An Analysis of the Effect of Sharing Economy Introduction to SMBs using the Simulation Method: Focusing on the Business of a Joint Distribution Center

HYUNG RIM CHOI, CHANG HYUN PARK, KANGBAE LEE, SOON GOO HONG, MIN JE CHO

***Abstract*—**As the competition among enterprises is increasingly being intensified, the SMBs are faced with difficulties in securing the necessary resources such as manpower and facilities. To solve these difficulties, the introduction of sharing economy among enterprises, which can solve the difficulties in securing resources by mutually sharing the surplus resources, is being studied. Sharing economy in the past was mainly focused on that between individuals, and the sharing economy between enterprises is also not a new concept but it had already existed in the form of cooperation, outsourcing, etc. With the development of information technology, the sharing economy between enterprises will have a greater ripple effect than ever. However, it is still in its early stage even with no establishment of the concept. Accordingly, to activate the sharing economy between enterprises, the effect of sharing economy introduction needs to be analyzed. In this study, a simulation model was constructed targeting a joint distribution center, a representative case of sharing economy, to analyze the effect of introducing the concept to enterprises. In particular, this study analyzed the introduction effect by carrying out the experiments on joint space utilization and on a transportation business that shares vehicles.

***Keywords*—**Distribution Center, Simulation, Sharing Economy.

I. INTRODUCTION

THE increasingly fierce competition among businesses add to the difficulties small and medium enterprises (SMEs) already have securing the necessary human resources, technology, and funding. SMEs are making diverse attempts to overcome these challenges. Some of their problems may be solved by introducing sharing economy [1].

A sharing economy encompasses cooperative activities through which individuals or organizations lend their private resources or services to other individuals or organizations, or make co-investments into the acquisition of such resources and services. The literature on the topic has so far focused on the individual level, but the concept is expanding to include other actors as well. The concept of sharing economy continues to gain growing implications thanks to the progress of information technology and personal networking. Sharing economy is not a novelty to businesses, as countless businesses worldwide today are already familiar with the ideas of common facilities, collective purchases, and collective shipping and handling [2].

A good example of sharing economy at the corporate level is the distribution center. By erecting a distribution center, the participating businesses effectively share their resources for storing, shipping and handling their goods. In order to foster sharing economy at the corporate level, it is crucial to develop and provide a quantitative index of performance to help participating companies anticipate and analyze the possible benefits and effects. Economic analyses, feasibility studies, and simulations are tools commonly employed to this end. Of these instruments, we need to pick simulation, as it is the optimal tool for predicting possible effects of sharing economy with relatively greater accuracy, and for accounting for all the available alternatives with respect to the required processes of operation. For the effects and outcomes of sharing economy may vary significantly depending on how it is run.

Simulations hold an advantage over the optimization method, which involves deterministic models, because they better account for variability. By analyzing diverse scenarios of external change, and producing quantitative results, simulations boost decision-making and provide clear solutions[3][13]. Computer modeling is also a cost-effective way for gathering data similar to those one could obtain from the actual world. Nevertheless, we need better alternatives for analyzing how the system would react to changing problems in

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either the system itself or the surrounding situation, and for solving the problems uncovered by system-level analysis[4] [14] [15].

The simulation researchers include Wen Wang (2013), Qiao Xiong (2013), etc. Particularly in the research by Wen Wang (2013), the storage cost and customer satisfaction in an automobile supply chain network, etc. were analyzed using the simulation method. To analyze the importance of the role of warehouse management in a distribution system, Qiao Xiong conducted the experiments for various situations using MATLAB simulation. To improve the efficiency of the urban taxi system, Xudong Zhu (2013) analyzed the behaviors of vehicles and guests by creating a simulation-based taxi management system.[10][11][12]

In order to predict and analyze the possible effects of sharing economy among SMEs, this study focuses on how the common spaces and shipping and handling tasks at a distribution center are used. To this end, a model of the spatial arrangement and common shipping and handling tasks at the center was developed. The simulation model then tested how the effects and benefits of the center differed depending on external changes. Section 2 of this study discusses the common spaces and common shipping and handling tasks at the logistics center in detail. Section 3 presents the simulation model used to analyze these elements. Section 4 details the effects of sharing economy as captured by the simulation model and analysis. Section 5 sums up the findings and conclusion.

II. Analyzing a Case of Sharing Economy

A. Overview

To predict and analyzes the possible effects of corporate sharing economy, this study analyzed a distribution center through simulation. Company B was established in 1992, and specializes in the storage and shipping and handling of a wide range of parts, tools, and equipment for shipbuilding. The logistics center is 25,740m2 in total area, and caters to 325 businesses in total (as of October 2012). In addition to storage, shipping and handling, Company B also provides education and training on corporate partnerships.

The shipbuilding materials and parts Company B handles can be mainly divided into five types: namely, pipes, machinery, engine parts, design elements, and electric-electronic parts. These goods vary widely in size and forms, and range from tiny screws to gigantic engines for massive ships. In addition to the extreme diversity of the goods required for shipbuilding, the relative unpredictability of the demand for these goods and the difficulty of shipping and handling them individually have led to the creation of this distribution center.

B. Spatial Layout

The overall space of Company B can be divided between the indoor area and the outdoor area. The storage yard and the rooftop are located outdoors, while the indoor area includes the first two floors of the building and the bonded warehouse. See Table 1. for a breakdown of the spatial layout.

Table 1. Breakdown of the Space at the Common Logistics Center

Type	Space	Area (m2)
Distribution center	Storage yard	7,600
	Rooftop area	5,619
	First floor	5,454
	Second floor	5,454
	Bonded warehouse	660
	Total	24,793

Heavier objects are stored on the first floor, and lighter ones on the upper floor. Clients sign individual contracts to secure certain parts of the available storage space to keep their goods.

C. Utilization of Joint Warehouse Space and Transport & Delivery Business

For our purposes, we may define common shipping and handling tasks as involving planning, sorting, and other such activities performed by a distributor who caters to multiple clients according to a system that is designed to minimize the cost of logistics, overcome the shortage of labor, and maximize the efficiency of delivery vehicles in operation [5].

There are mainly five types of common shipping and handling tasks, as listed in Table 2. The literature on these tasks consists of the study by Kim Seong-bong and Lim Seok-cheol, who together have conceptualized inter-regional models of common shipping. Kim et al. formulate a model of common shipping and a method for analyzing its effects.

Table 2. Types of Common Shipping and Handling Tasks

Type	Characteristics
Specific-shipper tasks	*The shipper decides the loading, unloading, shipping and delivery of the goods of the same category.*
Common-distributor tasks	*Multiple distributors divide a given region into multiple districts to load, unload, and deliver goods from unspecific shippers.*
Common delivery tasks	*Multiple shippers share the same distributor to handle tasks leading up to a given logistics center only.*
Common collection-line tasks	*The same lines for collecting goods are shared, or goods are transferred to the line operator designated by the shipper.*
Supply agency tasks	*The recipient of goods decides how the goods are to be delivered to end users or final clients.*

They compare the individual shipping model to the common shipping model they suggest by analyzing the fluctuations n the cost according to the distribution of cargoes, the number of manufacturers or clients involved, and the changes in the distances between the distribution center, clients, and manufacturers. They apply their simulation model to the case of shipping architectural coatings, and determine the number of nodes and links to be involved in creating an optimal logistics network that minimizes the quantities of inventories, the shipping and handling cost, and the delivery time [6][7][8][9].

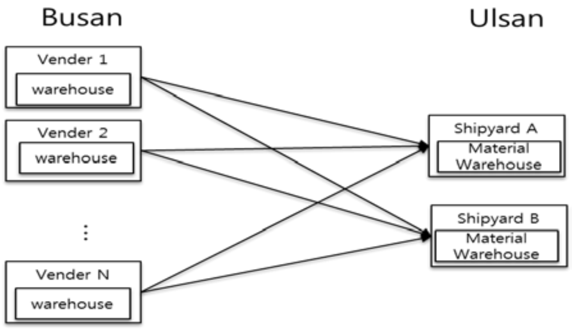

Fig. 1 Before the Establishment of the Joint Warehouse

Before the establishment of the joint warehouse of 'B' company in the past, the shipbuilding material manufacturers used the transport and delivery method as shown in Fig. 1 After receiving orders from shipbuilding yards, the individual shipbuilding material manufacturers produce the materials, store them in their individual warehouses, and deliver them to the shipbuilding yards located in the heavy industrial region using their individual trucks.

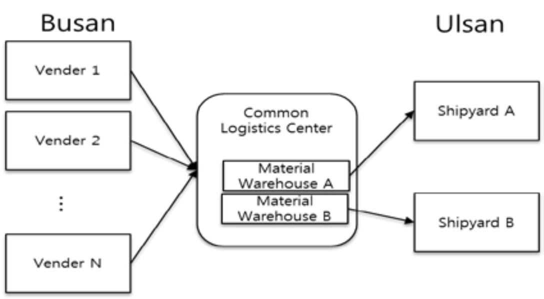

Fig. 2 After the Establishment of the Joint Warehouse

After the establishment of a joint warehouse, the equipment and materials produced by individual manufacturers are first delivered to the joint warehouse of 'B' company and then they are delivered to each shipbuilding yard, differently from the direct delivery of the materials to the shipbuilding yards by the manufacturers. At this time, the joint warehouse assigns the storage space for each shipbuilding yard for storage of the materials delivered by each manufacturer and then delivers the materials to the shipbuilding yards according to their proper delivery time.

Currently, the delivery is operated by an outsourcing transport company 'S'. The operation system has been well prepared but the relevant companies are not using the joint warehouse properly because they are worrying about exposure of confidential information. Therefore, a complete form of joint transport and delivery is not conducted due to the difficulty of integrated or mixed freight transportation for joint transport and delivery. So to apply and expand the joint transport and delivery, the effect of joint transport and delivery should be forecasted and it should be examined whether the current warehouse space utilization as well as the current transport and delivery system are the optimum methods of operation. To check this, a simulation model that can accurately evaluate the current operational situation in detail was developed.

III. Data Collection and Simulation Modeling

To develop an effective simulation model, the ARENA simulation software was used. This is a tool designed to help users develop and experiment simulation models with respect to a variety of subjects. ARENA is especially popular in research on developing schedules for factory operations and analyzing the performance of automobile assembly lines because the program facilitates the comparison and analysis of performance indicators according to a given order of priorities. It also helps to develop and analyze effective models for automobile assembly lines. In addition, ARENA is also frequently used in research involving the evaluation and development of effective supply chain management systems for SMEs [3][4].

A. Basic Assumptions

Goods produced by different manufacturers are stored first in the common warehouse before they are shipped to shipyards. These goods can be mainly divided into five types: namely, pipes, machinery, engine parts, decorative elements, and electric-electronic parts. The transportation vehicles that enter and leave the distribution center are those of the manufacturers supplying goods individually.

Five-ton trucks are usually used to bring goods into the center; 11-ton ones, for taking goods out of the center. In some cases, however, one-ton trucks may be used as well. This study confines its scope to the two former types of trucks—five- and 11-tons—only, while presupposing that the number of each type of trucks used can vary with great flexibility. Legal maximum rates are applied to calculate the loading rates.

Maximum loading rate = tonnage × 1.1(legally permitted loading rate)

The warehouse storage cost is shown in Table 3 below. Before the introduction of the joint distribution center, the individual enterprises used to store the products in their own warehouses or in the warehouses of professional warehouseman after paying a certain amount of money. As the qualitative cost cannot be calculated when the products are stored in the warehouses of the individual enterprises, the use of the warehouses was applied en bloc assuming that the cost arises according to the use of space when the products are stored in a specific place.

Table 3. Warehousing costs

Warehouse	**Joint distribution center**	**Renter**
Storage cost	*KRW 4,727*	*KRW ,576*

B. Data Input

The data entered in the early phase of simulation modeling concern the warehouse space, the storage duration, the number and types of vehicles entering and leaving the center each day, and the shipping cost. The distribution center, as described earlier, is divided between the indoor space and the outdoor one. The bonded warehouse is located outside the main building. Goods are stored for seven to 30 days. This study supposes an equal distribution of the storage durations of different goods.

In order to determine the varieties of goods to be simulated, interviews were held with employees of Company B and the distributions of the varieties, frequency, and sizes of the goods were obtained, as shown in Table 4. Each type of goods was also given a production cycle. The number of working hours per day is eight.

Table 4. Entered Data by Type of Shipbuilding Goods

Type	Proportion	Production cycle	Size distribution (0.2 to 22m^2)
Pipes	*30%*	*15*	*TRIA(0, 6, 22)*
Machinery	*20%*	*20*	*TRIA(0, 14, 22)*
Engine parts	*10%*	*25*	*TRIA(0, 2, 22)*
Decorative elements	*30%*	*15*	*TRIA(0, 18, 22)*
Electric-electronic parts	*10%*	*25*	*TRIA(0, 10, 22)*

Company B ships these goods mainly to three regions. Shipyards, the main clients of the company, are concentrated in these three regions. The level of demand varies widely from region to region (Table 5). Common handling is required in order to ensure that different goods be delivered to the right location on the right date.

Table 5. Proportions of Goods by Shipping Destination

Region	1	2	3
Proportion	40%	30%	30%

The material & equipment companies registered at B Company are located largely in 5 different areas. As shown in Table 6 below, the distance from each area to the shipyard was calculated to measure the transportation distance before the introduction of the joint distribution center. The transportation distance is divided into 120km, 100km, and 80km, depending on the location of the individual material & equipment companies.

Table 6. Distance of before the Establishment of the Joint Warehouse

Start point	Destination	Distance(km)
A area	shipyard	120Km
B area	shipyard	100Km
C area	shipyard	100Km
D area	shipyard	80Km
E area	shipyard	80Km

Table 7 shows the transportation distance after the introduction of the joint distribution center. The individual companies located near the joint distribution center transport the materials and equipment they produced to the joint distribution center, which gathers the materials & equipment with an imminent delivery date and with the same destination and transport them jointly to the relevant shipyards.

Table 7. Distance of After the Establishment of the Joint Warehouse

Start point	Destination	Distance(km)
A area	*center*	*35Km*
B area	*center*	*5Km*
C area	*center*	*20Km*
D area	*center*	*20Km*
E area	*center*	*30Km*
Center	*shipyard*	*100Km*

C. Simulation Model

As shown in Fig. 3, the simulation model is divided into a number of modules, including: the transfer module, the warehouse operation module, the shipping module, the shipyard process module, and the statistics saving module.

The vehicle entry module assumes that the 150 manufacturers will produce at least one of the five types of goods. As shown in Fig. 4, these manufacturers produce the five types of goods, which are then stored in the warehouse. The goods can be further divided into two types depending on how they are warehoused. The first type includes goods that manufacturers individually store without or before using the distribution center. These manufacturers keep the goods they produce in their own warehouses before shipping them to shipyards.

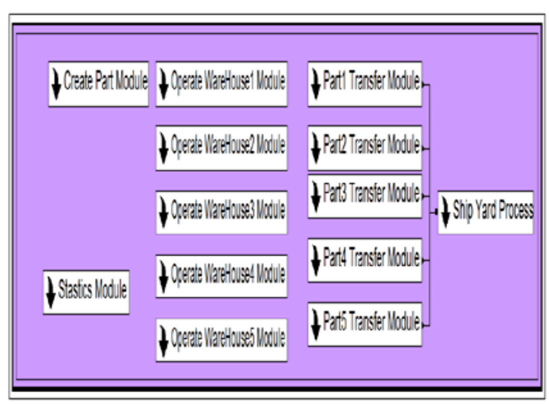

Fig 3. All the Modules in the Simulation Model

The second type includes goods that are stored at the distribution center before they are shipped to shipyards on due dates. The simulation compares the costs of both ways of storing goods and analyzes the effect of using a common storage space.

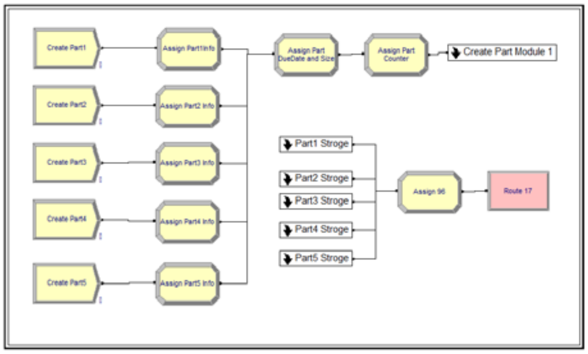

Fig 4. Entry Vehicle Module

Once the goods to be warehoused are created, the simulation model determines the dates on which they are to be shipped. The shipping and handling process in this model assumes that all the goods that are due are shipped on the same day using 11-ton trucks.

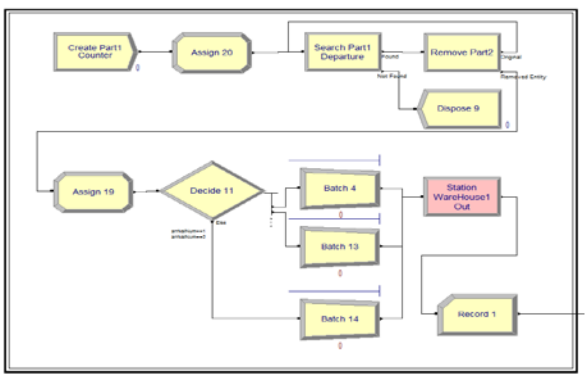

Fig 5. Exit Vehicle Module

The exit vehicle module models the process in which goods are taken out of the distribution center and shipped to shipyards. The simulated system searches goods that are due for shipping as of the current date, and stores them in temporary storage spaces arranged according to destinations, before shipping them to the destinations using designated vehicles. The statistics saving module saves the data on the daily ins and outs as well as common shipping and handling of goods everyday to help calculate the shipping cost.

IV. Modelling Outcome

In this chapter, the efficiency of the storage and delivery system done through the joint warehouse compared with individual storage and delivery by each material manufacturers was analyzed, and the variability of warehouse storage according to the increase of cargo traffic before and after the establishment of the joint warehouse and the number of transport trucks that do not affect the capacity of the warehouse storage with the increase in cargo traffic were measured through experiments.

A. Comparison of Space Utilization

A simulation experiment was conducted to measure the warehouse storage for the same production plan before and after the establishment of the joint distribution center.

Fig 6. shows the comparison of the whole storage costs before and after the establishment of the joint distribution center. The result of the simulation showed that the operation of a joint distribution center can lessen the movement to and from the warehouse storage and can store the materials & equipment using less space than the storage of materials & equipment in the warehouses of the individual companies. When the warehouses were operated individually, a daily average cost of KRW 895,937,760 (18,260㎡) was incurred but when the warehouses were operated jointly, a daily average cost of KRW 269,278,282 (56,966㎡) was incurred, which showed a savings of about 70% from an economic perspective and a savings of about 48% from a space utilization perspective.

In addition, the dispersion value of the warehouse storage for individual companies is 249,316,512, which is greater than 98,874,050, the dispersion value of joint storage. This indicates that operating or renting the warehouse by individual companies produces more phenomena of space wastage or shortage than jointly operating the warehouses

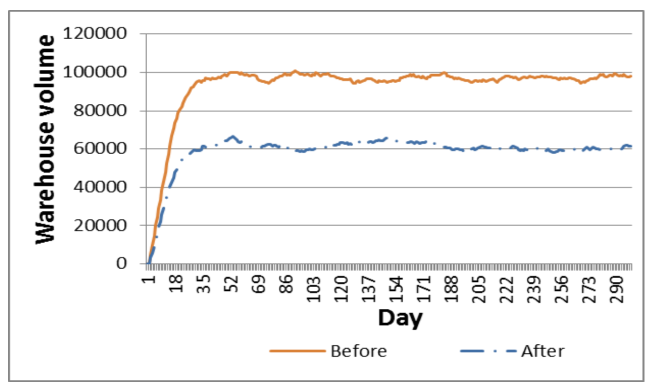

Fig 6. Comparison of Space Usage

B. The Effect of Joint Transport and Delivery

This study examined the warehouse storage before and after the establishment of the joint warehouse, which is maintained based on the cargo traffic, regardless of the number of trucks, by sufficiently allocating the trucks necessary for delivery. Fig. 7 shows the number of delivery that occurs before and after the establishment of the joint warehouse based on the volume of storage indicated on Fig. 7

The daily average number of delivery was 180 before the establishment of the joint warehouse and 40 after the establishment of the joint warehouse. As the equipment and materials produced by individual manufacturers were directly delivered to the shipyards before the establishment of the joint warehouse, they were more frequently delivered to shipyards than when they are first stored in the joint warehouse and then the materials with the same destination are jointly delivered to the relevant shipyards.

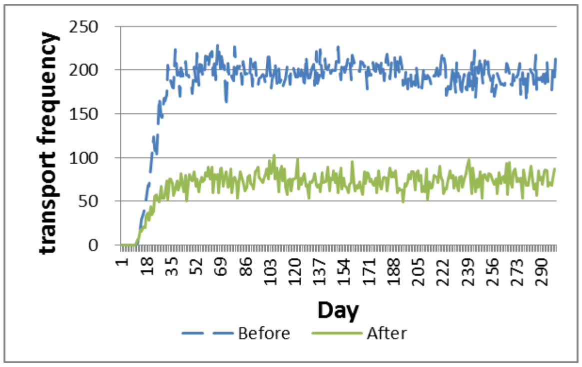

Fig 7. Comparison of Shipping Instances

Fig 8 shows that the whole transportation distance of the transportation vehicles also decreased by about 37% after the establishment (about 7,500km) from before the establishment (about 18,000km). This shows that it is more economical in distance for individual companies to deliver their products en bloc to a nearby joint distribution center and let the joint distribution center transport the necessary materials & equipment to the relevant shipyards than to deliver them directly to the shipyards after traveling long distances.

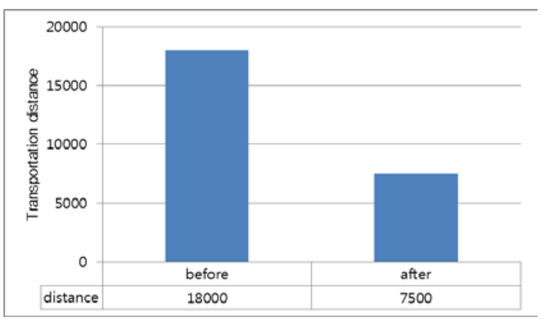

Fig 8. Comparison of the average Transportation distance

To compare the warehouse storage according to the establishment of the joint warehouse regardless of the number of delivery trucks, the above experiments were conducted by allocating a sufficient number of delivery trucks. As the joint warehouse is actually operated using a limited number of delivery trucks, this study tried to obtain the minimum number of delivery trucks that do not increase the warehouse storage space used.

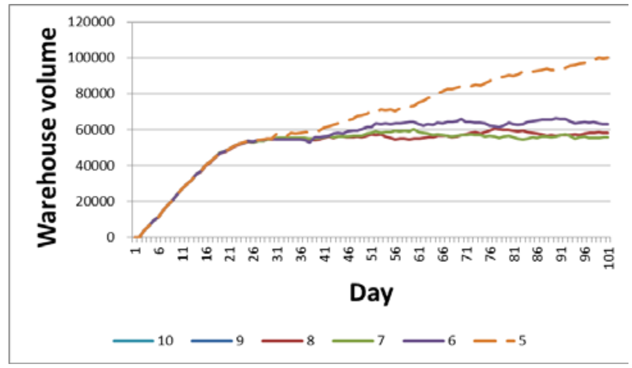

Fig 9. Volume of Warehouse Storage before the Establishment of the Joint Warehouse

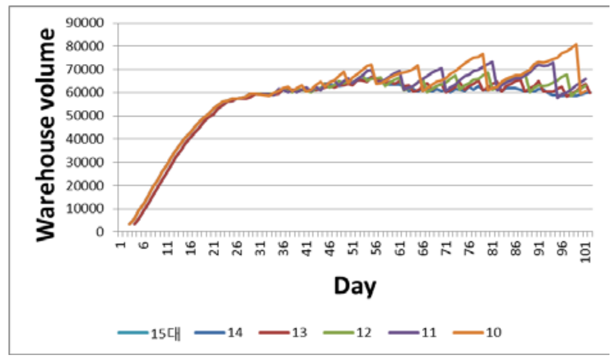

Fig 10. Volume of Warehouse Storage after the Establishment of the Joint Warehouse

Before the establishment of the joint warehouse, the volume of warehouse storage was maintained at up to 14 delivery trucks but the range of the change in the warehouse storage increased after 13 delivery trucks. However, after the establishment of the joint warehouse, the volume of warehouse storage was maintained at up to 7 delivery trucks and it increased after 6 delivery trucks.

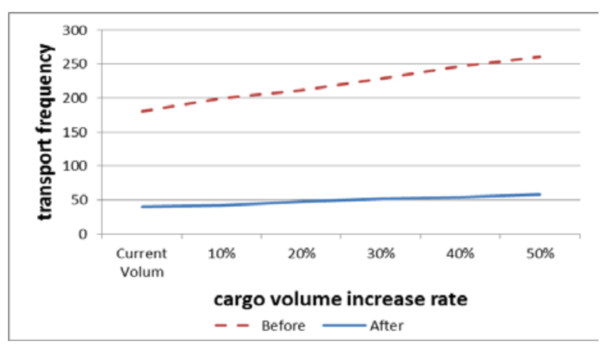

Fig 11. Comparison of the Number of Transport According to the Increase in Cargo

When the number of delivery trucks, which do not increase the warehouse storage space used according to the increase in cargo traffic, was measured, if the cargo traffic increases by about 20% from the current cargo traffic, allocation of 1 additional truck can carry out the delivery business while maintaining the volume of the warehouse storage, as shown in Table. 8

Table 8. Proportions of Goods by Shipping Destination

Range of Increase	**Optimum Number of Delivery Trucks**
Current Cargo Traffic	*7*
10% increase	*7*
20% increase	*8*
30% increase	*8*
40% increase	*9*
50% increase	*10*
60% increase	*10*
70% increase	*11*
80% increase	*11*

V. CONCLUSION

This study seeks to validate sharing economy at the corporate level by analyzing the case of a distribution center that stores and handles shipbuilding goods. Interviews were held with the employees of the center to determine how the center's storage space was being used and common shipping and handling tasks were carried out. The data thus gathered were then entered into the simulation model, developed using ARENA. This study also compared the individual storage and shipping and handling of the same goods by manufacturers to the common storage and shipping and handling by the logistics center to determine which is more efficient, and by how much. The findings can be summed up as follows.

First, the common system enables us to make a more efficient use of the available space. When manufacturers bring their goods into a shared space for storage, the total amount of space they need decreases by 48%

The second is the effect of joint transportation. The number of transportation times could be reduced to about 50% of the individual transportation frequency and the transportation distance could also be reduced by about 37% by jointly transporting the goods by sharing the vehicles, escaping from the existing method of individual transportation by individual companies. In addition, the effect of joint transportation further increases as the cargo traffic increases. It was identified that the number of individual transportation significantly increased when the cargo traffic increased but the number of joint transportation increased at a relatively small scale.

Simulation models like the one attempted in this study can be used to persuade economic actors to consider adopting sharing economy, and also to develop and improve the related processes, rules of operation, and the like.

The common shipping and handling process simulated for this study does not include the cases of mixed cargoes. Further research will be needed in the future to include mixed cargoes into the simulation model and produce more accurate outcomes

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