EFFICIENT TRANSPORTATION IN CITIES AND PERISHABLE GOODS SECONDARY PACKAGING

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Abstract. The paper deals with the transportation process planning analysis. Today it is extremely important to plan transportation by optimal way to reduce the transportation costs, as well as the delivery time, providing accurate deliveries of perishable goods to the customers and satisfying their needs- in this forwarder provides efficient transportation. There are a lot of principles managers and operators may use to achieve efficient transportation of perishable goods. On the one hand, it is significant to use appropriated vehicles, depending on the type and capacity. On the other hand, companies have to reduce the vehicle variable and fixed costs, fuel consumption and driving time. Packaging of goods also influences the result of the transportation process. Consumers generally buy products in small quantities. They sometimes make purchase decisions based on the product looks and packaging. Retailers are deeply concerned to get perishable goods that are easy to handle in logistics terms, do not cost too much to package or handle, yet retain their selling ability on shelves. Also packaging influences the goods safety and vehicle loading time criteria, which also characterizes the efficiency of transportation. The author of the paper recommends standardization of goods packaging to use the vehicle capacity in optimal way, reduce the vehicle loading/unloading time, providing a high level of goods safety in the transportation process.

Keywords: efficient transportation, secondary package, perishable goods.

Introduction

Traditionally there are two approaches of perishable goods packaging planning- marketing approach and transportation (also loading/unloading) safety approach. On the one hand, package should be good for the customer. On the other hand, package should be appropriated for transportation and loading/unloading, providing safety of cargo during these processes. Anyway, it is extremely important to plan package into one department, analysing requirements of logistics, marketing, transportation and other departments. There are different logistics functions of the packaging - that is, protection, storage, transport, information and handling [1-3].

As a result, packaging of perishable goods may be regarded only as a part of the entire logistics system. In packaging design, a compromise that addresses all functional areas must be found. The correct design of packaging can help lower the overall logistics costs and raise the level of supply and/or delivery service. In addition to the logistics functions, packaging must also fulfill the production functions, marketing functions and usage functions [4]. This means:

- through the choice of suitable packaging it is possible to produce directly from the packaging or into the packaging without intermediary processing procedures;
- packaging can lend a special character to a product, enabling it to be distinguished from the competitors' products. Important functions can also be assigned to packaging, including the roles in advertising and sales promotions.

Actually, transport managers usually do no connect the secondary packaging process with efficient transportation of perishable goods especially in cities and other built-up areas, planning circular routes with a great number of customers within the route.

If one department of the enterprise plans package separately, it is difficult to work out the packaging good for the business, company, state authorities, customers, transport companies etc. Normally, the manufacturer is responsible for production and legislation requirements of package materials; the logistics department plans transportation and other logistics processes, providing a high level of safety; the marketing department may be responsible for the shapes, design and information printed on the package as well as how to satisfy the customers' need in optimal way.

This is why many small and average companies use outsourcing service to work out package for their goods. Anyway, it is necessary to know what is the most important requirement of the particular commodity.

Usually specialists calculate only the cost of the package, finding new ways how to make it cheaper. It is necessary also to describe the effect or result the company receives using "good" package.

Both trading and forwarding companies have to pay a great attention to perishable goods packaging planning to provide efficient transportation.

The purpose of the investigation is to work our recommendations how to load vehicles in optimal way using standard package for perishable goods, that allows reducing the vehicle discharging time, providing a high level of goods safety.
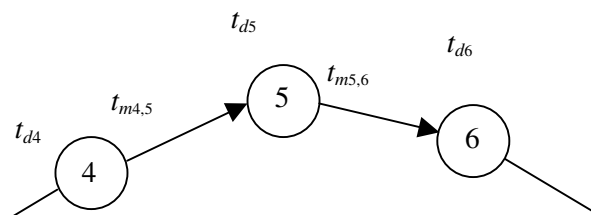
It is extremely important because perishable goods usually require accurate and fast transportation.

Perishable goods efficient transportation planning methodology

Despite the fact that transport packaging is a significant portion of the total packaging used globally every year, it does not receive much attention in various developed countries. Only some transport managers as well as that packaging influence perishable goods efficient transportation planning.

Primary packages hold the basic product and are brought home from the shop by the end consumer. Secondary packages, or transport packages, are designed to contain several primary packages. A secondary package could be taken home by the end consumer or be used by retailers as an aid when loading shelves in the store.

Habitually local delivery (connecting a great amount of clients) planning is a complex process for big cities, because there are many different ways how to complete it. Often operators make a typical mistake during the routing process, they try to minimize only the vehicle moving time, serving customers within the particular route.

Legend: 4,5,6 – numbers of customers.
t_d – vehicle discharging time.
t_m – vehicle moving time between customers.

Fig. 1. Circular route fragment

Each of the customers within the circular route requires a known amount of goods.

The total time of delivery within one route consists of the 2 main elements: vehicle moving time and vehicle discharging time [5] (Fig.1., formula 1).

$$T_d = \sum_{i,j=1}^{n} t(m)_{ij} + \sum_{i=1}^{m} t(d)_i \,, \tag{1}$$

where T_d – total delivery time, s
$t(m)_{ij}$ – vehicle moving time between the route points i and j, s (normally, not connected with packaging factor) – will not be investigated in the paper.
$t(d)_i$ – vehicle discharging time for customer i. (packaging factor influences the vehicle discharging time), s.

Despite of the fact that both elements are important to plan accurate JIT deliveries, the author investigates only the vehicle discharging time for the customer, because it is directly connected with the packaging problems and models.

Specialists often use different methods to plan and control the production delivery time, because nowadays customers have very high requirements for fast and accurate delivery. Unfortunately, it is impossible to use many of the methods to achieve the optimal result due to different reasons. Some of the methods may not provide the best result, because the time factor changes, other methods are labour-intensive and time-consuming, therefore it is not expediently to use these methods in real conditions.

Using of *mathematical methods* only will not provide the optimal result, because of the fact that majority of these methods use fixed and unchangeable time and speed factor data, but in our case one and the same parameter has different meanings depending on particular hours of a day.

Timekeeping or observation methods also may not provide the optimal result, because these methods are very labour-intensive and time-consuming. It is necessary to hire additional labour to evaluate particular routes when different parameters change (Figure 2).

Using of *average rates methods* also is not efficient, because it provides mistakes for many route deliveries time planning.

To achieve the result, it is expedient to use the combined approach, analyzing goods package, using mathematical and heuristic methods etc. Processes for standardization are divided into many small and micro units (elements). After that specialists investigate and control each element to optimize the total time of the process in general (formula 2).

$$tP = tp_1 + tp_2 + tp_3 + ... + tp_n,$$ (2)

where tP –time of the main process for standardization, s.
tp_1-tp_n – time of the small parts of the main process P, s.

Various companies from different countries use this method to improve different processes in different spheres of activity. Some companies in the USA used this method to control the staff's working hours and create an effective salary system as well as to calculate the actual cost of each produced unit.

Normally, standardization of package may make easy and fast vehicle unloading process, minimizing the number of mistakes and the delivery time uncertainty factor. It is necessary to control also the vehicle unloading process to plan good deliveries for cities with unstable traffic. Unloading conditions may change for different objects.

On the one hand, vehicle unloading (idle) time standardization using the micro-elements method makes the standardization process easy for the particular object. On the other hand, this method is really very important, because it is impossible to use many other traditional methods into practical conditions.

The vehicle unloading time for small objects (formula 3)[6] consists of some elements: vehicle unloading time T' (depends on the goods quantity and package specification) in seconds and other processes making time (does not depend on the production quantity).

$$T_u = T' + n_u \cdot T''_u,$$ (3)

where T_u – vehicle total unloading time, s.
T''_u – time, needed to move goods from the vehicle to the particular object, s.
n_u –quantity of production, needed for the particular object, pcs.
T' –another process elements' realizing time, s.

The last rate consists of the following main elements:

$$T' = T_m + T_o,$$ (4)

where T_m – vehicle moving time near object driving up and driving off (does not depend on the goods quantity and package specification), s.
T''_u – other (additional) operations realizing time (vehicle board opening etc.), s.[7]

The total time of vehicle discharging also depends on the type of the vehicle body, kind of cargo and its packaging. Packaging is an extremely important factor into this process. It influences not only the unloading time, but also the total delivery time as well as the choice of the vehicle for the particular route.

It is expediently to specialize planning and standardization of all processes depending on the time of the vehicle used for the particular route.

Very often the optimal solution is very simple for the JIT accurate deliveries. It is:

- reduce packaging specification, using standard packages (for instance, 2-5 types of package);
- divide the unloading process into elements, defining the time of each element;
- define elements of the unloading process, dependent on the type of package and quantity of production;
- choose the optimal vehicle for the particular delivery.

It is impossible to use usual transportation optimization methods without standardization of package, that reduces fluctuations of the vehicle loading time and improves usage of the vehicle capacity.

Perishable goods secondary packaging and goods delivery in cities. Problem analysis and results

Let us investigate the milk, yogurt and butter transportation/loading process.

Usually rates $t(d)i$ (formula 1) as well as T_u and T' (formula 3, 4) fluctuate seriously because of different sizes of package within the unloading process. So, it is very difficult to use these (and also other methods) to achieve the best result into the perishable goods transportation process planning.

Today a lot of companies in the Baltic States use different sizes secondary packages like plastic cartoons. As a result, either manufacturers, or transport companies or customers have the following problems:

- low capacity usage rate, because not all cartoons are full;
- increased pallet places quantity into the transportation process;
- increased transportation costs.

The solution is: to use standard-size packaging. For instance, demountable and movable metal containers with wheels that are used in Finland for milk packages (Fig. 2):

Fig.2. **Demountable and movable metal containers with wheels**

It is easy to move this container. It is possible to build it into a section, when it is empty; as a result it takes less place in the warehouse. Despite that the container is very suitable in use, it is quite expensive. If the Baltic retailing networks use it, they should increase the turnover of milk or the customer's price per 40 %. The author of the paper hardly thinks that it is possible, so, it is necessary to find other solutions.

The next opportunity is module plastic cartoons which are manufactured of durable, recyclable plastic. They are constructed for use over and over again on very hard conditions without affecting the quality. Special bottom for the conveyor, strong corners and an innovative bale arm system.

Crates are stackable together. Maximize transport efficiency and minimize the "air" transportation. As it has the biggest internal volume in the market and they can be cross stacked together it is possible to build up pallets with maximum height and get up to 200 % efficiency when delivering products.

The crates have been developed specifically to be handled with different kinds of robots and automated lines.
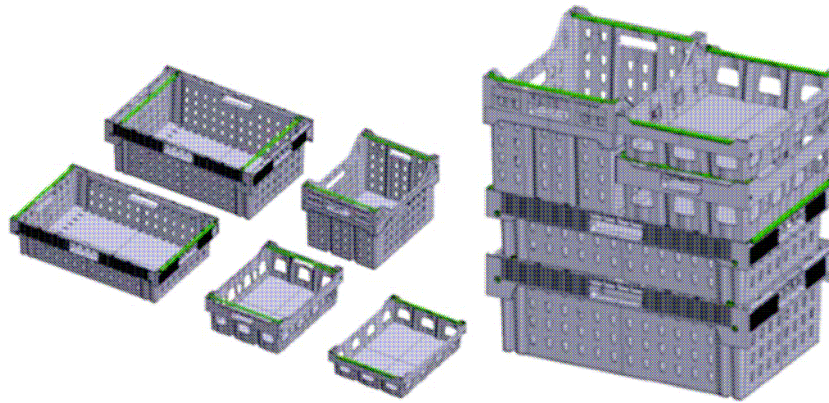
Fig. 3. **Five sizes of module package**

The average mass of each crate is 0.5-2.0 kg; so it is possible to move it without any problems.

It is necessary to use some standard size of secondary package. In accordance with Figure 3, there are 5 possible sizes which are suitable for different types of perishable goods.

According to Lithuanian market investigation, the usage of current package is ineffective. On the other hand, 5 sizes of module package (Figure 3) are very suitable for all perishable goods, allowing achieving the efficient results.

Today the average level of secondary package fulfillment does not exceed 75 %

It is expedient to use these standard size crates like the main type of secondary package. Figure 4 demonstrates that the particular package (size 400X300X115 mm) is suitable for various perishable goods.

Fig. 4. **Secondary package (size 400X300X115 mm) filled by various perishable goods**

So, usage of standard secondary package (Figure 4) allows:

- reducing the vehicles' run and costs (because of the optimal usage of the vehicle capacity);
- reducing of packaging material usage as well as the quantity of refuse;
- improving of space usage in the warehouse.

Figure 4 demonstrates that all crates are filled at least to 90 %; they also are stackable and suitable for cargo consolidation.

Advantages of usage standard secondary package are summarized in Table 1.

Table 1

Advantages of usage standard secondary package

Parameter	Current situation rate	Rate using standard secondary package
Average height of production on pallet	700-1700 mm	1500-1800 mm
Not fully filled cartoon (50 %)	x	
Inefficient storage and transportation of secondary package	x	
Crates filled at least to 85 %		x

It is possible to reduce the quantity of refuse per 5 % using refundable plastic crates.

The number of needed cargo places (pallets) also is going down due to improving of each pallet's cargo height. As a result, it is possible to use 4.5 pallets instead of 6 pallets. Finally, the vehicle capacity utilization rate also may be improved and achieves 90-95 %. The quality of transportation also improves, providing the highest level of perishable cargo safety within transportation and loading processes. In accordance to the trading companies' investigation, usage of these crates allows improving of the transportation and storage efficiency per 65 % because of the usage of folding package. Empty folding refundable crates takes less place than usual cartoons (see Figure 5).
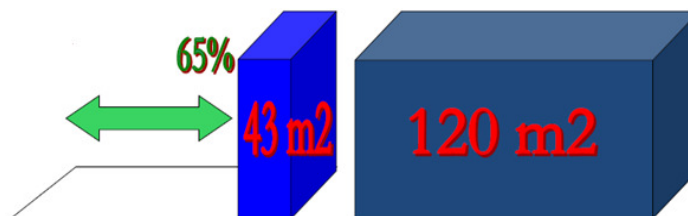

Fig. 5. **Improving of transport/warehouse usage efficiency:**
storage and transportation of empty folding refundable crates

The right side of Figure 5 demonstrates storage of usual empty package (cartoons) of perishable goods. The left illustration shows reduction of cargo place using folding refundable crates.

Also cargo unlading time takes less time using standard package for perishable goods. Table 2 demonstrates comparison of T''_u – time, needed to move goods from the vehicle to the particular object (formula 3) using usual and standard package, serving particular customer.

Table 2

Four perishable goods boxes unloading time (T_u) from the vehicle to the customer using usual and standard package

Activity characteristics	Time, s (using differed packages)	Quantity of activity , times	Total time of action, s	Time, s (using standard packages)	Quantity of activity , times	Total time of action, s
Open vehicle body	2	1	2	2	1	2
Take a box with goods from the vehicle body	7	4	28	2	4	8
Bring a box to the warehouse (distance 7 14m)($T''_{u,\text{ formula 3}}$)	20	1	20	10	1	10
Put boxes on the receiving place	2	1	2	2	1	2
Fix boxes	5	1	5	1	1	1
Draw up and turn around	3	1	3	3	1	3
Total			60			26

Usage of standard package allows reducing the unloading process more than 2 times (60 s using usual package and 26 s, using standard package), because some operation of the $t(d)i$ and T''_u requires

less time, if a company uses standard package. Therefore, the time of taking a box with goods from the vehicle body reduces from 7 to 2 seconds while the time of bringing a box to the warehouse (distance 14m) reduces from 20 to 10 seconds. As a result, usage of standard package allows reducing of the total delivery time when the route joins a lot of customers. Actually, these elements of the unloading process provide the main differences between the total processes time T_d, T''_u and T_u for formulas (2-4), because other processes time ($T(m)_{ij}$, T''_u and T', the same formulas) does not depend on the type of perishable goods package.

Conclusions

1. Manufacturing and trading companies of the Baltic states have to use standard folding refundable package for perishable goods, that allows to improve the efficiency and quality of transportation. On the other hand, this makes the price of the final good for the customers more expensive. To avoid it, manufacturing and trading companies should get investors and funds from international and state resources.
2. Usage of folding refundable package for perishable goods transportation and storage allows improve the efficiency of both the transportation and storage processes. For instance, companies need 65 % less warehousing space to store the same quantity of package.
3. Also the number of the vehicle runs reduces due to usage of folding refundable package for perishable goods because of reducing of cargo places quantity, increasing the height of each pallet cargo. The quality and safety of cargo achieve the highest level because of usage of folding refundable package for perishable goods, too. It is possible to solve problems with fragile cargo like eggs as well. Transportation of "air" reduces because of usage of standard package; the transportation cost also reduces.
4. Usage of standard package allows significant reducing of the total delivery time when the route joins a lot of customers.

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