sterman, 2000).

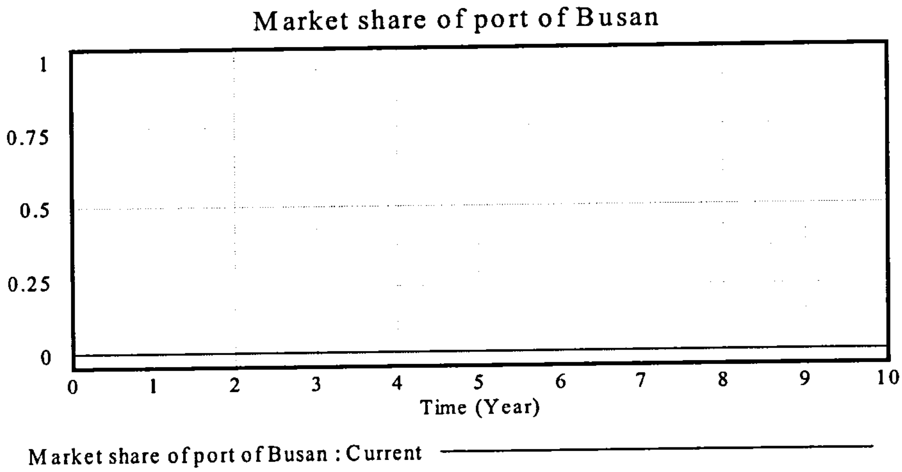
V. Analysis and Results

To highlight the dynamics of the simulated system, we first establish the model's base case as outlined in Figure 1.

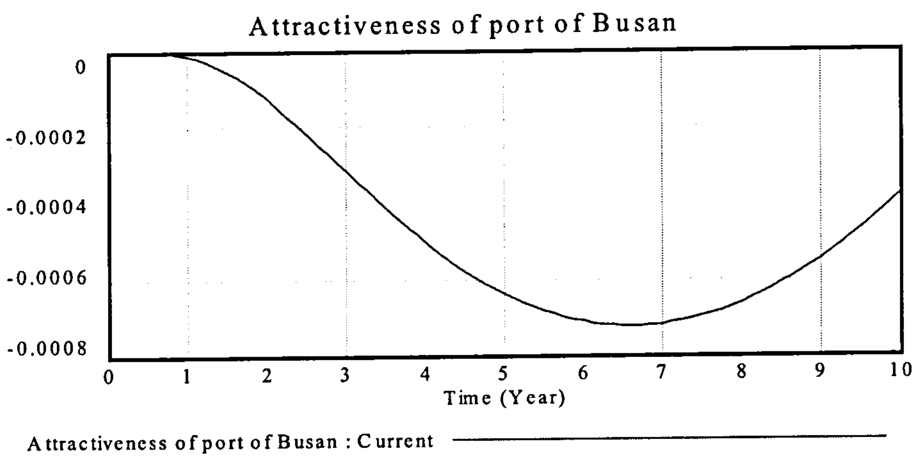
In the simulation run, investment in Port of Busan is steadily increases according to the growth of gross margin (Figure 4). And its market share remains at the same level of 4.4% (KMI, 2003) of world container shipping market (Figure 5). The attractiveness of Port of Busan, however, decreases for more than 6 time units, and this is affected from investment level in competitive ports (Figure 6).



[Figure 4] Increase of investment level in port of Busan before the kick-start

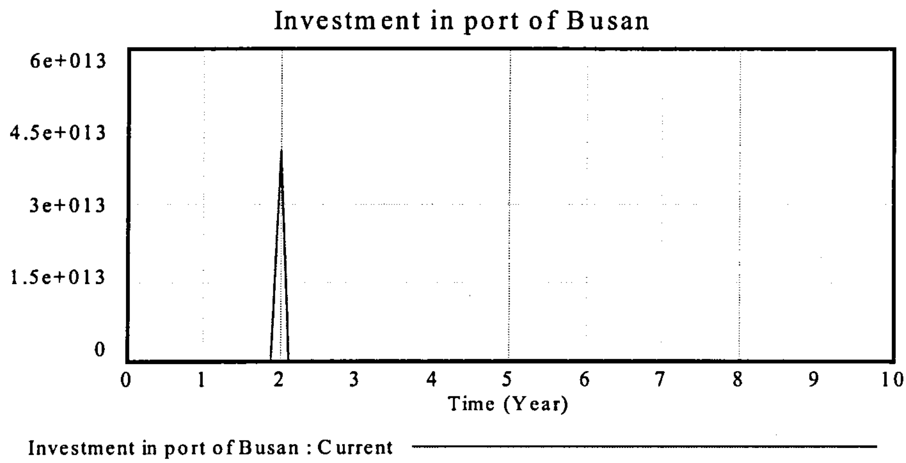


[Figure 5] Trend of market share of port of Busan before the kick-start



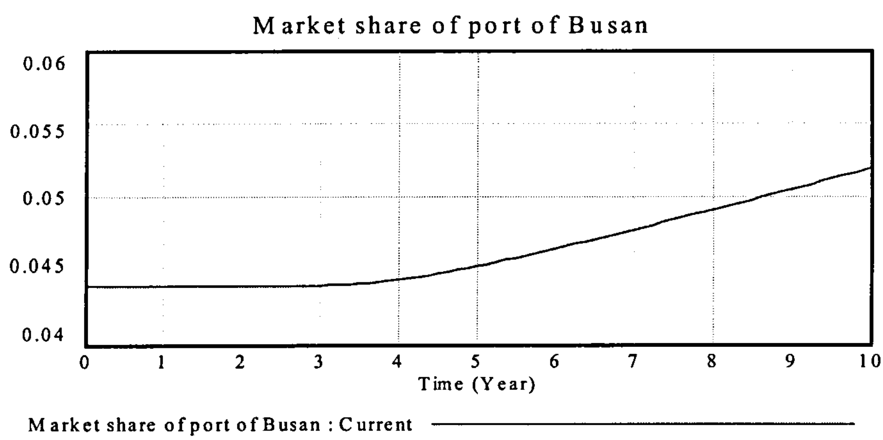
[Figure 6] Changes in attractiveness of port of Busan before kick-start

At the second year, we decide to kick start the amount of investment in the Port of Busan in order to see whether market share and the attractiveness can be boosted up by raising the investment. The attractiveness of the port continuously increases for next six years as a result. The market share of Port of Busan, however, does not change during the next year, but then it goes up moderately.

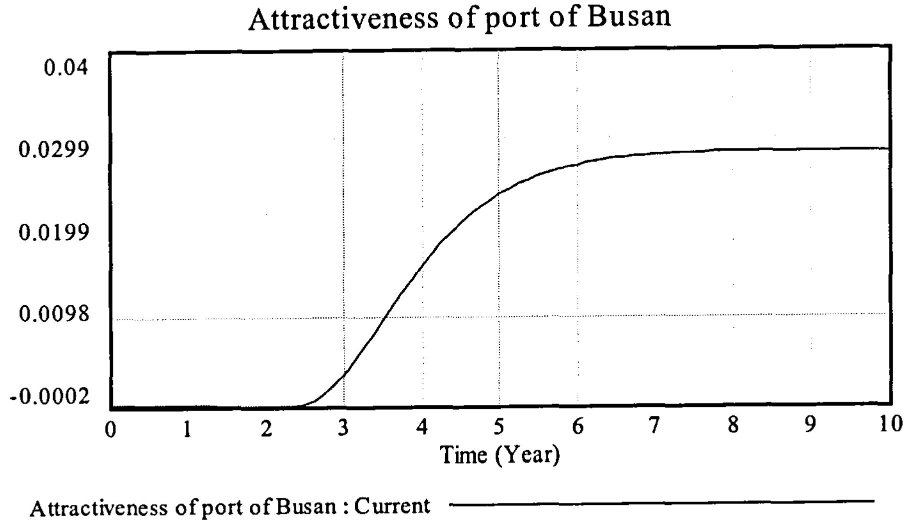


[Figure 7] Kick-start of investment in the port of Busan at year 2

This verifies the time delay between investment and increase of market share as it is explained before. Figure 7, 8 and 9 display the kick-start in the investment and changes of attractiveness and market share of Port of Busan respectively.



[Figure 8] Increase of market share of the port of Busan with time delay after the kick-start



[Figure 9] Increase of attractiveness of port of Busan after the kick-start

We consider exogenous influences from other competitive ports in the expanded model, and they are 'revenue of competitors', 'investment level in competitive ports' and 'attractiveness of competitive ports'. In order to make the simulation simple and to focus on the investment decision making about Port of Busan, we assume no change in investment patterns in competitive ports.

The results from the simulation suggest Port of Busan increasing its investment level in the port not only to become a more attractive port, but also to increase its productivity to match the speed of growing total traffic volume and attract larger-sized vessels in the world trade market.

Ⅵ. Conclusion and Remarks

Korean Government had decided to expand capacity of the Port of Busan by developing the Busan New Port, with investing £275,000,000, and it was planned to be completed by 2011. The decision was prompted by the prospect of economic growth in Far East region and South Korea's aim to become a hub port in the region. In order to ensure Port of Busan becomes a hub port after investing large amount of money and to provide portswith a basic guideline of investment, we designed a system dynamics model of relative attractiveness of a port and simulated it with several variables, using the Port of Busan as our example.

The results show that without aremarkable increase in investment level, the Port of Busan would not be able to increase its attractiveness to the customers or to expand its market share. It is, therefore, suggested to bring major investments into the port to compete with other ports and to achieve its goal of becoming a hub port in the Far East.

However, the research model of this paper is brief and remains at the primary stage. Considering more relevant factors, which are required essentially to become a hub port, such as service quality, connection with inland transportation, number of MNEs' branches in the hinterland, etc. is strongly recommended. Limiting the various changes from other ports in North East Asia, such as Shanghai or Kobe reduces the validity and substantiality of the model. But, this model is still logical enough to show the importance of understanding the feedback structure of port attractiveness and growth. Considering external factors from competitive ports with the updated statistics data is required to winnow the most qualified hub port in the Far East region.

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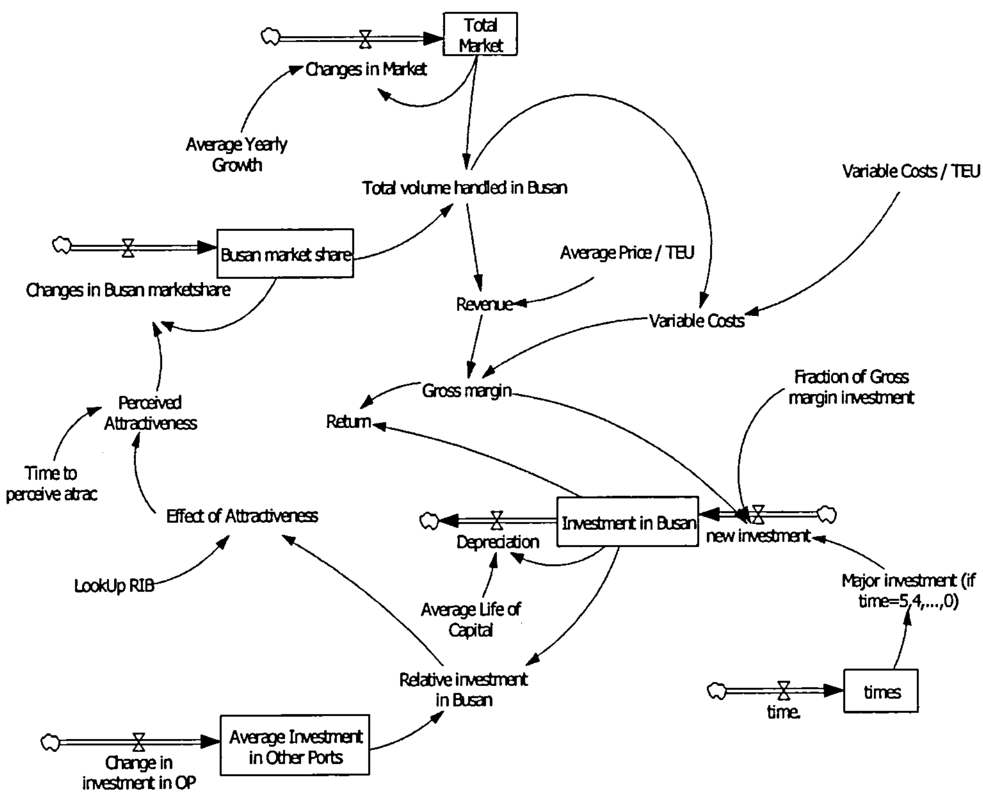
[Appendix 1 : Simulation Model]



[Appendix 2 : Equations]

(01) Average Investment in Other Ports= INTEG (Change in investment in OP, 4e+011)

Units: **undefined**

(02) Average Life of Capital=10, Units: **undefined**

(03) "Average Price / TEU"=1.76403e+008, Units: **undefined** price per 1000 TEU

(04) Average Yearly Growth=0.04 Units: **undefined**

Yearly growth rate as a fraction of existing

(05) Busan market share= INTEG (Changes in Busan marketshare, 0.044)

Units: **undefined**

Busan market share of world total

(06) Change in investment in OP=0 Units: **undefined**

(07) Changes in Busan marketshare=Busan market share*Perceived Attractiveness

Units: **undefined**

(08) Changes in Market=Average Yearly Growth*Total Market

Units: **undefined**

(09) Depreciation=Investment in Busan/Average Life of Capital

Units: **undefined**

(10) Effect of Attractiveness=LookUp RIB(Relative investment in Busan)

Units: **undefined**

(11) FINAL TIME = 10 Units: Year

The final time for the simulation.

(12) Fraction of Gross margin investment=0.5

Units: **undefined**

(13) Gross margin=Revenue-Variable Costs

Units: **undefined**

(14) INITIAL TIME = 0 Units: Year

The initial time for the simulation.

(15) Investment in Busan= INTEG (+new investment-Depreciation, 4e+011)

Units: **undefined**

(16) LookUp RIB([(0.5,-0.03)-(1.5,0.03)],(0.506116,-0.0197368),(0.61315,-.00947368),(0.738532,0.00447368),(1,0),(1.15749,0.0142105),(1.28899,0.0244737),(1.42049,0.0292105),(1.49694,0.0284211)). Units: **undefined**

(17) "Major investment (if time=5,4,...,0)"= IF THEN ELSE(Tim=2, (5e+012/0.125), 0)

Units: **undefined**

(18) new investment=(Gross margin*Fraction of Gross margin investment)+"Major investment (if time=5,4,...,0)" Units: **undefined**

(19) Perceived Attractiveness=DELAY3(Effect of Attractiveness, Time to perceive atrac)

Units: **undefined**

(20) Relative investment in Busan=Investment in Busan/Average Investment in Other Ports

Units: **undefined**

(21) Return=Gross margin/Investment in Busan

Units: **undefined**

(22) Revenue="Average Price / TEU"*Total volume handled in Busan

Units: **undefined**

(23) SAVEPER = TIME STEP Units: Year [0,?]

The frequency with which output is stored.

(24) ti= 1 Units: **undefined**

(25) Tim= INTEG (ti,0) Units: **undefined**

(26) TIME STEP = 0.125 Units: Year [0,?]

The time step for the simulation.

(27) Time to perceive atrac= 2 Units: **undefined**

(28) Total Market= INTEG (Changes in Market,9990)

Units: **undefined**

Units: in'000 TEU

(29) Total volume handled in Busan= Busan market share*Total Market

Units: **undefined**

(30) Variable Costs=Total volume handled in Busan*"Variable Costs / TEU"

Units: **undefined**

(31) "Variable Costs / TEU"=3.1046e+007 Units: **undefined**

논문접수일: 2004. 3. 26 / 심사완료일: 2004. 4. 30