Food Products Distribution Systems Redesign in the Food Corporation Acquisition and Fusion Conditions

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Abstract

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The distribution channel structure significantly affects the distribution costs, and in the food industry the distribution costs have very often an important share on the total products cost. In the food industry, merger & acquisition conditions in the Czech Republic are the expected synergic effects. One of them is the cost saving following up from the redesign of the distribution system. On the case of a real project of the new mineral waters distribution system, the authors demonstrate their methodology and methods for the distribution system redesign, which integrates together the problem of the distribution object location with the distribution strategy choice and transport system design.

Keywords: distribution system; distribution strategy; warehouse location; transport circuits design; supply chain management

Since resently, in connection with the wide market liberalisation and free admittance of companies on the foreign markets, the markets redistribution occurs. One of the basic tools for the market share growth are mergers & acquisition, which come about in the Czech food industry in the present period. As an example, we may note the acquisition and fusion of three producers of mineral waters, Mattoni, Poděbradka, and Dobrá Voda, several meat industrial plants Maso Planá, a.s., Kostelecká uzeniny, a.s., Hyza a.s., two large dairy factories, Mlékárna Klatovy, a.s., and Mlékárna Ostrava, merger of two biggest Czech bakery companies, Delta Pekárny, a.s., and Odkolek,a.s., to United Bakeries etc. These are the cases of horizontal fusions, in which the companies, which operate in the same market or market segment, are merged. The basic motive of a merger is based on the assumption that the market value of the new company will be higher then the market values of the individual companies before the merger. According to (Goedhart *et al.* 2005; Kislingerova 2007; Chládková & Kudová 2008), the resources of the expected synergic effect are:

– savings from the extent in manufacturing, distribution, management, marketing etc. These savings are typical for horizontal merger;
– market share growth;
– financial savings;
– know-how concentration;
– productivity improvement.

The synergic effect in the cost area is only one of the effects of the merger and is frequently not sufficient if not, for instance, attended by sufficient receipt growth. The main goal of our contribution is the identification of the distribution costs sav-

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ings and customer services growth opportunities in the redesign of the merged companies distribution systems as the integrated part of their supply chain management.

It is possible to describe the starting situation in the products distribution as:
– separated distribution systems of individual companies,
– which have their distribution warehouses,
– own mostly outsourced shippers,
– set of customers of companies, which are merged, are not disjointed.

It means that it may happen that one customer sends his orders to all companies which individually deliver him sometimes identical goods; the information and material flow in such a supply chain are from the global viewpoint of the new company very complicated etc. It is evident, that the first object of the managers concerning costs savings is the distribution.

METHODS AND METHODOLOGY

In the literature sources, there are a few special articles and books dealing with the distribution systems design. Hwang (2002) desribes methodology and approach of supply chain design with considering competitive customers sevice level meeting. The review of the facility location models is in Klose and Drexl (2005). Marrath and Kenneth (2001) describe six steps of distribution network design. The case of the warehouse network redesign is in Malachrinoudis and Hokey (2007). Strategic role of the supply chain modeling in discussed in Sharpio (2004) and critical overview about supply chain integration in the food industry contents discussed Donk *et al.* (2008). Ballou (1999) pays attention to an important step in the distribution system design, which is the location of the distribution centres. He discusses the influence of location of one or more facilities on total costs (transport and warehousing costs). Lambert *et al.* (1998) describe the common methodology of the distribution system creation in the case of a new product introduction on the market, which consists of 9 steps: objectives determination, distribution strategy creation, distribution system alternatives generation, alternatives evaluation, best alternative selection, distribution partners choice, performance of the distribution system evaluation and, if objectives are not met, going to the step of alternatives evaluation etc. The objectives of the distribution system are seen in the market cover, product characteristics, customer services level, and distribution profitability. Melo *et al.* (2008) published a literature review of 139 articles in the period of 1998–2008, which concerns the facility objects location in the context of the supply chain design and management. They claim that there are separate sections between the facility locations and supply chain management, that "many tactical decisions in the supply chain management, as it is the case with procurement, routing, and the choice of transportation modes, are far from being integrated with the location decisions", that "the structure of the supply chain network is considerably simplified" etc. Our contribution deals with the case of a real problem in which we tried to find the complex decision of the distribution system redesign. The described case is used for the description of our methodology for the distribution system design or redesign.

RESULTS AND DISCUSSION

In the Czech Republic, there existed before the acquisition 3 independent producers of different mineral waters produced as both natural products and those containing several flavours. All the producers had their own distribution systems, own outsourced carriers with different types of transport rates construction, and own distribution warehouses. The geographical layout of the production plants and basic customers is shown in Figure 1. At the authors' working place, a study was made which was used for the new distribution system design after the acquisition. This was an appreciated opportunity for the authors to verify their own developed methodology and algorithm for the facility location and routing optimisation (Gros *et al.* 2005).

The following facts affected the creation of the alternative distribution system structure and distribution strategy:
– The distributed products, mineral waters, have random consumption with seasonal fluctuations. All products are manufactured in many variations (different flavouring, bubbles amount and size) and are filled in several sizes of plastic or glass bottles, the goods attaining high levels of turnover.
– The consumption of all products is widespread in the distribution space of the Czech Republic,

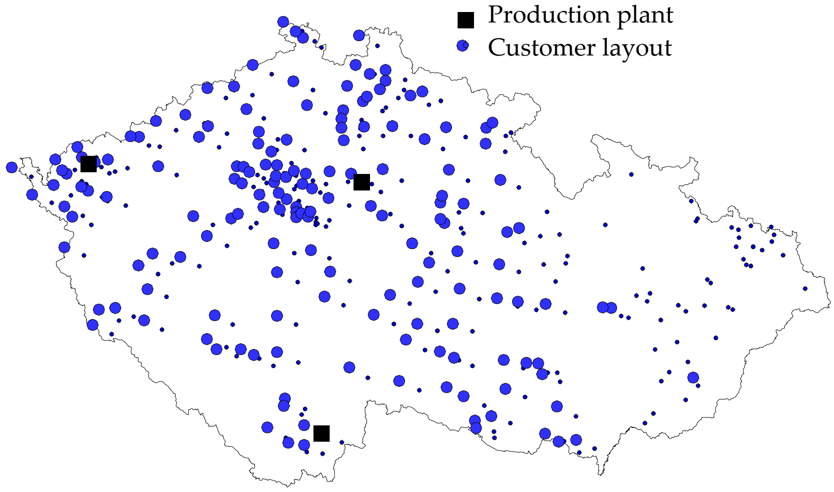

Figure 1. Production plants and customers layout

maximal distance between the factories and customers locations not exceeding 400 km (Figure1).

The last fact ensures that in the case of direct distribution, we are able to secure deliveries in 24 h from all factories with the road haulage used. Because the designed distribution system integration needs higher order picking requirements, it was decided to locate one distribution warehouse. More than one distribution centre was not considered because, from the customer services level view point, one centre is able to satisfy the needed level.

(1) In the first step, the distribution warehouse was located. The criteria function

$$\min z = k\sum_{j=1}^{n} w_j((x-x_j)^2+(y-y_j)^2)^{0.5}$$

where:

x_j, y_j – orthogonal coordinates in km of the supplied customers locations

x, y – looking for the coordinates of the new warehouse

w_j – amount of pallets delivered to customers and $k > 1$ the corrective factor of the direct distance used to the real one

Out of 8 methods of solution tested, the iterative one was used as the most effective for seeking new coordinates.

– In the first iteration, coordinates were estimated as

$$x = \frac{\sum_{j=1}^{n} w_j x_j}{\sum_{j=1}^{n} w_j} \qquad y = \frac{\sum_{j=1}^{n} w_j y_j}{\sum_{j=1}^{n} w_j}$$

– determine sufficient small e →0 and decrease of criteria function Δz_{min}, which we consider as non-essential and in all other $k + 1$ steps we estimate new coordinates as

$$x^{(k+1)} = \frac{\sum_{j=1}^{n} x_j f_j(x^{(k)}, y^{(k)})}{\sum f_j(x^{(k)}, y^{(k)})}$$

$$y^{(k+1)} = \frac{\sum_{j=1}^{n} y_j f_j(x^{(k)}, y^{(k)})}{\sum f_j(x^{(k)}, y^{(k)})}$$

where:

$$f_j(x,y) = \frac{w_j}{\sqrt{(x-x_j)^2+(y-y_j)^2+\varepsilon}}$$

- compute $\Delta z = z^{(k)} - z^{(k+1)}$.and if $\Delta z_{min} < \Delta z(x^{(k+1)}, y^{(k+1)})$ are the searched coordinates of warehouse; if not we repeat, the preceding step.

(2) For a more accurate location and transport costs calculation, we found out a useful process in which a set is found of real warehouse locations in the near area of (x, y) and the final location is based on the matrix of real distances. This step makes it possible to consider other factors influencing the object location such as the land price, accessible communications, possibilities of the existing objects utilisation etc.

(3) Very important step is the generation of distribution system alternatives. In this step, it was necessary to consider the distribution strategy and the transport system together.

(a) In the first alternative, individual deliveries to customers were designed without circuits design. Each factory attends to its customers independently and each truck dispatched delivers goods for one customer only. This "pure" direct distribution strategy was computed only as a comparison basis.

(b) The second alternative utilises the new warehouse and two stage distribution. The goods from the factories are transported to the central warehouse by deliveries loaded with maximum care

Table 1. Comparison of designed distribution system alternatives

Quantity of trucks dispatched _total (trucks)	52 543	75 259	49 279	49 138
Distance travelled_total (km)	10 338 352	10 019 311	8 583 885	8507 635
Travelling costs in Euro_ total	17 824 746	17 274 675	14 799 802	14 668 337
Travelling costs in Euro_ per palette	14.670	14.217	12.181	12.072
Travelling costs in Euro_ per bottle	0.0263	0.0255	0.0218	0.0216
Average truck capacity utilisation (%)	68.9	99.9	99.8	86.6
Average stock level (palettes)	28 354	26 155	36 242	35 691
Required storage capacity (palettes)	61 585	56 313	68 245	66 706

and the customer deliveries are realised in circuits designed by the savings algorithm.

(c) In the third alternative whole truck deliveries are transported from the factories directly to the customers and the remaining quantity of goods is transported to the central warehouse by whole truck deliveries. The customer deliveries are realised again in circuits designed by the savings algorithm.

(d) The fourth alternative combines the direct and step-by-step distributions. The distribution warehouse is supplied from factories by full loaded trucks and the customers deliveries are realised again in circuits form the warehouse designed by the savings algorithm with the exception of customers who are supplied directly from the individual factories not farther that 50 km.

(4) Ten best warehouse locations were found, all near Prague, the average level of the criteria function being 103 million with 11 million variance in pallet km. The valuation of the 4 alternatives given above was based on several assumptions: the truck capacity was 30 to 33 pallets, the average speed of trucks 50 km/h, loading and unloading time 1 h, lead time max 24 hours. The results of comparison of the designed distribution system alternatives are given in Table 1.

The number of trucks used for the transport between the members of the distribution system vary around 200.

The important part of such a distribution system design is the use of simulation modelling for the verification of their functionality. In this case, important information was that about the designed warehouse utilisation in time, because the consumption of the distributed drinks has seasonal variations. One case of the result of such simulation is shown in Figure 2 (third alternative, 3(c)). The simulation was based on the real data of mineral waters consumption coming from the last period. With this model, we were able to find a variant with the lowest costs possible while maintaining the service standard required by customer. The simulation model was created, using the visual simulation product Witness (Wit-

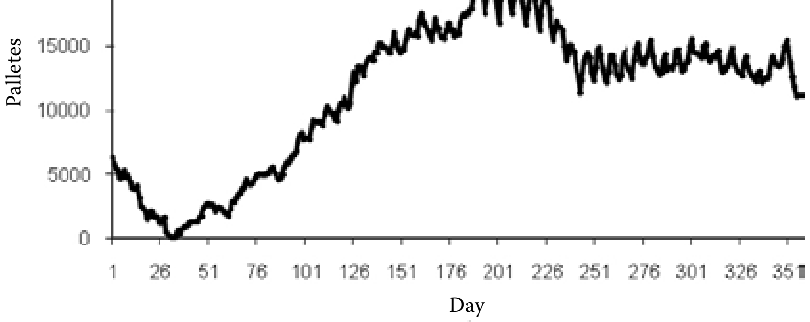

Figure 2. Stock level development in the warehouse in the time

ness Lanner Group Ltd., Redditch Worcestershire, United Kingdom).

CONCLUSIONS

The corporation acquisition and fusion are a very important chance for the design of a new distribution system with a higher customer services level and with a better economic efficiency. A great number of mathematical location models, models and algorithms for the transport system optimisation which are published in the literature are only sometimes linked in one complex approach to solve such a complicated problem like the distribution system design. Our contribution is a direct reaction to several callings for the integration of the object location and transport system design (Melo *et al.* 2008). The solution of the real problem forced us to use such an approach. Besides the use of location modelling, we applied our own variation of the savings algorithm for the routing design and simulation approach for the designed system verification.

We are not yet satisfied with the results, which are being realised step by step, because a very important problem is the manufacturing system management, which very significantly influences the distribution system in the food products supply chains. In further scientific work, we shall try to solve this problem.

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