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CROSS DOCKING IMPLEMENTATION IN DISTRIBUTION OF FOOD PRODUCTS

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Summary

The research domain of this paper is food distribution improvement using the logistic concept of cross docking. The study purpose is to explore, analyse and demonstrate effects of cross docking implementing in business trading company and the factors influencing to implementation effectivness, as well. The metodology used in the study includes the actual logistics and supply chain management literature review and the real-world study with the concept implementation. The main achieved results are that under defined circumstances cross docking can be suitable tool for food distribution improvement and valuable for the company's competitivness increasing. The validity of the cross docking implementation is reflected in multiple (direct and indirect) benefits not only for the company, but also for the whole supply chain.

Key words: *distribution strategy, cross doking performance factors, trading chain, case study, process improvement.*

JEL: *D39, L81, M19, Q13, R41.*

Introduction

In today's business and logistics environment, which often requires frequent deliveries and small orders, cross docking can serve as one of the logistics concepts that contribute to the achievement of timeliness and economical supply. Cross docking is defined as a logistic concept used to consolidate shipments from inbound trailers to outbound trailers in the warehouse/distribution facilities, known as cross docks. Inbound trailer (transportation vehicles) typicaly arrives from a different origin points, carrying shipments for different

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destinations. The shipments are then unloaded, sorted, consolidated and reloaded into outbound trailers (transportation vehicles). It is common that all shipments handling is completed with minimal retention and no holding of stock in the cross dock.

Cross docking can contribute to achieving significant benefits. Instead of shipping small orders, that do not occupy the entire cargo area, directly on the trailers (Less-Than-Truckload, i.e. LTL), cross docking consolidates small orders into one big shipment, in order to fullfill the entire cargo area (Truck-Load, i.e. TL). Thus, with the help of a cross docking, more frequent and more economical deliveries could be made, because, with every other delivery, orders meet the entire cargo area in trailers. With these just-in-time deliveries, inbound shipments are transferred directly to outbound shipments with little, if any, warehousing.

Globalization trend exposes Serbian food chain to higher level of competition with entering domestic market by foreign companies and market deregulations. The process of transition of Serbian food sector is still ongoing and many changes happen on every level of food chain. Besides costs, the main characteristics of the current food distribution systems in Serbia are the requirements of just-in-time delivery and flexibility. Most buyers on Serbian food market expect the delivery within one or two days or even the same day („day for day" delivery), as the authors [5] and [14] point out. This was a major impetus for our research.

This paper has following structure. Part of the work entitled as Theoretical background includes a review and analysis of attitudes of recognized researchers and authors in terms of precise definition of the concept, systematization and classification of the cross docks, as well as conditions and resources necessary to implement the concept. The third part deals with the systematization and analysis of factors influencing the success of the cross docking operations. The fourth chapter, given as a real-world case study, represents the implementation of cross docking in a food distribution company. In the conclusion we discuss about the achieved results and give concluding remarks and some possible directions for future research.

Theorethical background

In the scientific and professional literature that belongs to the field of *Logistics & Supply Chain Management, i.e. L&SCM*, there are a number of studies that indicates different aspects of a cross docking. However, there are not many authors who were researching on implementing of cross docking in the food industry, especially in Serbia.

Although cross docking is considered as a relatively new logistics strategy according to [19], its roots are tied for 1930s. Even if there are claims that it is used in U.S. military operations in the supply during WWII, the business world has recognized the importance of the cross docking concept until the late of 1980s, when it was applied by the retail chain Wal-Mart, which thereby achieve significant savings.

Although there are many authors that have been regard cross dock and warehouse as identical, [2] point out the basic difference between them, indicating that goods are stored in the facility (Cross Docking Centre, i.e. CDC) for at most 24 hours, which made a clear distinction from conventional or tradicional warehousing.

During the 1990s a mainly issues of the authors heve been addressed by the forms and modeling of cross docking, the resources needed to carry out operations themselves, as well as the implementation of the concept. In this view, the authors in [18] indicates the three basic models of cross docking: manufacturing cross docking, distribution cross docking and terminal cross docking, while most of the authors consider only the terminal cross docking, as the way of sorting and consolidation of goods in cross dock center and their transportation to and from the center. Nevertheless, there are some extensions of mentioned classification. The authors [11] and [17] suggest the models of retail and opportunistic cross-docking. It is the same logistics technics and the diferences between cross-docking models are related to the place of cross docking application (manufacturing plant, distribution system, retail outlets). According to time when customer is assigned to a product the author [8] differs pre-distribution and post distribution cross docking. But generally speaking, as pointed out [16] the best candidates for cross-docking are fast-moving products with constant demand. The authors [3] classify cross dock as: a single-stage, a two-stage and free-staging. In the first case, pallets (e.g. goods) are unloaded and placed into staging lines that correspond to either the receiving or shipping gates, depending on whether there is known final destination. Two-stage cross dock allows workers in the CDC to sort out pallets from the staging lines that correspond to the receiving gates into the staging lines that correspond to the shipping gates, which is advantageous in terms of greater flexibility and transparency of the process. A free-staging cross dock does not use any queue (e.g. stages, lines) where pallets are placed at one end and pulled from the other. Instead, a free staging area is reserved next to each receiving, shipping, and/or both gates. There are also authors, like [6], which suggest that receiving shipments need to diverte to a special section for reallocation and repackaging items, before they are being transported to the shipping gates.

There are opposing opinions on the implementation of a cross docking, among the authors. Specifically, one group of authors, including [18], considers that the implementation of the concept is relatively simple if you clearly define the company's specific needs for cross docking. In contrast to such views, most authors, including [20], considers that the implementation of the cross docking concept is a complex process which, if not done properly, can have the outcome in the form of traditional warehouse and distribution processes. What speaks for the complexity of the implementation process is the research group of authors [15] who have tried using simulation techniques to ensure that the concept is implemented exactly as it was planned. An important success factor of the implementation of the concept is location of cross dock center, and some authors such as [1] and [7] dealing with the problems of determining the optimal location of such a center. It is alleged that this problem is NP-hard, and authors such as [9] using the heuristic methods does not always find an optimal solution, but the suboptimal and feasible solutions. In our paper the problem of optimal location of cross–docking center is not considered because the company in the focus has reorganized distribution proces using its own facility without green-field investment. Generally, most of the authors belives that the cross docking is widely applicable. According to [2], in certain circumstances, cross docking can be perfectly applicable in agri-food industry and distribution of perishable goods. Moreover, cross docking should improve coordination and cooperation

in distribution chain, and the authors [10] have the oppinion that coordination mechanisms must be reconsidered in agri-food chain's efficiency term. In that sence, the authors [12] and [13] underline the influence of knowledge sharing, cooperative and collaborative concepts on efficiency and organizational performances in agro-business sector.

Factors influencing cross docking effectivness

Greatest benefits of cross-docking operations are shipment consolidation and customization, reduced transportation cost, reduced needs for warehouse space and labor cost, just-in-time of deliveries, improved service level and demand and supply balancing. The main factors influencing cross docking effectivness are following:

1) Pallet handling
2) Freight mix
3) Number of forklifts
4) Number of receiving gates
5) Gates layout and size of a cross dock.

For handling pallets between the incoming (inbound) and outgoing (outbound) trailers, a manager has the options of direct or indirect pallets manipulation. In the case of indirect pallets manipulation (indirect unloading and/or indirect loading) storiging areas (buffers) are used between the incoming and outgoing trailers. In that view, there are the four basic options of pallets handling shown in Table 1:

Table 1. Pallet handling options

Option	Inbound storaging	Outbound storaging
1	No (Direct unloading)	No (Direct loading)
2	Yes (Indirect unloading)	No (Direct loading)
3	No (Direct unloading)	Yes (Indirect loading)
4	Yes (Indirect unloading)	Yes (Indirect loading)

Option 1 eliminates double handling of goods, while options 2 and 3 require additional lifting and lowering operations beside ingoing or outgoing gates. Option 4 requires two additional handling operations and additional hyman resources, but it maximizes the capacity of a cross dock facility.

When it is about freight (pallet) mix, according to [4] authors showed that the flow rates to different destinations typically differ by a factor of 2 to 10. They examined two pallet mixes: Uniform and Bayes'. Under the Uniform pallet mix, each pallet received is assigned a destination with equal probability, while under the Bayes'pallet mix; each pallet is randomly assigned a destination such that 70% of the pallets are directed to 30% of the destinations. Usually in practice, a few outgoing gates take over most of the transported goods and the cross dock managers must focus their attention on these gates.

Number of forklifts is also a very significant factor of cross docking effectivness. In most cross docks, each forklift is assigned to a certain number of receiving gate to move pallets from its assigned gate to any shipping gates. However, when more forklifts are assigned, it will increase congestion and slow pallet movements process. Thus, the problem of determining the optimal number of forklifts and transport vehicles is particularly significant.

As for the number of receiving gates, many cross dock managers are interested, mainly due to several reasons, to minimizing the number of receiving gates. One reason is to reduce the number of security and receiving inspection points by opening fewer gates. Second reason lies in the fact that delays are more predictible by ingoing than outgoing gates (theoreticaly all forklifts can be simultaneously on the same outgoing gate). Another important reason is a smaler number of gates means less transported distance.

The size and internal layout of the receiving and shipping gates also have affect at the cross docking process performance. In practice, usually there are four combinations of gate layouts: (1) LALS (*i.e. Left Arrival and Left Shipping*) layout uses receiving gates from left to right and assigns destinations with the heaviest traffic to shipping gates from left to right, (2) LARS (*i.e. Left Arrival and Right Shipping*) layout uses receiving gates from left to right and assigns destinations with the heaviest traffic to shipping gates from right to left, (3) CACS (*i.e. Central Arrival and Central Shipping*) layout uses receiving gates in the central part of the cross dock and also assigned destinations with heaviest traffic to shipping gates nearer to the central part of the cross dock, and (4) SASS (*i.e. Spread Arrival and Spread Shipping*) layout attemps to spread the traffic as evenly as possible along the entire cross dock.

Cross docking based distribution of food products: A real world case study

To evaluate the validity of using cross docking in real industrial conditions, for the purpose of this research, concept of cross docking has been tested on the example of a large retail chain in Serbia. This retail chain, with over 3000 employees, has its own wholesale trade facilities in several cities in Serbia and also has dozen retail stores. It has its own fleet of vehicles for different purposes and capacities used for distribution of goods. Also, a certain number of vehicles have been taken on lease.

Analyzing logistics costs in this company it was noted that transportation costs, as well as in most other companies in this industry, have the largest share. Costs of transportation goods from wholesale trade object in Belgrade to the 21 retail stores in Vojvodina were very high, so a primary goal of this study was to reduce them by using a cross docking concept. One of the possible solutions is to make entire transportation of ordered goods from Belgrade to the wholesale center in Subotica town, which shall serve as a cross dock center, and then send goods from Subotica to retail stores.

This study contains an overview of the starting condition in the distribution sector (before the implementing of the cross docking concept), the situation after the implementing of this concept and calculated effects that cross docking brings. The observed time horizon in this study was one quarter of a year e.g. three months. The transportational goods structure

consists of packeted goods (50%) and fruits and vegetables (50%). Initial constraint, that must be taken into account, is that wholesale center in Subotica has no refrigeration or special storage equipment required for perishable goods.

The initial strategy was based on the distribution of direct deliveries from the central wholesale center in Belgrade to 21 retail stores in Vojvodina, with an average of 7 trucks per day. The fuel price that the company purchased in that period was 75 [RSD/l]. Driver's hourly wage was 150 [RSD/h], while the cost of leasing was approximately 2080 [EUR/vehicle] (the price is converted from euros into dinars with the average exchange rate for the reference month; 1 EUR=76,73–91,63 RSD, data from 4th quartal of 2008 year, source: National Bank of Serbia). Calculated toll rates were: Belgrade-Novi Sad 710 [RSD] and Novi Sad-Subotica 990 [RSD], one dirrection only. The individual and the total amount of costs for the three-month period before the implementing a cross-docking are shown in Table 2.

Table 2. The Distribution costs of goods from Belgrade to the retail-store objects

Indicators	Periods			Total
	Month 1	Month 2	Month 3	
Distance crossed [km]	47.330	41.357	48.360	137.047
Fuel consumpion [litre]	11.832	10.339	12.090	34.261
Value of fuel consupmion [RSD]	887.437	775.443	906.750	2.569.630
Total time spend on touring [hour]	1.148	974	1.527	3.649
Value of total time spend on touring [RSD]	172.260	146.053	229.093	547.406
Number of tours [1]	197	157	204	558
Toll value [RSD]	669.800	533.800	693.600	1.897.200
Number of pallets transported [piece]	2.358	1.953	2.719	7.030
Total weight transported [kg]	1.205.200	858.450	1.422. 232	3.485.882
Vehicle maintence costs [RSD]	1.111.576	994.913	1.174.420	3.280.909
Lease costs [RSD]	1.442.815	1.362.643	1.697.352	4.502.810
Total sum [RSD]	4.283.888	3.812.852	4.701.215	12.797.955

Source: Own calculations based on a survey
Note: The values in the table are calculated without VAT (Value Added Tax)

After putting cross dock center in Subotica into operational mode, the new business strategy required the distribution of fruit and vegetables directly from Belgrade to retail stores in Vojvodina, while packaged goods first transported from Belgrade to the cross dock center, and from there, using only three trucks, further distributed to retail stores in Vojvodina. Thus, by implementing a cross dock center, distribution costs of goods asquire following structure: the cost of distribution of fruit and vegetables from Belgrade to the retail-store objects in Vojvodina (Table 3), the cost of distribution of packaged goods from Belgrade to Subotica via transport service (Table 4), and distribution costs of packaged goods from Subotica to retail-store objects in Vojvodina (Table 5).

Table 3. The Distribution costs to the retail-store objects in Vojvodina

Indicators	Periods			Total
	Month 1	Month 2	Month 3	
Distance crossed [km]	23.665	20.678	24.180	68.523
Fuel consumpion [litre]	5.916	5.169	6.045	17.130
Value of fuel consupmion [RSD]	443.718	387.721	453.375	1.284.814
Total time spend on touring [hour]	574	487	764	1.825
Value of total time spend on touring [RSD]	86.130	73.026	114.546	273.702
Number of tours [1]	98	77	102	277
Toll value [RSD]	334.900	266.900	346.800	948.600
Number of pallets transported [piece]	1.179	976	1.358	3.513
Total weight transported [kg]	602.600	429.225	711.116	1.742.941
Vehicle maintence costs [RSD]	555.788	497.457	587.210	1.640.455
Lease costs [RSD]	721.407	681.321	848.676	2.251.404
Total sum [RSD]	2.141.943	1.906.425	2.350.607	6.398.975

Source: Own calculations based on a survey

Table 4. The Distribution costs of packaged goods from Belgrade to Subotica via transport service

Indicators	Periods			Total
	Month 1	Month 2	Month 3	
Number of pallets transported [piece]	1.179	976	1.358	3.513
Number of tours [1]	37	31	42	110
Transportation costs [RSD]	1.079.000	876.500	1.209.500	3.165.000

Source: Own calculations based on a survey

Table 5. The distribution cost of packaged goods from Subotica to retail-store objects

Indicators	Periods			Total
	Month 1	Month 2	Month 3	
Distance crossed [km]	12.926	11.295	13.208	37.429
Fuel consumpion [litre]	3.231	2.823	3.302	9.356
Value of fuel consupmion [RSD]	242.378	211.790	247.653	701.821
Total time spend on touring [hour]	314	266	417	997
Value of total time spend on touring [RSD]	47.048	39.890	62.570	149.508
Number of tours [1]	98	77	102	277
Toll value [RSD]	0	0	0	0
Number of pallets transported [piece]	1.179	976	1358	3.513
Total weight transported [kg]	602.600	429.225	711.116	1.742.941
Vehicle maintence costs [RSD]	203.858	164.970	224.806	593.634
Lease costs [RSD]	480.938	454.214	565.784	1.500.936
Total sum [RSD]	974.222	870.864	1.100.813	2.945.899

Source: Own calculations based on a survey

Total sum of the distribution costs after implementing cross docking concept for the three-month period is shown in Table 6.

Table 6. Total costs of goods distribution using a cross docking concept

Indicators	Periods			Total
	Month 1	Month 2	Month 3	
The distribution costs of fruits and vegetables from Belgrade [RSD]	2.141.943	1.906.425	2.350.607	6.398.975
Transport service costs [RSD]	974.222	870.864	1.100.813	2.945.899
The distribution costs of packeted goods from Subotica [RSD]	1.079.000	876.500	1.209.500	3.165.000
Total sum [RSD]	4.195.165	3.653.789	4.660.920	12.509.874

Source: Own calculations based on a survey

Considering distribution costs before and after implementing cross docking concept, Table 7 presents accomplished savings:

Table 7. Cost savings using a cross docking concept

Indicators	Periods			Total
	Month 1	Month 2	Month 3	
The distribution costs of goods from Belgrade [RSD]	4.283.888	3.812.852	4.701.215	12.797.955
The distribution costs with cross dock [RSD]	4.195.165	3.653.789	4.660.920	12.509.874
Total cost savings [RSD]	88.723	159.063	40.295	288.081

Source: Own calculations based on a survey

Therefore, recording the current situation it was found that the total cost of distribution of goods amounted to 12797955 [RSD] for the period of 3 months. By implementing cross dock center in Subotica, the total distribution cost of goods have been reduced to 12509874 [RSD], thus, saving in the amount of 288,081 [RSD] in one quarter of a year. For the expectation is that annual savings amounted to around 1200000 [RSD]. If we consider impossibility of cross dock centre in Subotica to store fruits and vegetables, it is reasonable to analyze the feasibility of equipping such centre with cooling systems that would allow short-term storage of perishable goods, which will eliminate a need for holding such goods in central warehouse in Belgrade.

Conclusion

The main conclusion that arises from the above is that the cross docking implementation in food products distribution can lead to the significant cost advantages and savings. It schould be noted that these savings are realized under particularly favorable circumstances or that company owned storage facility located in Subotica and adapted it into cross-docking center with insignificant investements and no extra-maintenance costs. These savings could be significantly higher if the investment is made in appropriate equipment to implement cross docking concept on the entire contingent of goods, not only the packeted goods. From

the designing and managing cross docking aspect it is important to consider factors such as size of a cross dock, the number and capacity of inside transport vehicles, the number of receiving gates and their layouts, etc. Also, by oppening to many receiving gates in a cross dock will increase the cost of security and inspection and it will have a negative effects on the performance of a cross dock. If the objective is to maximize the capacity of a cross dock, indirect unloading and indirect loading seems to be the best solution. Hence, it is interesting direction for our future research in domain of the organization analisys of CDC and impact quantitatification of all identified factors that determine the performance of a cross docking approach.

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PRIMENA CROSS DOCKING KONCEPTA U DISTRIBUCIJI PREHRAMBENIH PROIZVODA

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Rezime

Problem koji se u radu istražuje je mogućnost unapređenja distribucije prehrambenih proizvoda primenom logističkog koncepta cross docking. Cilj rada je da se analiziraju i istaknu prednosti i mane primene ovog koncepta u poslovanju trgovinskog preduzeća, kao i faktori koji utiču na uspešnost implementacije koncepta. Metodologija koja je korišćena u istraživanju obuhvata pregled savremene literature u oblasti distribucije i upravljanja lancima snabdevanja, kao i primenu koncepta na realnoj studiji slučaja sa prikazom ostvarenih ušteda. Osnovni zaključak koji se nameće je da u definisanim uslovima koncept cross docking može biti u funkciji unapređenja distributivnog procesa trgovinskog preduzeća u industriji hrane, kao i njegove kompetitivne prednosti u celini. Društvena opravdanost primene cross docking-a se ogleda u direktnim i indirektnim benefitima ne samo za preduzeće, već i za lanac snabdevanja u celini.

Ključne reči: *strategija distribucije, činioci performansi cross docking-a, trgovinski lanac, studija slučaja, unapređenje procesa.*

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CONTENT