Int. J. Production Economics 168 (2015) 234–244

Contents lists available at ScienceDirect

Int. J. Production Economics

journal homepage: www.elsevier.com/locate/ijpe

Returnable packaging management in automotive parts logistics: Dedicated mode and shared mode

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ARTICLE INFO

Article history:
Received 10 September 2014
Accepted 28 June 2015
Available online 9 July 2015

Keywords:
Automotive parts logistics
Returnable logistics packaging
Transportation cost
Inventory holding cost

ABSTRACT

We compare two different modes, i.e., dedicated mode and shared mode, used in packaging management in automotive parts logistics. In dedicated mode, every parts supplier uses his own packaging; while in shared mode, packages can be shared among the suppliers. For each mode, we calculate the total costs consisting of transportation cost and inventory holding cost, and prove that the total costs, the transportation cost and the inventory holding cost are all smaller under shared mode. We further illustrate the factors that influence the cost savings of shared mode, i.e., the total cost of dedicated mode minus that of shared mode. In particular, the cost savings are proved to be negatively related to the number of package categories, and are positively related to: (1) the demand gap of packages between areas, i.e., sum of the volume difference of every kind of packages that transported in and out of one area; (2) the failed ratio factor of the returned packages, i.e., the ratio of the packages that cannot be returned to the supplier because of broken, pilferage, misplace, etc.; and (3) the time savings of short distance transportation, i.e., the transportation time consumed between areas minus the transportation time within one area. Finally, numerical examples show that the cost savings can be considerable, and the number of package categories is the most important influence factor.

1. Introduction

In automotive parts logistics, returnable plastic or metal packages (including pallets, containers, racks) are used by most of the companies. Compared to disposable packages, returnable packages, because of their longer lifetime, can reduce the total amount of packages that needed, which is more environmentally friendly and better from the point view of sustainability. However, returnable packages may have higher costs of procurement, transportation, and other costs caused by cleaning, repairing, storage and management, etc. Moreover, the supply uncertainty caused by damage, theft, or misplacement, also incurs some costs and affects the supply of parts. Therefore, returnable packages management is an important issue in automotive parts logistics, especially for the automotive industry facing cost reduction pressure due to higher competition and lower profit margin.

Two different modes are used in managing the returnable packages: (1) shared mode (or buyer-managed mode), which means the assembler owns the packaging and the packaging can be shared between the suppliers; and (2) dedicated mode (or vendor-managed mode) which means suppliers own packages themselves and no package can be shared between suppliers. In China, Shanghai General Motor (SGM) uses shared mode, and has a branch called Container Management Center (CMC) to design, procure and manage the containers. While Dongfeng–Nissan (a joint venture automaker) and the other assemblers use dedicated mode, and pay packaging cost to the suppliers who are in charge of procuring and managing the packages. In Sweden, automotive assemblers Scania and Volvo also use shared mode in managing packages. In particular, Volvo Logistics Corporations is in charge of managing the packages for Volvo, and an information system called VEMS is used to support the management of the packages.

Dedicated mode has its merits of easy managing, while shared mode is better in reducing safety stock and damages of packages. In specific, when dedicated mode is used, every supplier needs to hold its own safety stock of packages and the empty packages are easily got lost or misplaced; while for shared mode, since the packages are centrally managed, the risk pooling effect can reduce the total safety inventory, and misplacement or lost is reduced. However, in shared mode, information system and collaborations between suppliers and assemblers are necessary, and additional management costs are usually incurred.

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http://dx.doi.org/10.1016/j.ijpe.2015.07.002
0925-5273/

Practical cases give more insights about the comparison of the two modes. SGM is reported to be better in managing packages after replacing dedicated mode by shared mode from 2003. In contrast, for one assembler using dedicated system, many of its parts suppliers begin to complain the bad performance of the packaging management, like rude unloading/loading, collapsing, lost, damage, misplacement, not timely return, etc.

Even though shared mode seems to be better, it is still need to be proved theoretically and more questions should be answered, including what is the cost gap between the two modes? What are the main factors that influence the cost gap? The quantitative analysis is essential since shared mode is more difficult in administration and has higher information system requirements. In this paper, based on a real project, we try to propose a simple model to calculate the logistics costs of shared and dedicated modes and, by comparing the costs, address the cost differences between the two modes.

The rest of this paper is organized as follows. In Section 2, we summarize some related literature. In Section 3, we list the notation and describe the two modes. Section 4 and Section 5 propose the costs of the shared mode and the dedicated mode, respectively. We compare the two modes in Section 6. Section 7 presents the numerical examples. The conclusions are discussed in the last Section.

2. Literature

The benefits and disadvantages of returnable packages are the first issues when a company wants to replace disposable packages by returnable packages. The main benefits, as argued by Leite (2009), are better product protection, decreased cost, legislation and environmental benefits, etc. These benefits have also been addressed by Silva et al. (2013), with a case, and Accorsi et al. (2014) who further discussed both the economic and environmental assessment of the reusable plastic containers based on a food catering supply chain. The disadvantages, on the other hand, include the transportation costs, flow management, reception, cleaning, repair, storage, and capital invested, etc. Ilic et al. (2009), and Mason et al. (2012) discussed the loss of returnable containers because of damage, lost, misplacement, and other costs. When comparing the two sides of the same coin, as argued by Leite (2009), the benefits usually exceed the disadvantages. Therefore there is a global trend of using returnable packaging instead of disposable packaging (Twede and Clarke, 2005).

When returnable packages are used the management is a challenge, and some papers addressed such issues, mainly from the operational level. For example, Duhaime et al. (2001) carried out a case study to evaluate the system of collection and distribution of returnable packaging for Canada Post and its large mailing customers. Hellström and Johansson (2010) discussed the control strategies of the returnable packaging by simulations based on the case of a Swedish food company. Buchanan and Abad (1989) studied the inventory control problem for containers and considered the returns in a given period as a stochastic function of the number of containers in the field. Kim et al. (2014) also discussed the influence of the stochastic return times on the total cost of closed loop of the perishable products. Chew et al. (2002) developed performance measures to monitor and control the deployment of containers. Das and Chowdhury (2012) proposed a mixed-integer linear programming framework and model for the design and management of reverse network for collection and recovery of products, and the method and approach proposed are very applicable for recovery and collection of packages as well.

In order to improve the efficiency and reduce the mistakes happened in allocating the packages, RFID is proposed by some articles. See Johansson and Hellström (2007), Hellström (2009), and Kim and Glock (2014), for example.

Our work supplements the above mentioned literature by comparing the costs of the whole system under two different modes. In contrast, the previous literature usually set the system as given and focused mainly on some parts of the packaging management system.

The article that is more similar to this paper is Lützebauer (1993) who distinguished three types of systems that used to manage the empty packaging, i.e., switch pool systems, systems with return logistics, and systems without return logistics. Further, Kroon and Vrijens (1995) gave a case to show how to design the returnable packaging system according to the classification. However, the above classification mainly focused on the ownership of the packaging; while in this paper, we consider mainly on whether the packaging can be shared between suppliers; and it is easy to find that, the dedicated mode belongs to the switch pool system, while the shared mode belongs to the system with return logistics. In addition, we discuss the differences of the two modes by quantity models.

3. Assumptions and notation

As a benchmark, we consider a production network consisting of two assembly factories and many parts suppliers located nearby each assembly factory. Our model can be easily extended to the case of n assembly factories. However, considering the complexity of notation, we just illustrate the two assembly factories case.

As shown in Fig. 1, for the dedicated mode, packages filled with parts are transported from suppliers to the assembly factories by milk-run or/and through distribution center or by direct delivery. When parts are unloaded in the assembly factories, the packages are collected, sorted, collapse, and returned to the suppliers by the trucks that are assigned to fetch the parts. When the trucks arrive to the suppliers, the empty packages are unloaded and then cleaned and repaired by the suppliers. In the dedicated mode, the suppliers own the packages, and thus one supplier can use only his own packages, which cannot be shared among suppliers.

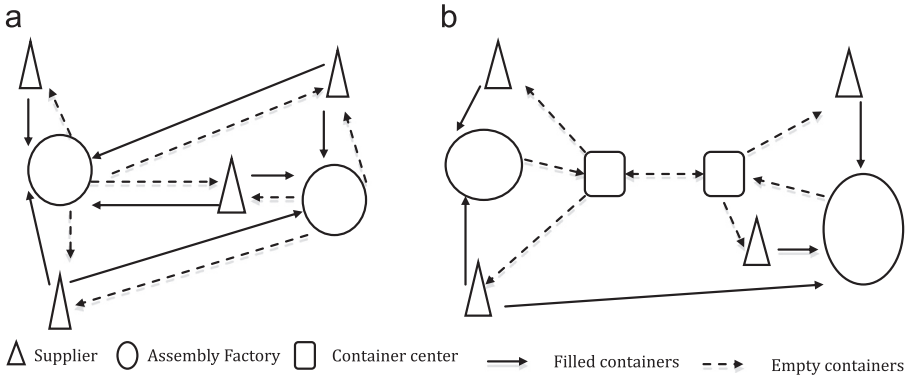

Fig. 1. The flows of packages in automotive parts logistics.