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COSTS AS A DETERMINANT OF CHOICE OF DISTRIBUTION CHANNEL IN A DIY ENTERPRISE

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Abstract: We attempt to validate the algorithms related to the costs of distribution and to create an analytical model enabling the identification of an effective distribution channel for suppliers of one of DIY chains. Within the framework of the paper, the substantive issues related to the topic of distribution channels and costs generated at this stage of the supply chain were described.Our main finding is that carrying out a comprehensive analysis of distribution costs contributes to minimizing these costs. Individual products or suppliers can generate a loss or profit for a business, depending on whether the distribution channel is assigned appropriately to them.

Keywords: distribution channel, supplier and retailer cooperation, cost optimization, reeingineering, do-it-yourself (DIY) enterprise

INTRODUCTION

In the last two decades of the twentieth century, the retail sector began to consolidate and the strength of the companies in this sector began to increase [Fernie et al. 2000]. This situation had two consequences. First, retailers have taken control over the supply chain and therefore they have been able to enforce demand-driven deliveries instead of deliveries based on production schedule [Sirohi 1998]. Together with the increase in the size of retail business, retailers began to focus on operations optimization. Second, since many retailers operating in the particular sectors had a significant market share, there was a slight possibility of gaining greater advantage over their competitors by purchasing power [Achrol et al. 2003].

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Forthis reason, even a greater attention was paid to the optimization of operational processes and to the increased awareness of stock-related costs [Seth et al. 2001].

As a part of the modern planning in an enterprise, emphasis is placed on the environment, analysis of organization and continuous monitoring of key processes. Regardless of the form in which an enterprise acquires resources from its suppliers, a well-thought-out strategy for the selection and management of suppliers is essential [Grant et al. 2006]. Strategies for suppliers vary depending on their importance to the company. The importance of suppliers relates to the impact of their products on the purchasing enterprise and the possibility of gaining market dominance [Romanowska 2009].

According to A. Rushton [Rushton 2010], channel objectives that differ from one company to another, are the first criterion in the distribution planning process for the development of the most appropriate distribution channel. But there is a number of general points that are likely to be relevant to most companies. The key points that should be addressed are as follows:

- Good product availability for the market. Ensuring product visibility in an appropriate type of store is the most important factor here.
- Increasing the probability of selling a product. This objective can be achieved in several ways. Good selling space, as well as active support from sales force are the main assumptions. Product should be easily seen, perhaps even presented in an attractive way for customers [Parasuraman et al. 1994].
- Achieving a certain service level. Both from the supplier and the retailer perspective, a certain quality level should be established, measured, maintained and monitored.
- Minimizing of operational and total costs. Costs are of highly significant as they are reflected in the final product price.
- Complex products often require direct selling because any intermediary may not be able to explain how the product works to potential customers.

Once the objectives of distribution channels are set, it may be helpful to consider the characteristics of the channel. This factor influences the decisions that have to be made by designing the distribution channel. The characteristics of distribution channel includes: specificity of the market, specificity of products, specificity of competition, enterprise resources [Lovell et al. 2005].

Distribution process covers several types of actions: production planning, sales forecasting, transportation processes, warehousing processes, packing, order processing and many others. Each of this actions is a source of cost. In some cases distribution costs amount to 30-40% of total product cost. According to Bendkowski [Bendkowski et al. 2011], total distribution cost includes transportation (37%),stock financing (22%), warehousing (21%), order processing (20%).

According to M. Christopher [Christopher 2005] distribution costs change together with the decision regarding the number of warehouses. Transportation

cost, storage cost and cost of order preparation increase if the number of warehouses increases. On the other hand, cost of local deliveries decreases significantly. Therefore, it is crucial to develop algorithms enabling calculation of these costs, what as a result significantly simplify making decisions regarding the choiceof the distribution channel.

The paper deals with issues related to one of the key logistic management processes - distribution. The aim of the paper is to optimize the decision making process regarding the selection of distribution channels for suppliers of one of the Polish DIY companies. An additional inspiration to address this issue is the fact that there is little research on complex cost analysis at the distribution stage between suppliers and retailers, especially regarding the DIY retailers. Mathematical relations used in the analysis based on algorithms commonly used in the literature, however they have been modified and adapted to the analyzed company, its products and suppliers.

METHODOLOGY AND DATA

The data used in the empirical analysis was provided by the analyzed DIY retailer operating on the Polish market. The company cooperates with over 600 national suppliers. A chain of supermarkets (28 stores) and a warehouse (in central Poland) belong to the companies' distribution network. The data concerns both logistic and cost parameters. Within the framework of the study over 46.000 products and over 460 suppliers have been analyzed. The products are distributed within two channels: direct delivery from supplier to store and delivery through the warehouse (supplier – warehouse – store).

Due to the fact that the direct delivery channel is the dominant one, the question was asked, what if a given supplier is moved from this channel to the delivery through warehouse. The preliminary assumptions stemming from the enterprise's specifics and arrangements with suppliers are as follows:

- Lead time to the stores will be significantly reduced, as an order is delivered from the warehouse (1-2 days), and not directly from the supplier (1-30 days).
- Minimum order value/quantity (established by each supplier) will not have a decisive influence on the decision if an order can be placed. It will be much easier for the retail chain to place one order (stock in the warehouse), than if each store orders individually.
- Safety stock in the retail chain will be significantly reduced as the stock is kept in the warehouse.
- Total cost of transportation and storage of products, and hence of all products from a given supplier, may be reduced or increased, depending on the specificity of the products and other variables.

The conducted analysis included the following stages:

1. Exclusion of suppliers which products are unsuitable for storage (eg. flowers or products sold only in three or lower number of stores) and establishment of constraints for minimum suppliers' order value/quantity, lead time and possibility of ordering multipacks instead of pallets.
2. Definition of groups of costs generated while delivering through the warehouse (transportation cost from supplier to the warehouse, costs of receiving goods into inventory of the warehouse, storage cost, cost of order picking, cost of preparing the products to the shipment from the warehouse, cost of transportation from the warehouse to the stores), creation of analytical models for each cost groups and use of formula for GMROI index (gross margin return on inventory index) on the product level.
3. Aggregation of the results to the supplier level.

The next part of this chapter includes the methodology for estimating the costs generated by delivery via warehouse.

The cost of transportation is calculated on the stage of delivery of products from supplier to the warehouse and from the warehouse to the stores. The following equation shows how the annual cost of transportation per product is calculated:

$$C_{yt} = \bar{C}_{wt} \cdot D_{wr} \cdot n_w \tag{1}$$

where: C_{yt} – annual transportation cost, $\bar{C}_{wt}$ – average weekly transportation cost of one pallet, D_{wr} – weekly demand for a product in the retail chain (in pallets), n_w– number of sales weeks for a product.

The following equation describes how weekly stock in the warehouse for the retail chain is calculated:

$$S_w = \frac{1}{2}U_p + \frac{1}{2}\bar{C}_{of}\bar{D}_{ws} + \max\left\{z \cdot \delta\bar{D}_{ws}\sqrt{L + \bar{C}_{ofr}} \cdot \sqrt{n_{sr}};\ \sqrt{n_{sr}} \cdot U_s\right\} \tag{2}$$

where: S_w – weekly stock in warehouse for the retail chain in pallets, U_p – number of pieces in the purchase unit,$\bar{C}_{of}$ – average order fullfillment cycle (number of weeks the warehouse needs to meet the minimum order quantity/value of the supplier),$\bar{D}_{ws}$ – average weekly demand for one store,z – level of service,$\delta\bar{D}_{ws}$ – standard deviation of average weekly demand for one store[1], L – supplier lead time, $\bar{C}_{ofr}$ – average order fullfillment cycle for stores where the product is the range product,n_{sr} – number of stores where the product is the range product,U_s – number of pieces in the shipping unit.

The calculation of weekly storage cost of a product in the warehouse is presented below:

$$C_{ys} = \max\left\{\frac{S_w}{q_p}; 0{,}125\right\} \cdot \bar{C}_{ws} \cdot n_{sw} \tag{3}$$

[1] We assumed that standard deviation is equal to 30% of the average weekly demand. Standard deviation is calculated from the equation $\delta\bar{D}_{ws} = 0{,}3 \cdot \bar{D}_{ws}$.

where: C_{ys} – annual storage cost, S_W – weekly stock in warehouse for the retail chain (in pallets),q_p – quantity of pieces on a pallet,$\bar{C}_{ws}$ – average weekly storagecost of one pallet,n_{sw} – number of weeks when product was sold.
The number 0,125 is a parametric value. It is introduced to the equation due to the fact that a lot of analyzed products are small in size and for example 1 piece occupies 0,0004 of a pallet. In order to take such products into consideration, we acknowledge that they cover 1/8 of a pallet.

The following equation shows the calculation of the annual handling time (per 1 product) :

$$T_o = T_{pp} + T_{ip} + T_{op} + T_{opi} + T_p + T_{ppi} \tag{4}$$

where: T_h – time of handling operations, T_{pp} – time of pallet picking, T_{ip} – time of inserting pallet to the location, T_{op} – time of pallet opening, T_{opi} – time of order picking, T_p – time of palletizing, T_{ppi} – time of pallet picking to the intermediate storage area.
Annual cost of labour is calculated as below:

$$C_{yo} = \bar{C}_{mw} \cdot T_o \cdot D_{yr} \tag{5}$$

where: C_{yo}– annual operational cost, $\bar{C}_{mw}$ – average cost of 1 minute work[2], T_o – time of handling operations, D_{yr} – annual demand of a product in the retail chain.
The total annual cost of keeping a product in the warehouse is calculated as follows:

$$TC_y = C_{yo} + C_{ys} + C_{yt} \tag{6}$$

where: TC_y – total annual cost, C_{yo} – annual operational cost, C_{ys} – annual storage cost, C_{yt} – annual transportation cost.

The last stage of the cost analysis is the use of stock effect index and GMROI index. The quantity stock effect index shows how the stock changes after a product is moved to the warehouse distribution channel. If the index is greater than zero, it means that after the change of the distribution channel the stock of a product increases in the retail chain. If it is lower than zero, it means that the stock in the retail chain decreases. If the index is equal to zero, there are no changes in the stock quantity. The equation for the quantity stock effect is presented below:

$$SE_q = S_w + (S_s - S_s') \cdot n_{sr} \tag{7}$$

where: SE_q – quantity stock effect, S_W – weekly stock in warehouse for the retail chain in pallets, S_s – stock in a single store if a product is ordered directly from supplier, S_s' – stock in a single store if a product is ordered directly from warehouse, n_{sr} – number of stores where the product is the range product.

[2] Handling operations last from 5 till 60 seconds on average (based on the company's data).

Stock in a single store if a product is ordered from the supplier is calculated as follows:

$$S_s = \frac{1}{2}U_p + \frac{1}{2}\bar{C}_{of} + z \cdot \delta\bar{D}_{ws}\sqrt{L + \bar{C}_{of}} \quad (8)$$

where: S_s – stock in a single store if a product is ordered directly from supplier, U_p – number of pieces in the purchase unit, $\bar{C}_{of}$ – average order fullfillment cycle (number of weeks the warehouse needs to meet the minimum orderquantity/value of the supplier),$\bar{D}_{ws}$ – average weekly demand for one store,z – level of service, $\delta\bar{D}_{ws}$ – standard deviation of average weekly demand for a single store, L – supplier lead time.

Stock in a single store if a product is ordered from warehouse is calculated as follows:

$$S_s' = \frac{1}{2}U_s + \frac{1}{2}\bar{D}_{ws} + z \cdot \delta\bar{D}_{ws} \quad (9)$$

where: S_s' – stock in a single store if a product is ordered directly from warehouse,U_s– number of pieces in the shipping unit, $\bar{D}_{ws}$– average weekly demand for a single store, $\delta\bar{D}_{ws}$– standard deviation of average weekly demand for a single store.

The stock effect can also be expressed in terms of value. The below equation shows the calculation:

$$SE_v = SE_q \cdot P_n \quad (10)$$

where: SE_v– value stock effect, SE_q– quantity stock effect, P_n– net purchase price.

The final indicator for making the decision if a product should be moved to the distribution channel via warehouse is the GMROI index (gross margin return on inventory index). The index is calculated with the following equation:

$$GMROI = \frac{C_y}{-SE_v} \quad (11)$$

where: GMROI – gross margin return on inventory index, SE_v– value stock effect, P_{net}– net purchase price.

If the value stock effect is greater than zero, it means that the costs of handling and transportation are much higher than the benefits of decreasing the stock in the retail chain. Therefore, such products are not taken into account in the analysis.

The treshold for the GMROI index is 1. If the index is lower that 1, a product should be moved to the warehouse distribution channel. The costs that are generated due to changing the distribution channel (value stock effect is lower than zero) are lower than the benefits of decreasing the stock in the retail chain.

Due to the fact that each supplier should only use one distribution channel, the decision whether the distribution channel should be changed or not has to be made on the supplier level and not on the product level. Therefore we aggregated the results from the previous part of the analysis to the supplier level. As a result, if the GMROI index is lower than 1, supplier should be moved to the warehouse distribution channel. The costs that are generated due to handling and

transportation operations (value stock effect is lower than zero) for all products of the supplier are lower than the benefits of decreasing the stock in the retail chain.

EMPIRICAL RESULTS

The purpose of the study was to create a comprehensive analytical model to identify products and suppliers which should change the distribution channel from direct delivery to the distribution channel via warehouse. The change of the distribution channel should result in better stock availability for the retail chain and a reduction in distribution costs. With use of the algorithms presented in the previous part of the paper we conducted an empirycal analysis that gives us the recommendation which suppliers should change the distribution channel.

In the first stage of the analysis we excluded products that should not be stored in the warehouse (eg. plants). Furthermore, products that are sold in three or lower number of stores (out of 28 stores) were also excluded. It was considered that if a product is not poplar in the whole retail chain there are no prerequisites for keeping stock of these products in the warehouse.

The next step was to impose constraints on the analysis. The constraints based on the specifics of the analyzed enterprise and suppliers. We assumed that a product should be distributed via the warehouse if:

- Minimum order value is greater than 500 PLN (with a logistic minimum of more than PLN 500 PLN, a store may have no place to store products from a given order and funds to pay for an order).
- Lead time is greater than 7 days (if the supplier determines the delivery time for more than 7 days, it is much safer to keep his products in the central warehouse to avoid products' unavailability).
- There is a possibility of reducing a purchase unit (multipacks instead of a pallet).

Based on the constraints mentioned above we chose 8 priority groups. These groups indicate which products were more or less likely to change the distribution channel even before conducting the cost analysis. This means that the following breakdown is based only on products' specifics. The groups are as follows:

- Group 1 – products that fullfill all three constraints. The change of the distribution channel is most likely.
- Group 2, 3 and 4 – products that fullfill two out of the three constraints.
- Group 5, 6 and 7 – products that fullfill only one out of the three constraints.
- Group 8 – products that do not fullfill any of the constraints. The change of the distribution channel is least likely.

Based on the available data concerning the three constraints, the classification of the products and suppliers to each priority group has been presented in Table 1. We analyzed 238 suppliers that offered 31,549 products.

Table 1. Classification of products and suppliers to each priority group

Group	Minimum order value > 500 PLN	Lead Time > 7 days	Possibility of decrasing the purchase unit	Number of supliers	Number of products
1	X	X	X	34	6,712
2	X		X	75	10,232
3	X	X		26	2,467
4		X	X	10	1,663
5	X			27	2,480
6		X		4	151
7			X	45	6,985
8				17	859
Sum:				238	31,549

Source: own work based on the data of the analyzed company

Group 1 (all constraints met) includes 34 suppliers with almost 7 thousand products. Constraints connected with minimum order value and the possibility of reducing the purchase unit (group 2) were fulfilled by 75 suppliers and over 10 thousands products. Only 17 suppliers and almost 900 products did not fullfill any constraint (group 8).These suppliers has not been taken in the consideration in the next step of the analysis.

The second stage of the analysis covered the cost analysis in the distribution channel via warehouse. We calculated average annual costs of transportation and cost of handling. Due to the fact that both suppliers and stores are located throughout Poland we estimated the average transportation cost of 1 pallet to be 60 PLN.

Table 2 includes average time and cost of handling operations in the warehouse. Based on the company's data we estimated that 1 minute of work of a warehouse employee is equal to 0.21 PLN.

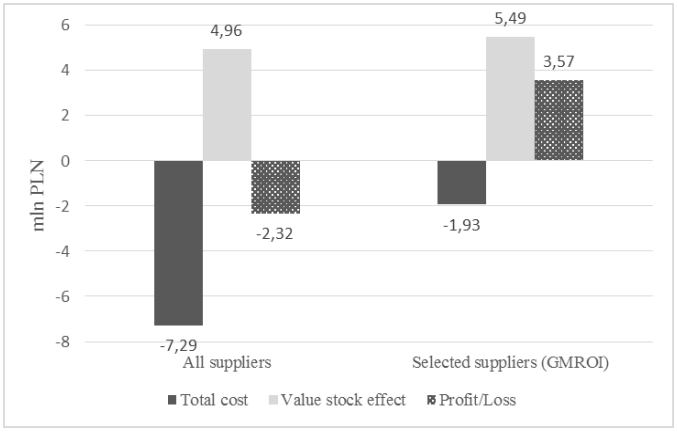
Table 2. Parameters of handling operations

Operation		Average time (sec.)	Average cost (PLN)
Pallet picking		60	0.21
Inserting the pallet to a location		20	0.07
Oppening the pallet		30	0.11
Order picking	Purchase unit = shipping unit	5	0.02
	Purchase unit > shipping unit (pallet to multipack)	10	0.04
Palletizing		60	0.21
Pallet picking to the intermediate storage area		30	0.11

Source: own work based on the data of the analyzed company

Figure 1 presents the results of the cost analysis for two scenarios. The first scenario concerns the situation when all the suppliers classified to the 8 priority groups and their products are moved from the direct delivery distribution channel to the warehouse distribution channel. As a result, the costs of transportation, handling and storing of the products far outwiegh the savings connected with moving the stock from the retail chain shops to the warehouse (value stock effect). We estimated that in this scenario the company could lose over 2.32 mln PLN annually.

Figure 1. Results of the cost analysis (in mln PLN)



Source: own work based on the data of the analyzed company

Obviously, the change of the delivery channel for all suppliers and their products is not beneficial to the company. Therefore, we calculated the GMROI index for each supplier in order to select the suppliers which do not generate additional costs for the company, ie. the benefits resulting from decreasing the stock in the retail chain outwiegh the costs of changing the distribution channel (the second scenario). After the GMROI index analysis we stated that 105 suppliers (44% of the suppliers) should be moved to the warehouse distribution channel. These suppliers deliver 11,528 products to the company (36% of all products).

If only the selected suppliers are moved to the warehouse distribution channel, the company can save around 3.57 mln PLN. The costs connected with transportation, handling and storing of the products are equal to almost 2 mln PLN and the value stock effect exceeds these costs almost three times.

CONCLUSIONS

This paper contributes to verification of the algorithms related to the costs of distribution and to creation of an analytical model enabling to identify an effective distribution channel for suppliers of a DIY enterprise. Based

on the empirical study the analyzed enterprise suppliers with recommendation for the change of the distribution channels have been selected. As a result, the enterprise could benefit from the lower costs of distribution and even generate profit. Taking into consideration the result of the analysis and the literature overview it may be stated that a comprehensive analysis of distribution costs contributes to the minimization of these costs. Individual products or suppliers can generate a loss or profit for a business, depending on whether the distribution channel is matched appropriately with the product, supplier, market and retailer specifics.

Although the analysis was conducted at a complex level, it was tailored to the needs of only one DIY company. Obviously, the obtained results may be generalized to the level of the whole non-food retail sector. However, there are still other sectors which were not included within the framework of the study. Therefore, this paper should be followed by an attempt of creation of analogous analytical models for other sectors, especially those dealing with products of a completely different nature, such as food sector. Furthermore, the study can be extended for non-Polish retail markets. In countries with different market environments, companies can organize their distribution processes in a completely different way.

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