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# Multi-period stochastic packing and shipping model for online retail

Bayrem Tounsi<sup>1</sup>, Luce Brotcorne<sup>1</sup>, Frédéric Semet<sup>2</sup>

**Mots-clés :** *Packaging and shipping operations, multi-period, integer programming, stochastic optimization, online retail.*

## 1 Introduction

Online retail have been continuously growing in the last years. In France, during the second quarter of 2013, online retail rose by 20% in comparison to same period of the year before<sup>1</sup>. The success of an online retailer is closely related to how efficient its supply chain is [2]. To reduce global cost, coordinating warehouse management and transport planning in a global optimization model was considered in [1][3]. In keeping with this trend, this work investigates a new model for coordinating packaging and shipping operations. The packaging of an order consists in different sequential phases. First, the products that form the order need to be picked up in the storage zone of the warehouse, then they need to be inserted in standard packages with transaction and delivery informations. Finally packages are loaded in corresponding trailers. Orders are shipped using a set of delivery options, called channels. Joint Packaging and shipping enables us to define actions that influence the standard processing in term of hundling peak of activity : packaging postponement, channel change and order anticipation. Uncertainty of orders arrival at warehouse guided us to consider stochastic optimization techniques in a rolling horizon schema. Numerical experimentation are conducted using realistic data provided by a major logistic services company.

## 2 The packaging and shipping problem (PSP)

(PSP) consists in determining the daily operations at the warehouse over a planning horizon  $H$ . A day is designated by a period and it is associated with a set of orders to be treated. Each order is composed by a number of packages and it contains a default delivery channel chosen by client. On the other hand, each channel has a number of trailers to ship packages. Du to the limited number of docks, we include trailers management. The latter handles arrival and departure of trailers in and from docks. Packing and shipping are made by workers distributed in disjoint shifts that cover the period. Workers can be permanent or temporary. Both have a cost and a productivity which is the amount of packages that they can prepare in a time unit. While permanent workers are hired for the whole planning horizon, temporary workers can be hired for one shift. The problem looks for an operational plan that minimizes the cost of hiring workers. In addition, considering that the number of docks is usually a critical resource, we look for a plan that minimizes its usage (called trailers management policy).

After building a first model for (PSP), we introduce new actions that can be used by warehouse manager to deal with peak of activity. In fact, standard processing only enable the use of more temporary when a peak occurs. We define first the postponement of packaging. Henceforth orders can be prepared during a period later then the one of arrival. Besides, we let an order be assigned to a channel different from its default one. Postponement and channel

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1. <http://www.fevad.com/espace-presse/les-ventes-sur-internet-en-hausse-de-16-au-2eme-trimestre-2013>

change can lead to reduction of the workers used. But they generate penalties added to the global cost. Finally, a part of orders initially planned for the day after can be anticipated. This occurs when it is possible to have access to part of orders of coming period. In our study, part of next day period can be known at middle of current period. Thus it becomes possible to prepare them. We illustrate the influence of each type of actions and their combination. The resulting model is challenging. Indeed, commercial solver used is not able to solve the considered large instances. Thus we are working on decomposition technics and heuristic methods.

### 3 The rolling horizon

Packging and shipping optimization is carried out in a dynamic and uncertain context. At a current period, new orders are known and can be prepared or postponed to a futur period. This is partially impacted by future period orders, which are not known, but just estimated. For this purpose, we build a resolution method using a rolling horizon. This technique suits multi-period problems where not all data is revealed at the beginning of the horizon [4].

1st		Deter.	Stoch.			End
1	...	t	t+1	t+2	...	H

FIG. 1 – Rolling horizon schema

Iteratively, the problem is solved over a restricted number of periods forming the rolling horizon (3 periods in gray in Figure 1). Orders of period  $t$  are revealed. Orders of periods  $t + 1$  and  $t + 2$ , which are estimated, are considered to better guide operations planning of period  $t$ . After resolution over the rolling horizon, decision variables of period  $t$  are implemented. Then the rolling horizon is shifted one period until the end of the planning horizon. Currently, we are investigating stochastic optimization techniques to improve the rolling horizon schema.

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