THE APPLICATION OF CROSS DOCKING TECHNIQUE AND OPTIMIZATION METHOD IN SUPPLY CHAIN FOR PHARMACEUTICAL BRANCH

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Abstract
The objective of the article is to present the solution how to distribute products in the pharmaceutical branch. It is based on cross docking and just in time rules. Solution applies a simple and at the same time effective optimization methods in order to increase the effectiveness of the distribution process for medical products.

An analysis of the input state of the company specializing in medicines distribution was carried out using methods such as Ishikawa Diagram and 5WHY. The results of the analyzes showed that changes were indispensable. The result of the implemented solution is the shortening of the order processing time, the reduction of the storage area, the elimination of the goods storage phase, the optimization of the transport routes, and thus the increase in efficiency and lowering the costs of the operations.

Keywords:
distribution, Just in Time, cross docking, optimization, the problem of the salesman, solver

1 INTRODUCTION
Cross-docking warehouses are increasingly used in supply chains distributing perishable products as the products have short shelf-life. Cross docking is a “process of consolidating freight with the same destination (but coming from several origins), with minimal handling and with little or no storage (Van Belle et al. 2012).

Implementation of proper cross docking has significant advantages over traditional warehouse approaches, such as reduction or possible elimination for material storage and order picking, thus reducing inventory holding cost and labor cost associated with them (Galbreth et al. 2008), making the supply chain more efficient.

The pharmaceutical market in Poland has seen rapid growth in recent years, and consequently the emergence of new companies dealing with the distribution of medicinal products. As a result, we are seeing an increase in competition and forcing better and better adhering to the market demands that consumers create. It significantly influences the need to improve the efficiency of the logistics processes of all actors involved in the supply chain. In particular, this applies to industries where the delivery of products to the customer in the state of superior quality is a priority.

Particular attention is paid to the satisfaction of the final customer from the delivered product while achieving high efficiency in the distribution process and reducing the business costs. Nowadays each distributor of medicines connects the operation of the business models of customers and suppliers, carefully defining their needs and implementing modern solutions in herein domain.

Cross docking is a special method of distribution that involves the delivery of any quantity of goods from the manufacturer or supplier to the distribution center and further to the customer. Everything is carried out based on current needs of recipients. The main processes involved in cross docking include consolidation and deconsolidation of consignments. Cross docking system is presented on Figure 1. However cross docking can not be always implemented.

Ideal conditions when it is closed system where suppliers deliver supplies on a daily basis and shipments are delivered on a regular basis to the same customer group(Cyplik P., Hadaś Ł., 2012, s. 72-76).

Acceptance of delivery

Completion

Shipment

Figure1: Cross docking system.

In practice, staging is required because many inbound shipments need to be sorted, consolidated and stored until the outbound shipment is complete. So, this strict constraint is relaxed by most authors. Cross docking then can be described as the process of consolidating freight with the same destination (but coming from several origins), with minimal handling and with little or no storage between unloading and loading of the goods. If the goods are temporarily stored, this should be only for a short period of time. An exact limit is difficult to define, but many authors talk about 24 h (e.g. Bartholdi, Gue 2004, Li et al. 2004, Vahdani, M. Zandi, 2010, Wen et al 2009)

2 JUSTIFICATION OF THE SUBJECT MATTER CHOICE

The objective of herein paper is to conduct an analysis of distribution process of medicines in the company and propose changes to this process using cross dock and Just in Time methods. Proposed solution based on cross docking is a response to the growing distribution chains for medicinal products in the researched entity.

It demonstrates itself with getting new markets what is characteristic of the modern enterprise, aiming to get the position of the leader on the given market. The appearance of new, serviced delivery points is associated with more shipments. The cross docking-based product distribution
meets all the requirements, but it requires rigorous synchronization of all the supply chain links.

Paper presents a diagram of changes in the process of handling orders, storage and distribution of a company that uses cross docking. The layout of the warehouse that meets the requirements of the adopted solution is also presented. In addition, the salesman method is used, which helps to allocate and optimize fixed transportation routes. Solver, which is available in Microsoft Office Excel, is used to solve the salesman problem. The research part precedes the analysis of the research area.

3 THE ANALYSIS OF RESEARCH AREA

The company in the subject of study is specialized logistics operator whose main task is the distribution of medicinal products. Firm has a complex distribution network in Poland. Accordingly, the research will be limited to one selected area - the Poznań region in Poland. The company is a leader in the distribution of medicines.

Within its key competences, it performs the following services:

- Supply chain management of pharmaceutical products
- Distribution of pharmaceutical products
- Storage of pharmaceutical products

All above activities has to be performed in accordance with regulations of Good Distribution Practice (GDP), Pharmaceutics Law and keeping the rules of the partnership. The company outsources the transportation services needed to perform tasks in this area. The company has implemented a Quality Assurance System that has a strong influence on its organizational structure, processes and resources. The pharmaceutical industry is characterized by very high requirements at each supply chain.

The company complies with these requirements as evidenced by its stable position on the market of distribution companies and customer satisfaction. The company's primary goal at this moment is to capture more retail customers and gain industry leadership. However, to achieve these goals, it is necessary to harmonize, synchronize and optimize all logistical processes in the supply chain. Key processes are order handling and delivering the medicines.

Lean Management tools were used to determine the effectiveness of the implemented processes: the Ishikawa diagram and the 5WHY method. The analysis of logistical processes using the Ishikawa diagram showed numerous problems with delivery of the shipments. The main problem that occurs during the execution of orders is its timely and faultless delivery to the customer. The lack of delivering parcels can have its source in two causes. First it is a fault of the carrier and in fact such a situation most often takes place. The second is due to the fault of the company itself. Mistakes caused by the fault of the company were identified during the 5WHY analysis. This is most often incorrectly filled or incomplete contact details on shipping documents. Due to the reasons given by the carrier, the most common cause is the failure of the means of transport and damage to the consignment in the course of the service.

Another identified cause, which unfortunately neither the company nor the carrier has any influence is affected by weather conditions and unforeseen road events. They can greatly affect the effectiveness of delivery or even prevent it altogether. The presented results show that special attention should be paid to the elimination of errors when filling the shipping documents and the work of the forwarder. That is why these processes should be analyzed and controlled carefully. This will allow for quick response and implementation of corrective and preventive actions. These actions should be primarily aimed at limiting non-deliveries of parcels.

However, it must be assumed that each process is to some extent fraught with the risk of failure, which can be completely eliminated or minimized by the available localization and communication tools.

4 PRESENTATION OF THE SOLUTION

4.1 The general scope of changes in the enterprise

The company under the study plans to initiate a change in the distribution process for all destinations. The main factor that influences this decision is the fact that the company has recently gained a lot of new customers and has led to a significant expansion of the distribution network to other cities. The occurrence of such a large number of new collection points requires the separation of certain fixed routes, because through this organization the distribution process will be optimal and controllable. Of course, ‘fixed’ in this case means until a new point on the route will appear.

The changes will also involve the transformation of a warehouse adapted to the classical storage of medicinal products into a cross docking warehouse. The implementation of proposed changes in distribution process requires a new solution and approach to deal with delivery supplies and customer orders. Pharmaceutics will not be stored in the company’s warehouse, but only accepted and completed in shipping units and forwarded to the forwarder.

4.2 The essence of cross-docking and changes in the process of handling orders

The essence of cross docking is to receive, store and release goods from the warehouse within a short period of time. All warehouse operations should be performed in less than 2 to 6 hours. The most important success processes are fast, efficient and error-free order picking from customers and their faultless labeling, sorting and release to the delivery man. When company implement solution based on cross docking technique it must in the first step implement changes in the process accepting and drawing orders up.

After the benchmarking analysis of the available distribution solutions, it was decided that the entire process of developing and forwarding customer demand would be conducted at the cross docking terminal. At this place will be also conducted all activities related to the acceptance and control of deliveries, order picking, packing, security, labeling and delivery for shipping.

This aims on the one hand to preserve the quality of the product and optimize the process and, on the other hand, to eliminate errors and mistakes while controlling them. The process of order realization begins when customer demand is accepted.

So that order could be carried out on next day customers are obliged to place one's requirement up to 12 p.m. Orders placed later or on a free day are accepted for the next working day. At 12 p.m. all list of requirements is closed and orders are sent to the manufacturers and suppliers of medicines as well as the demand for transport services to the freight forwarder. Deliveries are carried out in accordance with Just in time concept. In the Just in Time system, the delivery volume from the suppliers is consistent with the current recipients’ requirements.

Total amount of requirements $\sum \alpha_{O_i}$ for assortment $O$ for given supplier $D_i$ is equal to its supply corresponding to the
quantity of the supply di and is given by the formula (Fertsch M., Ponikierska A., 1999, p. 37):

\[ \sum_{j=1}^{n} \sum_{i=1}^{m} a_{ij} = d_i \]  

(1)

All shipments defined on a given day must arrive from the manufacturers and suppliers to the cross docking warehouse at the appropriate time, no earlier or later but on time. Such technique guarantee that a distribution process runs smoothly. Deliveries are executed in time windows from 4:00 a.m. to 4:30 a.m. Consequently cross docking packing is done from 4:30 a.m. to 6:30 a.m.

The fixed time intervals provide for the smooth transfer of goods arriving from the delivery to the disposal zone, which is considered to be the reception zone and the area where the picking operation takes place.

Parcels delivered from producers and suppliers of medicines are being carefully checked in terms of quantity and quality and furthermore accepted to the stock. In case of non-compliant delivery, the appropriate Quality Assurance System procedure is started.

On the other hand, the goods conforming with the requirements are immediately transferred to the picking zone, where the customer requirements are met. Particular attention is paid on the quick and proper completion of the goods in the picking container in accordance with the picking list. All mistakes generated at this stage are caught at a special control station, where quantitative and qualitative checks on the contents of the picking list are carried out.

At the next stage the goods are secured, packaged and labeled according to the customer data. All shipments that crossed the cross docking go into the dispatch zone, where are located properly prepared intermediate storage areas. These fields are marked with the route number that the forwarding agent will move. For example, the field labeled ‘1’ has all the consignments marked on the consignment note ‘1’. The sign clearly determines the shipment to be discharged on route 1. The diagram of the crossover system is shown in Figure 2.

![Crossover System Diagram](image)

**Figure 2. Scheme of cross docking system.**

Shipment to be forwarded and transported are prepared by an appropriate sorting in the terminal with the separation into individual routes and placement in the appropriate intermediate storage areas in the release zone to be taken to the freight forwarding.

In this place release control takes place. The outbox label is checked at the control position and whether the consignment was correctly assigned to given route. The consignments are then picked up by the drivers designated to handle the route. The driver takes the shipment from the appropriate stocklot and uses the scanner to send the parcels to his account by assigning his / her personal data, vehicle registration and route number. At the next stage an employee responsible for coordinating the process issue the shipping documents indispensable for driver. The final step is to properly deliver the shipment to customers by a certified forwarder. The Freight Forwarder is responsible for the correct delivery of shipments when accepting orders.

The certified transport service provider in given supply chain is responsible for delivering the consignment to the designated address in accordance with the consignment note and delivering it in an appropriate quality condition under certain temperature conditions.

This is an important decision-making process for ultimate success.

That is why it is important to select and certify the transport service provider to choose to carry out these critical and key tasks’ best of the best'.

Proposed solution is based on cross docking technique and is quite simple and effective activity.

However, the whole process requires perfect timing of all processes and work in the disposition and release areas.

Deliveries from manufacturers and suppliers are subject of an adequate coordination and then shipments are quickly and faultlessly completed and grouped during the cross dock reloading process. Any shipment cannot to be shipped to another route. The consequence of not keeping up the proper order and meticulousness of the entire process is chaos, which leads to errors and delays in the process of order fulfillment.

### 4.3 Changes to the storage system

Changes in the storage system will mainly be based on the transformation of the current warehouse adapted to the classical storage of medicinal products into the cross dock warehouse. The size of the storage area will be subject to change, as the demand for warehouse space for picking warehouses is much smaller. It will also be necessary to reorganize the warehouse adapted to the implemented solution. The warehouse intended for cross docking handling needs to be adapted accordingly. It must be adapted both technically and organically for the fast processing of large flows of consignments.

It is possible through dedicated release and disposal zones that perform appropriate warehouse processes and provide efficient material flow and optimally spaced storage areas.

Technical equipment should be characterized by a large number of reloading docks, high quality means of internal transport, automatic identification devices and calculation technology. Essential components are also systems that provide adequate storage conditions. The implementation of cross docking also requires a reliable, adequate, tailor-made IT system. This system is designed for fast, real-time, automatic data exchange. Thanks to this, every logistic process will be fully analyzed, controlled and corrected.

### 4.4 Changes to distribution system

The researched company decided to implement the cross dock solution to distinguish the list of cities in the Poznan region in Poland in which its customers are located.

The most common collection points are pharmacies. They are the main retailer of distributed medicines. The demand of hospitals or clinics is a wholesale one and occurs intermittently. That is why the company is mainly focused on the distribution of general deliveries up to 5kg.

In the Poznan region, the following places where reception points are located are: Poznań, Wolsztyn, Puszczykowo, Kościan, Komorniki, Mosina, Czempin, Śmigiel, Grodzisk Wielkopolski, Opalenica, Nowy Tomyśl, Pniewy, Międzychód, Zbąszynek, Plewniska, Buk, Oborniki, Krzyż Wielkopolski, Pila, Chodzież, Czarnków, Szamotuly, Wrónki, Trzcianka, Środa Wielkopolska, Leszno, Śrem,

This is a preliminary list of cities on the basis of which route routes have been identified, agreeing a solution with the carrier. It is possible to modify fixed routes according to the definition of subsequent cities where new customers will appear. Seven routes have been established. Six of them are group of geographical locations that are closest to each other. Each of the six routes is operated by one driver. Route number seven is the city of Poznań. There are 3 drivers dedicated to this route, and this route will not be included in the optimization calculations below.

5 Optimization of Transportation Routes

5.1 The problem of the salesman

The method of salesman was used to arrange and determine the exact route. Traveling Salesman Problem (TSP) is designed to find a route that results in all points on the route and returning to the starting point.

In order to solve the task and define the objective function (Fc), it can be searched either for the shortest distance traveled (D) (where D aims to min) or the one to travel at the lowest cost (K) (where K aims to minimum) or the shortest time (T) (where T aims to the minimum). Finding the minimum depends on which criterion we give the highest importance (weight).

In graph terminology graphs are vertexes of the graph, and the routes between them are edges with weights.

The weight of the edge, depending on the predetermined objective function (Fc), may correspond to the distance between the cities connected to that edge, trip time, or transit cost. The salesman’s route, which is a cycle passing through each vertex of the graph exactly once, is a Hamiltonian cycle.

Formulating the problem of the salesman to find the shortest path (D) should be carried out as follows:

1. The construction of a weighted graph whose vertices are the names of cities that the salesman must visit
2. Each pair of cities should be joined by edges,
3. Each edge should give weight. The weight is the distance between the given pair of cities

The result of these activities is to receive a full graph with as many vertices as cities must visit the salesman. Visiting all cities corresponds to the Hamilton cycle that passes through each vertex of the graph exactly once.

So a cycle is searched about the minimum sum of scales of the edge. For “n” of tops we receive the graph:

\[ L_H = (n - 1) + (n - 2) \ldots + 3 \cdot 2 \cdot 1 = (n - 1)! \] (2)

solutions. Algorithm problems of exponential complexity are treated as np-hard.

As an example the route no. 1 is considered. This route was assigned to the following destinations: Poznań, Wolsztyn, Puszczykowo, Kościan, Komorniki, Mosina, Czempień, Śmigiel, Grodzisk Wielkopolski. The order of cities is quite random and it is an initial route. The supplier starts with the goods from the cross docking terminal from Poznan to deliver the goods to all the other cities and then return to Poznan.

The problem is as follows: how should a trip be planned so that the supplier goes on the route with the least possible number of kilometers? As a result, the goal is to minimize transportation costs and achieve the fastest possible working time.

With the nine cities defined on the itinerary, the number of solutions \( L_H \), ie, the capacity of travel routes amounts

\[ L_H = 8! = 40320 \] (3)

This result illustrates the number of possible solutions for arranging routes and showing the complexity of the task. Its implementation, without IT support, would not only be difficult and time consuming, and sometimes impossible to implement.

5.2 The application of Solver to Solve the Salesman Problem

Solver has been used to solve the salesman problem and perform optimization calculations. It is available in Microsoft Office Excel. It allows you to analyze linear, nonlinear, integer, and binary optimization problems.

To solve an operational research problem following option exists:

- LP Simplex method for solving problems of linear optimization,
- The nonlinear GRG method used when the objective function and / or certain constraint parameters contain nonlinear functions and are calculated using mathematical functions or operations,
- An evolutionary method in which the objective function and / or certain constraint parameters contain non-smooth functions referring to variable cells.

Solver requires to save a problem as mathematical model consisting of the following elements:

- Objective function – (OF) this is a cell that has the minimum or maximum value as a result of the analysis,
- Variables (Diff) - these are cells that contain the values which, in the course of the analysis carried out by Solver, are substituted for the objective function until an optimal solution is found,
- Constraints – This is a formula that contains constraints to be included in objective function or variables. Limit values must be within certain limits or target values.

(https://www.researchgate.net/publication/273612128_Planowanie_tras_z_wykorzystaniem_narzedzia_Solver_jako_zadanie_logistyczne_w_malej_firmie)

The input to solve the problem is: the city names assigned to the route and the distance between cities in kilometers. Data are signed into a matrix in a spreadsheet and this replaces the construction of the graph. Data in the form of matrix for route no. 1 is presented in Table 1.

<table>
<thead>
<tr>
<th>Table 1. Input data for route 1.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poznań</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>Poznań</td>
</tr>
<tr>
<td>Wolsztyn</td>
</tr>
<tr>
<td>Puszczykowo</td>
</tr>
<tr>
<td>Komorniki</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>--------------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
</tbody>
</table>

On the initial route set, the number of kilometers is summarized. The route between these cities is initially 339.9 km. Each locality was assigned a variable in the range of numbers 1 through 9.

The objective function is to minimize the length of route. Furthermore variable cells and their constraints were subsequently defined. The data table, variables and objective functions is presented in Table 2.

Table 2. Objective function, variables and constraints for route no. 1.

<table>
<thead>
<tr>
<th>City</th>
<th>variable</th>
<th>distance[km]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poznań</td>
<td>1</td>
<td>71</td>
</tr>
<tr>
<td>Wolsztyn</td>
<td>2</td>
<td>63,3</td>
</tr>
<tr>
<td>Puszczykowo</td>
<td>3</td>
<td>13,4</td>
</tr>
<tr>
<td>Komorniki</td>
<td>4</td>
<td>44,2</td>
</tr>
<tr>
<td>Kościan</td>
<td>5</td>
<td>28,9</td>
</tr>
<tr>
<td>Mosina</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Czempień</td>
<td>7</td>
<td>24,3</td>
</tr>
<tr>
<td>Smigiel</td>
<td>8</td>
<td>32,1</td>
</tr>
<tr>
<td>Grodzisk</td>
<td>9</td>
<td>47,7</td>
</tr>
</tbody>
</table>

The next step was to carry out calculations to obtain the minimum route length, reduce the number of kilometers on each route, and determine the optimal route taking into account the shortest route for the driver starting and ending at the starting point. This is in the Poznań city.

Obtained results presents Table 3.

Table 3. The result of optimization of route no. 1.

<table>
<thead>
<tr>
<th>City</th>
<th>variable</th>
<th>Distance[km]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Czempień</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Kościan</td>
<td>5</td>
<td>13,5</td>
</tr>
<tr>
<td>Smigiel</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Wolsztyn</td>
<td>2</td>
<td>36,6</td>
</tr>
<tr>
<td>Grodzisk</td>
<td>9</td>
<td>25</td>
</tr>
<tr>
<td>Komorniki</td>
<td>4</td>
<td>36,6</td>
</tr>
<tr>
<td>Poznań</td>
<td>1</td>
<td>12,7</td>
</tr>
<tr>
<td>Puszczykowo</td>
<td>3</td>
<td>15,2</td>
</tr>
<tr>
<td>Mosina</td>
<td>6</td>
<td>4,8</td>
</tr>
</tbody>
</table>

The length of route - 171,4 km

Solving the salesman's problem for route no.1:

Length of the route before optimization - 339,9 km

Length of the route after optimization - 171,4 km


The route can also be driven in the reverse order.

Figure 3 presents on the map the order of visited cities, precisely defining the route and the road that the driver should use.

Figure 3. Visualization of route no.1.

Summarizing Solver's proposed optimization solutions for all analyzed routes is Table 4.

Table 4. The results of optimization for routes 1-6.

<table>
<thead>
<tr>
<th>The length of route</th>
<th>before [km]</th>
<th>after [km]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route 1</td>
<td>339,9</td>
<td>171,4</td>
</tr>
<tr>
<td>Route 2</td>
<td>319,4</td>
<td>230,9</td>
</tr>
<tr>
<td>Route 3</td>
<td>426,9</td>
<td>297,7</td>
</tr>
<tr>
<td>Route 4</td>
<td>446,2</td>
<td>268,4</td>
</tr>
<tr>
<td>Route 5</td>
<td>562,7</td>
<td>299,8</td>
</tr>
<tr>
<td>Route 6</td>
<td>477,3</td>
<td>279,5</td>
</tr>
</tbody>
</table>

Solved problem of a salesman using the Solver tool has significantly reduced the length of each route. On average this length decreased by 39% compared to the input situation. The biggest decline of the route’s length was obtained on the route number 1 and the least number on the route number 2. The results for all routes are shown in Figure 4.

Figure 4. Percentage reduction in the length of the route.

6 SUMMARY

The implementation of cross-dock and Just in Time systems as material flow management systems facilitates the organization and optimization and timing of logistical processes within the whole supply chain. The company under the study as a distributor of medical products, by means of the cross docking, goes against the key customer...
requirements such as fast, timely and reliable delivery of goods. Just in Time and cross docking systems completely change the rules of the entire supply chain.

These changes are mainly based on the fact that the goods are delivered according to current and actual requirements defined by the customers, and the complete handling is guaranteed by the delivery of plenty goods from multiple sources of supply in a single consignment.

Thanks to the synergistic cooperation of these two systems, the speed of response to customer needs is increasing, and the order processing time is reduced to a minimum. These elements are an important factor influencing customer satisfaction.

The new solution does not require a lot of storage space, and stocks are limited to inventory that is driven by customer demand. The storage space required for storage is much smaller than for classical disposal. When company adopts a cross docking technology, it reduces costs and frees up capital previously frozen for a much larger storage space and maintaining a certain level of inventory closely related to the customer service level.

The logistic costs associated with stockpiling and inventory maintaining, as well as warehouse service and protection are also reduced.

As a result, the storage space and equipment including technical and service equipment are minimized, and the need to maintain inventory is eliminated. Focusing on key processes: order picking and delivering and packaging enables the company to be able to efficiently and effectively manage them. By taking full control of above processes, it is possible to completely eliminate mistakes. It is important to mention that picking is a quick process but also requires efficient and reliable management.

An unquestioned work organization should be introduced in each chain of the entire supply chain.

The work of all manufacturers and suppliers of medicines shall be synchronized. Packaged orders must be prepared efficiently, quickly and error-free, as they are the basis for the fulfillment of customer requests. The staff that conducts the picking process at the terminal must be trained, disciplined and aware of the importance of fulfilling duties. Delivery of distribution processes must be carried out to the highest standard by the ‘best of the best’. Outsourcing is always a risk. However, imposing a service provider's standards of service and data for a specific way of delivering the distribution process in the form of correctly labeled consignments and the designated and optimized lengths of the carriage route will minimize this risk.

In addition, the warehouse for picking must adapted to this in a appropriate way. Throughout the warehouse, a large flow of consignments will flow, so the store must be technically and organically organized to carry out such a process. It must be equipped in special zones to provide a smooth flow of goods and optimal location of intermediate storage areas.

Equipment should be characterized by a large number of reloading docks, high quality means of transport, automatic identification devices and calculation technology. The implementation of cross docking also requires the implementation of reliable, appropriate, tailor-made IT system. This system is designed for fast, real-time, automatic data exchange located in the cloud in accordance with Logistics 4.0 concept. Thanks to this, every logistic process will be fully analyzed, controlled and fast corrected in a real time. Of course, the solution presented has its advantages and disadvantages, so any company which implement a similar solution must consider and be aware of both the benefits of the solution and its risks.

References


