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A Study on the Restructuring and Cavitation of the Data-based Pick-up and Delivery Business*

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ABSTRACT

The recent rapid growth of the parcel delivery market has led to a rapid increase in the volume of traffic in urban logistics centers. Excessive competition among courier companies and a lack of logistics infrastructure in urban areas have seriously reduced service quality and profitability and have led to traffic congestion in urban areas as well as environmental problems. This study develops a model for integrating services among more than two courier companies for the same service area by proposing a way to design and assign routes for luggage delivery to each participating company. We verify the results of the proposed integration and cooperative operation model by comparing performance indicators (including total cost) between two routing approaches, the dynamic and fixed models, based on the demand pattern. The proposed model may enable a reduction in traffic congestion and environmental problems caused by courier services in urban areas. It may also address the profitability problem caused by the overheated competition in the courier business.

1. Introduction

The parcel pick-up and delivery service (hereafter; PUDS) market has changed along with such innovations as mobile shopping, home shopping, and overseas direct and indirect purchasing and delivery services. These have led to a rapid growth in the B2C (Business-to-Customer) transaction market, which has led to the rapid increase in the freight volume. Especially, in the metropolitan area like Seoul in Korea with the high population density, the demand for PUDS is very concentrated in the certain area like the bed town. Currently, several logistics companies keep their own PUDS business based on the contract with a large number of branch offices. It makes the delivery service network complicated. In

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addition, excessive competition among companies makes their profitability lower. Also, it is very trivial that the service efficiency will keep decreasing if a lot of service providers compete with each other in the same area. In addition, it causes various social and environmental problems as well as the reduced profit in the last-mile delivery process, the final delivery process to the customer. As a result, the satisfaction degree of customer has been continuously decreased due to the limited resource. All of service providers are trying to find a various alternatives to increase their service level while minimizing the cost of last-mile delivery services, but they have not yet come up with innovative solutions. (Lee, 2016)

In order to solve these problems, service providers should collaborate with each other by sharing information or resources. The fundamental root causes of these problems cannot be solved by simply increasing the efficiency of each service provider or a single type of resource. Indeed, it may seem be the more effective alternative by maximizing the shared value by hollowing-out their business through collaborating and integrating business model. However, there remains the more fundamental reason which makes it difficult to hollow-out services in the same area, the lack of infrastructure, standard process and integrated system (Heo et al., 2016).

Some of previous research pointed out the necessity of integrating the logistics system, selecting the location of the branch offices, and allocating demand of PUDS. However, only one or two studies suggested how to innovate operations and procedure through horizontally integrating PUDS in a certain area.

In this research, it has been proposed a different way to innovate the current operation model by sharing and integrating PUDS among different service providers considering the practical business environment in Korea. In order to build more advanced plan for PUDS, we have utilized machine learning algorithm, *K*-Means clustering, and build the mathematical model, Vehicle Routing Problem (VRP) based on the location of customers. In addition, the performance of the proposed model is compared with the current model by examining the varous quantitative service indicators including the total cost. It has been proved that the proposed model may guarantee better performance in terms of both service providers and customers. Also, the proposed approach may help to eliminate various fixed costs, effectively utilize their internal resources, and increase service level.

The rest of this paper is organized as follows. Section 2 reviews the research and discusses its limitations. The proposed methodology using k-means clustering and VRP is explained in Section 3. The experiment design and results are discussed in Section 4. Finally, we conclude by describing the value and limitations of the proposed approach.

2. Literature Review

2.1. *Last Mile Pick-up and Delivery in Urban Logistics*

Ferdinand (2015) compared two courier service network systems and proposed a service center operation plan shared by multiple companies for low-demand service centers; the study also presented a strategic alliance model integrating service centers and compared the scenario's maximum profit among the participating companies using the max–min method and a genetic algorithm.

Gabriele (2015) developed a type of cycle logistics based on interviews with experts to clarify definitions and terms for assessing the sustainability of urban logistics by measuring the potential of freight cycles and encouraging proliferation. With the result of case study, the author discussed the lack of regulative policy and the obstacles to implement more efficient framework for urban logistics system. The author proposed a governance system for utilizing the potential of the cargo cycle for sustainable urban cargo transportation. Also, it has been proposed a sustainable urban logistics system considering the operations in logistics.

Lee et al. (2016) researched the need for differentiated logistics service enhancement due to intensified competition among e-commerce companies' last-mile delivery services. Improving terminal shipment efficiency was discussed in terms of improving the efficiency of the base and the efficiency of the means of transportation. An area with high volume was selected through the Getis-Ord Gi statistic. The study also analyzed regional scenarios for the existing plan, base point efficiency plan, and base point and transportation efficiency plan, and calculated the expected effects using ArcGIS Network analysis based on Dijkstra's algorithm.

2.2. *Vehicle Routing Problem with Clustering*

Rodolfo et al. (2007) proposed a heuristic-based clustering algorithm for the vehicle routing problem within a time window framework to examine the efficient cost management of different kinds of vehicles providing pick-up and delivery services to customer groups given certain requirements. The preprocessing step of node clustering was performed, and the cluster-based MILP problem formula was calculated to allocate vehicles to the clusters and specify the vehicles' arrival times at the customers' locations in each tour.

Sergio et al. (2007) considered a location pouting problem by combining a facility location problem and vehicle routing problem. Several hierarchical and non-hierarchical clustering techniques were integrated into sequential heuristic algorithms, and various clustering techniques were applied; the study then tested their performance by routing them.

2.3. *Consolidation of Courier Business or Courier Operation Structure*

Lee (2014) compared efficient delivery and delivery strategies that reduce operating costs through the integrated operation of sales offices located in areas with low collection and delivery volumes through strategic alliances among courier companies. He constructed a mathematical model that maximizes total profit, solved a test problem by using a genetic algorithm, and allocated the costs using the Shapley value, one of the distribution methods of cooperative game theory. The study also proposed methods of comparing incomes among mathematical models and solving their income imbalance, enhancing profits through strategic alliances, and enhancing the competitiveness of courier companies.

Bo et al. (2012) studied the problem of cargo mixing in the carrier collaboration problem in pickup and delivery services (CCPPD) for last-mile delivery. The study also examined profit distribution among operators through centralized collaboration and proposed three profit distribution mechanisms based on the contribution of each carrier using the Shapley value. Moreover, a carrier collaboration problem with time constraints and a profit allocation mechanism for pickup and delivery problems were investigated. Randomly generated scenarios composed