



INVENTORY METHODS IN ORDER TO MINIMIZE RAW MATERIALS AT THE INVENTORY LEVEL IN THE SUPPLY CHAIN

Judit Oláh¹, Zoltán Lakner², Dávid Hollósi³, József Popp¹

1) University of Debrecen, Debrecen, **Hungary**, 2) University of Szent István, Budapest, **Hungary**, 3) Erste Bank Hungary Zrt., Budapest, **Hungary**

ABSTRACT. Background: Each international producing organization seeks to implement its processes more effectively to minimize its costs and to maximize its profit. The primary purpose is to keep their inventory value at the lowest possible rate to minimize costs. To this end, the investigated organization operates several processes. One of them is the so-called Vendor Managed Inventory [VMI], in which the supplier manages the inventory at the customer and the second is the consignment inventory processing, in which suppliers store goods at the customer location. The principal goal of this paper is to examine whether the application of these methods may result in cost-effective savings for the examined organization and if yes, to what extent.

Methods: This research was carried out in the framework of a case study at a producing organization in Hungary. The selected case is the producing organization located in the North-Great Plain Region in Hungary. Analyses were performed using the relevant data from the inventory reports exported by the SAP as provided by the enterprise. The research was performed in the examined enterprise between 1st – 14th July 2016.

Results: The situation analysed in this study provides an opportunity to describe the bullwhip effect and to demonstrate the opportunities to reduce it. This study found that the investigated company could save considerable amounts on packaging materials. We examined six high-volume packaging materials to identify the amount of potential savings. The process is recommended for the company to maintain it in the future; moreover, to expand it in the circle of new suppliers as well. The other investigated method for the minimization of inventory levels was the consignment procurement process. It can be concluded that consignment procurement process is the best method to reduce the examined costs.

Conclusion: This research revealed the current distribution-side supply chain management practice, pinpointed the shortcomings and the potential directions of development. The obtained results draw the attention of Hungarian and international enterprises to the importance of conscious supply chain management and the wide range of tools which are available for the development of supply chain efficiency, thereby achieving a higher level of customer service.

Key words: vendor managed inventory, consignment inventory management, supply chain, supplier, raw material inventory.

INTRODUCTION

Globalization also has an impact on the development of supply chains, as purchasing and sales markets keep expanding. Participants in the increasing international division of labour are companies that operate dispersedly in the world. The smooth operation of the mechanism requires the fast and liquid flows of materials, products and information. The fact that producers may carry out their

activities in markets of such dimensions makes it possible for them to generate a production volume exceeding the size of international markets and to achieve maximum economies of scale. Therefore, globalization promotes the development of supply/distribution logistics. Regarding production, globalization leads to the development of international networks. Therefore, production is carried out in the most cost-effective sites, where spare parts and subassemblies are often manufactured separately, just like the final assembly. Supply

chain development and integration are one possible way of reducing costs and inventories to increase efficiency and to optimize processes, which may arise partnerships in the long run. Besides the determination of optimum inventory level, particular attention is paid to inventory holding costs. These costs include not only inventory costs, but lockup in inventory that can be minimized by the conclusion of consignment agreements and consignment inventory management. Raw materials stocking is necessary to ensure continuous production, as high volume production requires a high inventory level. The appropriate level should be available for production at all times, which is a difficult and complicated task. Specifically, inventory management ensures that all the required products are available. Nevertheless, it is in the interest of the producer to have the lowest possible inventory level to minimize enormous costs.

The principal goal of this study is to examine whether the application of these methods may result in cost-effective savings for the examined organization and if yes, to what extent. In the focus of this research is the fundamental interest of the enterprise to work with as low inventory level as possible, thereby saving a significant amount of costs.

LITERATURE REVIEW

The prevailing trend in the supply chain practice between a supplier and a customer, and in the cooperation of organizations is that short-term, transaction-centred competitive relations are replaced by long-term, mutually beneficial partnerships. The value of a vendor for an organization is represented by the significance of delivered raw materials with regard to the finished-product. However, the system of relationships among companies is much more than that. Even the less significant vendors have realized that although they are not directly related to the final manufacturer, the success of the latter has a real effect on their success. To this end, their task is to take account of the needs of final customers and satisfy their needs by their products. This process leads to the development of supply chains [Chikán, Demeter 2004].

A supply chain is defined as a set of three or more entities (organizations or individuals) directly involved in the internal and external flows of products, services, finances, and/or information from a source to a customer [Mantzer et al. 2001, Némon et al. 2005]. The existence of supply chains is as early as that of companies; therefore, as the development of intercompany cooperation. Their primary objective is to satisfy consumer needs. The supply chain may be interpreted as a kind of cooperation among market players [Gelei 2002].

Cooperation and coordination between enterprises can bring great benefits in supply chains. It means the type of typical operation of certain organizations is joint action instead of isolation. Essentially, a supply chain comprises the logistics aspects of these relations. In his decision-making process, the ultimate consumer evaluates not merely the performance of a business but that of the whole supply chain.

Efforts to reorganize the internal processes of organizations emerged over the past decades. Efforts to outsource certain areas of business activities lead to the increasing involvement of vendors and service providers in internal business mechanisms, which resulted in renewed dependency on other companies. Consequently, complex links have been generated along the supply chain from the supplier to the ultimate user [Barna 2005].

Today organizations must face the increasing challenges of the global market. It does not mean that companies should set their ambitious targets for global market leadership, but the majority of those concerned with business activities operate and think in international dimensions, including market partners, customers, suppliers, competitors and strategic partners [Chikán 2001].

Manufacturer, supplier, and retailer play a vital role in the supply chain and are important links in effectively providing high levels of customer service while maintaining minimum levels of inventory [Williams, Toker 2008]. Chopra and Meindl [2001] considered inventory the major driver of a supply chain owing to its strong influence over the supply-

chain performance. Over the past few years, organizations have realised that they need to supply the right product at the right time and in the right place. However, to achieve this supply, the organizations need the collaboration of internal as well as external actors [Borade 2013].

Vendor Managed Inventory

Vendor Managed Inventory (VMI) is an inventory management strategy [Waller et al. 1999] to let a vendor manage his retailers' inventories, which makes the vendor have the opportunity to obtain some inventory and market-related information of his retailers [Yu et al. 2009].

This mechanism is usually interpreted as a process between the central warehouses of the customer and the supplier. Its purpose is to eliminate errors in the traditional acquisition system including high safety stocks, long lead times, hectic dispatch and poor services. VMI enables the supplier to gain access to sales and inventory data and to optimize the process of replenishment.

VMI is a practice for improving the inventory management in supply chains [Oláh, Vad 2015]. The VMI system has been widely applied by vendors and buyers in the grocery, household appliance, and hardware and houseware industries, as well as the general merchandise industry [Chen, Wei 2012].

In a VMI system, a vendor decides on the appropriate inventory levels of each of the products for all his retailers, and the appropriate inventory policies to maintain these levels [Clark, Hammond 1997, Waller et al. 1999, Simchi-Livi et al. 1999, Kulp et al. 2004, Dong et al. 2014]. However, high inventory levels are often characterised by poor cash flow, require space to store the goods, and include the high risk of dealing with obsolete goods. VMI is meant to identify appropriate inventory levels to be maintained at different echelons, by choosing a single decision-maker who would determine the best

profit outcome of the whole supply chain [Givindan 2013].

In this system, the supplier takes full responsibility for managing the inventory of the customer. Therefore, the customer will have to provide real-time inventory data for the vendor who can determine the date of inventory replenishment accordingly. Hence, VMI is a cooperation agreement between the customer and the supplier and seeks to optimize the availability of a product by keeping the lowest possible inventory level between the customer and the supplier. The vendor is in total control of the operative inventory management. The main advantages of the process are improvements in stockouts and service levels. For the supplier, the most significant aspect of this mechanism is the capacity to carry out production activities in response to real customer demand, thus becoming able to reduce fluctuations and implement the tasks in a pro-active way. As a result, the customer's costs incurred by the needs planning process, the dispatch of orders and the stockpiling of losses and returns will reduce. Lead time, the period between receipt of an order and until when it is available for packing or shipment is reduced and a better level of service is provided. The minimization of inventories accumulated at certain points of the supply chain is a benefit to the whole mechanism [Nagy 2010].

Supply chain benefits include reduction of inventory related costs due to on-going replenishment schemes and the definition of minimum and maximum stocks. The advantage of long-lasting partnerships is a particularly interesting potential benefit for suppliers and it is an indicative of dominance over market competitors. Long-term partnerships enhance the profitability of customers and suppliers [Disney et al. 2003]. The product characteristics are also a central issue for a successful VMI. The products that are appropriate for VMI should be selected carefully. According to Nirnjan, et al. [2012] high volumes are most beneficial. VMI collaboration is also simplified if the numbers of items are not too large.

The advantages of the VMI system are summarized and presented in Table 1 for

the customer, the supplier and the supply chain. Most of these benefits have already been mentioned except the potential reduction of

the bullwhip effect regarding the supply chain by the VMI system.

Table 1. VMI advantages regarding the customer and the supplier, in view of its impact on the whole supply chain
Tabela 1. Zalety VMI dla klienta oraz dostawcy, z punktu widzenia jego wpływu na cały łańcuch dostaw

Customer	Supplier	Supply chain
Reduced administration costs	Production adjusts to customer demands	Reduced inventory-related costs
Reduced lead times	Proactive adjustment	Optimization of the whole process instead of sub-processes leading to reduced processing costs
Elimination of stockouts and returns	Flexible, continuous replenishment	
Higher service level	Lower shipping expenses	Reduced bullwhip effect
	Long-lasting partnerships, safe sales	

Source: Claassen et al., 2008; Nagy, 2010.

Implementing VMI enables lower shipment costs through inventory and shipping management by the vendor. Vendor controlled inventory has a positive impact on both customers and suppliers. Benefits to suppliers include the development of their production schedules to meet existing customer demands. Regular and weekly updated forecasting helps overcome changes and may function proactively instead of reacting to events subsequently. In case of purchasing the considerable amount of materials necessary for production from a given vendor, the vendor can optimize its shipping and can deliver full cargoes. Inventory holding costs can be reduced by sending full-loaded trucks. Suppliers may derive maximum benefit from long-lasting relationships, loyal customers, and secure ongoing sales. VMI customer benefits comprise reduced administration costs and lead times. There is no need for inventory monitoring to identify the level when new orders are to be placed. It is not necessary to determine the quantities and the requested deadline of delivery. There is no need to place purchase orders for inventory replenishment. VMI includes the development of a long time shipment schedule (Scheduling Agreement: SA). Depending on the quality and type of materials and the agreement between the parties, orders usually contain a quantity of three months to one year that suppliers manufacture and ship according to forecasts. Better customer service is also an additional benefit to buyers due to effective cooperation and coordinated vendor-customer activities [Claassen et al. 2008].

VMI has been introduced owing to high bullwhip effects encountered in supply chains, and its main objective was to decrease the bullwhip effect through information sharing. Several dynamic VMI models with a focus on bullwhip reduction are presented below. The dynamic VMI is of particular interest owing to its ability to adapt to fluctuations that are most likely to be encountered within everyday business [Govindan 2013].

All of them identified that the stock levels would be lower under such a partnership. On the other hand, Clark and Hammond [1997], Kulp et al. [2004] found that interorganizational programs, such as VMI, can be significantly more effective at reducing inventories or improving service levels than what could be realized by just sharing data between supply chain partners through electronic data interchange (EDI).

The product characteristics are also a central issue for a successful VMI. The products that are appropriate for VMI should be selected carefully. According to Nirnjan et al. [2012], high volumes are most beneficial. VMI collaboration is also simplified if the numbers of items are not too large. For VMI to be successful it is necessary for a large amount of information to be transferred between both parties, particularly data regarding end user sales and inventory levels at the buyer [Andel, 1996]. VMI can not only reduce costs, but also improve service levels and create business

opportunities for both parties in the supply chain [Tarikere et al. 2012].

Consignment Inventory Management

Consignment Inventory Management (CIM) implies that a retailer agrees to accept a product that is still owned by the supplier as long as the actual sale takes place. Physically, the stock is kept in the retail store and becomes the property of the retailer only after the sale. Consignment Inventory is an inventory placed by the supplier at the user. The location designated for storing is the consignment store. The user can call-off the necessary raw materials by the pace of production. Continuous call-offs from consignment stocks require the definition of minimum stock level, and if it is reached, the supplier automatically replenishes the inventory. The goods change owners at the date of implementation and the payment of the exchange value of the goods becomes due at this time. Users exclusively pay for the removed quantities of goods.

The implementation of Consignment Inventory offers various benefits to retailers and suppliers.

Benefits to vendors:

- close relationships with retailers,
- reduction in (own) inventory capacities,
- optimization of transport and packaging costs,
- reduction in lead times,
- clear inventory removal system,
- availability of reliable forecasts for call-offs,
- optimized deliveries,
- clear payment conception.

Benefits to retailers:

- reduction in supply risks,
- low level of lockup,
- enhanced clarity for inventories,
- lower inventory levels,
- increased security of supply [Bányainé et al. 2002].

Within the literature, some authors considered two situations (VMI on Consignment Inventory: VMCI) when discussing VMI: one in which an invoice is

sent to the retailer at the moment when replenishment is executed, and a second case in which the vendor monitors and owns the inventory at the retailer until the product reaches the end customer (a Consignment Inventory situation combined with a VMI partnership called VMCI). A VMCI partnership does not seem to be popular, and only a few studies have been carried out. VMCI is also known under the name of supplier-owned inventory [Govindan 2013].

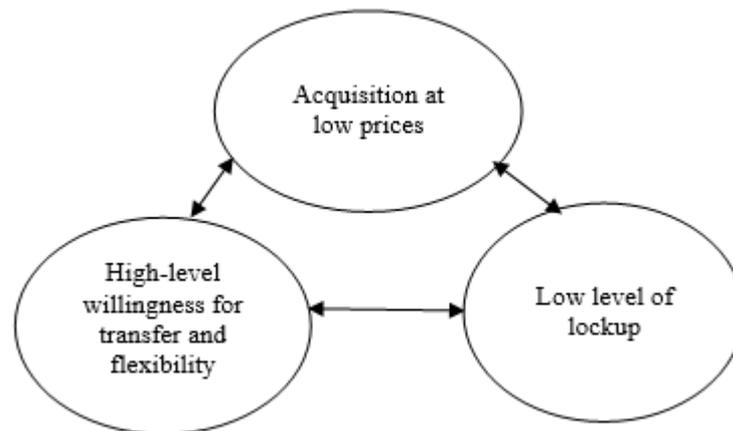
Material Supplies

Supply Chain Management provides the given production unit with all the necessary materials required for its operation. It includes activities ranging from procurement to the transfer of materials into the production system. Its basic functions are procurement, stockpiling and other related logistical functions. Its primary objectives are the following:

- to ensure high-level willingness to transfer,
- to provide high-level flexibility in the face of demand and supply changes,
- to carry out procurements at the lowest possible prices under favourable conditions,
- to meet high-level quality requirements,
- to minimize the level of lockup by stockpile reduction.

However, these objectives are conflicting in some respects, as to increase the willingness to transfer and flexibility requires increased inventory, which would lead to a higher level of lockup. A company can carry out procurement at relatively low prices under the condition of placing large-scale orders for one occasion, which also leads to higher inventory levels entailing a higher level of lockup. These conflicts are clearly represented in Figure 1.

After the careful consideration of these conflicts, this study seeks to find the optimal answers to the following questions: From what? When? How much? What quality? At what pace? - are to be procured for the company [Prezenszki, 2007].



Source: Prezenszki, 2007

Fig. 1. Conflict of objectives in supply chain management
Rys. 1. Konflikt celów w zarządzaniu łańcuchem dostaw

RESEARCH METHODOLOGY

This paper employed the methods of primary and secondary examinations. The typical form of this analysis is a case study. Regarding its structure, it is a descriptive case study, which seeks to examine an integrated element of a specific case. The integrated element is the study of processes to reduce the raw materials inventory. The case study analyses the issues emerging in a concrete organizational unit in the past and the present, in a real life context, i.e. it explores the history, background, inner structure, hierarchy, objectives, problems and tasks of the organization [Majoros 1997]. According to another wording, a case study observes a given group or event at a given point of time, generally following a phenomenon that induced some change [Ghauri, Gronhaug 2011]. Although the two types of wording are somewhat different and underline various elements in the case study, however this research represents the content described by both definitions. The inventory statements made by the organization proved essential to explore the research topic, and the tables developed accordingly clearly demonstrate the differences that we attempted to indicate. The

selected case is a producer organization located in the North-Great Plain Region in Hungary. Analyses were performed using the relevant data from the inventory reports exported by SAP as provided by the enterprise. These analyses were carried out using Microsoft Excel. The research was performed between 1st – 14th July 2016. The inventory report referred to the above mentioned 6-week-long period.

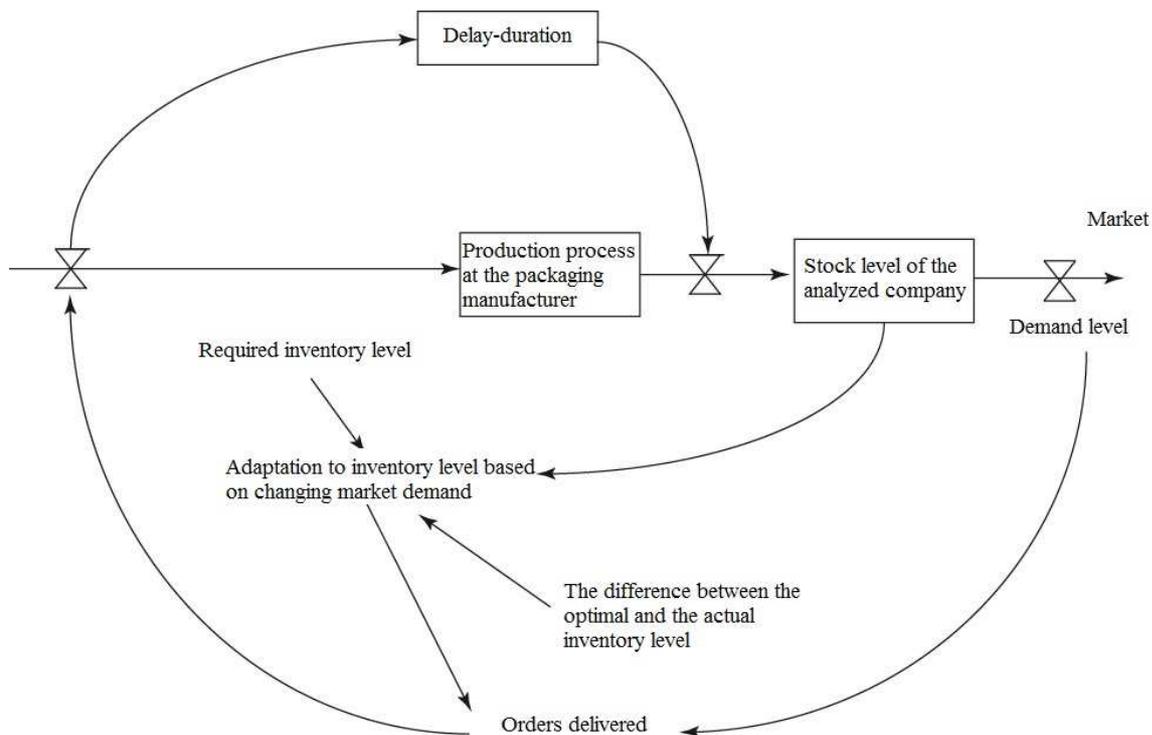
The optimization of inventory levels needed for production has long been in the focus of mathematical economics and operations research. Simon [1952] – who was later awarded the Nobel prize for working out the theory of bounded rationality – attempted to optimize the inventory level using analytical solutions, such as using the Laplace transform. Chikán [1983] recommended to optimize the inventory level by applying regulation theory. In the 1960s, the recognition and implementation of the opportunities of system dynamics modeling resulted in notable new findings and the inventory management school based on the bullwhip theory was gradually developed. The essence of this school is that stochastic changes occurring in market demands result in significant – practically unmanageable – deflections in the logistics supply chain [Forrester 1958, 1961].

Increasingly complex regulation models were developed to reduce this impact [Towill 1982, Udenio et al. 2015, Devika et al. 2016].

The favourable situation analysed in this study provides an opportunity to describe

the bullwhip effect and to demonstrate opportunities of its reduction.

The model used for our research is shown in Figure 2.



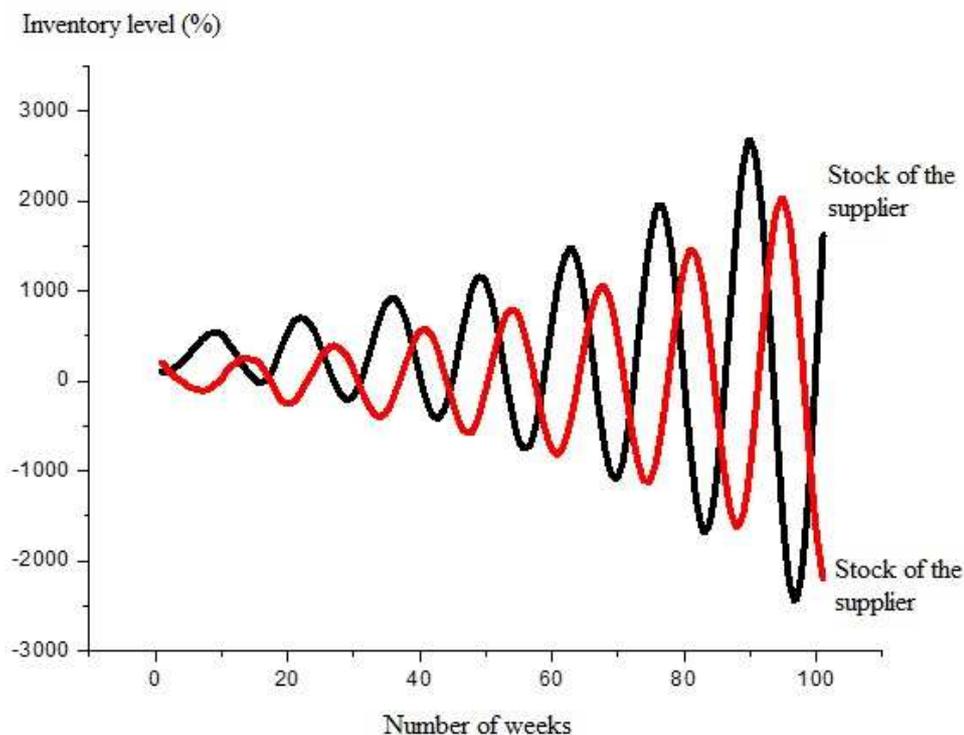
Source: own construction 2017

Fig. 2. The model used for inventory management analysis
Rys. 2. Model stosowany do zarządzania zapasem

RESULTS AND DISCUSSION

The examined enterprise can be characterized by the relative predictability of the market, even though uncertainty still has to be taken into consideration. Inventory fluctuation was approximated with normal distribution, the standard deviation of which is 15% of the expected value. The tolerance of the deviation between the planned (optimum) and actual inventory level in the system is considered to be 0.5, which is the level of launching order.

In the examined simulation, 100% initial inventory was planned on behalf of the supplier and 200% on behalf of the examined enterprise. In the conventional system, two weeks pass between order and delivery. If the system is “unleashed”, i.e., no central intervention is assumed, it can be observed that if the order starts from 50% of the difference between the optimum and actual inventory level, an unmanageable situation, i.e., the bullwhip effect unfolds in a few weeks (Figure 3). Figure 3 shows that the supplier faces a much bigger inventory fluctuation than the producer.



Source: own construction 2017

Fig. 3. Development of the bullwhip effect in the examined system

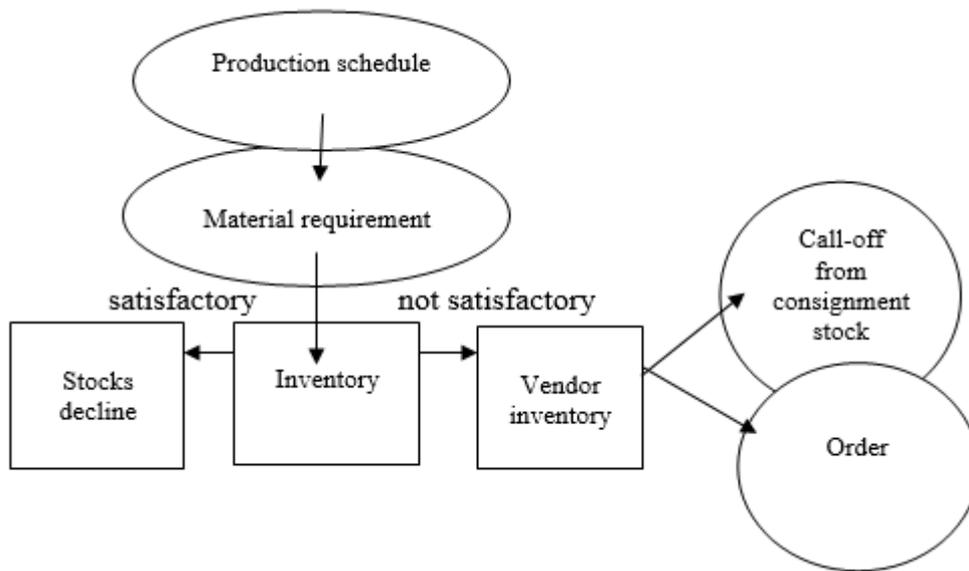
Rys. 3. Rozwój efektu wzmocnienia w łańcuchu dostaw w badanym systemie

It follows from the described correlations that if demand shows fluctuations under market circumstances, the conventional inventory management system is unpredictable and it imposes significant extra burden on suppliers. This is the reason why it is necessary to employ the new logistics concept outlined in this study. The findings of this part of the performed analyses draw attention to the fact that the currently used complex systems may lead to the accumulation of unrealistically large stocks and, eventually, uneconomical operation of the system in enterprises which follow traditional inventory management systems.

Presentation of the Consignment Process

Therefore, the essential element in this process is that the company gets the retailer to produce raw material quantities for two or three months in proportion to the amounts used and places them on the producer's premises. The goal is that the production unit can provide instant services to the customer, eliminating the problem of urgent need for a particular raw

material and waiting for its arrival after purchase. The method makes the immediate availability of the given raw material easier. The other and even more important goal is to ensure that these materials are not included in the inventory of the producer, although they are physically stored on its premises. They are called off in proportion to weekly production quantities and only the momentarily required volume is represented in the inventory. Call-offs are reported to the producer monthly and they serve as a basis for invoicing and consequent payment. By this method, the inventory of the producer can be minimized almost to zero, as no safety stocks are to be kept and in the case of emergency, raw materials may be obtained from these so-called blocked stocks. Suppliers are informed about raw material call-offs; once the amount is lower than the safety stock, the supplier replenishes it. Figure 4 shows the process of the consignment method.



Source: own computations [2016]

Fig. 4. Consignment process
Rys. 4. Proces konsygnacji

The inventory owned by the company under investigation can be divided into two parts: the first one is the so-called Work in Process (WIP). WIP inventory means that materials are partially converted through the weekly production process. These items are typically located in the production area. The second one is the warehouse inventory, a central warehouse where materials are stored. The total value of the WIP and the warehouse inventory is equivalent to the total inventory value. Companies call off materials from these inventories in a standard process.

If the consignment process is used Consignment Inventories are held in central warehouses, but their values are not represented in stocks. Consignment Inventory means that the value of the warehouse inventory is zero, but materials are always physically available and they are used, if needed. It is a useful method to minimize the inventory, although as a result of certain legal issues, this method has not been used for some time. As the investigated company manufactures special products by using special raw materials, these are called specific materials. The fact that when the company terminated the production of a certain product or replaced the raw materials, and

consequently the contracted supplier had a stock of unused materials raised several problems. As they are unique materials, the supplier cannot sell them to other market players. For this reason, the consignment process has been abolished, although only for direct materials (those incorporated into products), as this method is still used for indirect (those not incorporated into products) materials. It can be understood since producers can sell indirect materials to other market players if stockpiling a certain product occurs at the customer or the given company does not need the product any longer. As the company can save considerable inventory management costs by this method, measures have recently been taken to re-introduce the above process for direct materials. Efforts have been made to identify the necessary legal framework to meet the demands of both parties without risks.

The following data show what methods described above mean in terms of savings. Table 2 demonstrates the inventory level of a standard (normal) acquisition, where inventories identified by the colour “grey” represent the warehouse inventory levels and the other ones the value of operational inventories.

Table 2. Inventory value in standard procurement
Tabela 2. Wartość zapasu w standardowym systemie zakupów

Identification of material	Unit of measure	Quantity	Inventory value (HUF)
1001319	kg	2.548	543.406
1015698	kg	1.418	615.653
1015698	kg	0.231	100.293
1091959	kg	0.056	13.094
1091961	kg	0.367	89.475
1214768	kg	0.824	24.025
1091959	kg	0.994	232.414
1095183	m	317.58	350.475
1214768	kg	1.520	44.317
1267022	kg	0.030	7.676
1267023	kg	0.047	11.960
1091959	kg	0.893	208.798
1015698	kg	0.182	79.019
1001319	kg	1.395	297.508
1015698	kg	0.360	156.301
1091959	kg	0.998	233.349
1091961	kg	0.455	110.930
1095183	m	149.52	165.007
1214768	kg	1.048	30.556
1267023	kg	0.577	146.827
1095183	m	1568.33	1.730.778
1001317	kg	5.402	1.620.814
1001319	kg	27.336	5.829.886
1015698	kg	4.304	1.868.668
1091959	kg	5.028	1.175.630
1091961	kg	1.041	253.797
1095183	m	1967.00	2.170.742
1214768	kg	20.490	597.409
1267022	kg	2.282	583.910
1267023	kg	1.851	471.016
Total			19.763.733

Source: own computations [2016]

The total amount of values indicates that the inventory of the investigated materials at the time of the examination was of 19.763.733 HUF. In the event of a standard procurement and inventory process, the company stores and stocks all the materials to be used. If, however,

procurement was a consignment process, then, as the inventory stored in the warehouse was a so-called blocked inventory, its value would be 0, and only the values of inventories in production would represent costs.

Table 3. Inventory value of the consignment process
Tabela 3. Wartość zapasu w konsygnacyjnym systemie zakupów

Location of storage	Inventory type	Inventory value (HUF)
KGG9	operational inventory	1.159.059
KSBB	operational inventory	226.887
KSCA	operational inventory	646.842
KSEQ	operational inventory	208.798
KSH5	operational inventory	79.019
KSHD	operational inventory	453.809
KSPD	operational inventory	686.669
KSST	operational inventory	1.730.778
S023	operational inventory	0
Total		5.191.861

Source: own computations [2016]

Table 3 shows the simplified version of the above mentioned method, i.e. the values of certain operational inventories and warehouse inventories and also their total value in the case of the consignment process.

Table 3 indicates that if the company had used the consignment process, the total value would have been 5.191.861HUF for the investigated products. The difference between the two total sums gives the amount of savings, i.e. 14.571.872 HUF, which seems to be high. The volume of potential savings makes it apparent for the company to apply this inventory management method again. The company could save huge amounts through inventory management should it have the opportunity of re-using the consignment process for its direct materials.

Vendor Managed Inventory of the company analysed

VMI is actually a form of reducing the level of raw materials inventory, applied widely in the factory of the studied company. VMI is an inventory management technique in which the company places its order against the manufacturer for the batch quantity of 3-4 months, the supplier places the inventory at his location, at his costs and the company calls off the required items according to a weekly timeline. Payment is not made until the arrival and receipt of the requested quantity. In this way, the inventory of the company involves the amount required by production exclusively. It leads to improved inventory and inventory

costs, as only daily or 2-3 day replenishments would take place in the production location and warehouses. Production could focus on its core tasks, as spare parts are always available at the point of actual use, in our case, in the warehouse.

In terms of packaging materials, the investigated company uses the EOQ (Economic Order Quantity) model, i.e. it orders the raw materials required by the following production cycle based on this model. EOQ quantity is assessed according to forecast data. It places orders in relatively small volumes, merely the batch quantity of 3-4 months mentioned above, since the vendor ships out the remaining stock at the end of the contracted storage period. The duration of this period is usually six months.

When this period expires, the vendor ships out the remaining stock for the manufacturer and the manufacturer shall complete his payment obligations to the vendor in one instalment. This process ensures a safe position for the vendor as the manufacturer may be exposed to risks due the incorrect assessment of production requirements.

The analysis of some packaging materials represented in the following table shows these savings expressed in numbers. Table 4 demonstrates the manufacturer inventory level regarding six investigated material types.

Table 4. Development of manufacturer inventory level
Tabela 4. Rozwój poziomu zapasu producenta

Marking	Quantity (pcs)	Inventory value (HUF)
1242917	2255	5.525
1242917	5000	12.250
1289041	1022	2.126
1289041	24500	50.960
1293679	4410	22.579
1293679	3600	18.432
1334939	6585	13.828
98001641	3840	46.080
98001640	0	0
Total		171.780

Source: own computations [2016]

The total of measured values revealed that the inventory level of packaging materials owned by the investigated company was 171.780 HUF at the time of the examination. Under the actual production scheme, this is the required inventory level for manufacturing purposes in the weekly cycle. The last line but one of the table shows an item with 0 producer-owned inventory value, but the

producer places his inventory at the supplier's location, so the required material can be called off immediately. A comparison between producer-owned inventory value and supplier's inventory value, i.e. the value of inventory level stored for the company suggests that company savings regarding materials can be determined. It is shown in Table 5.

Table 5. A comparison between producer inventory and supplier inventory regarding value
Tabela 5. Porównanie zapasów producenta i dostawcy w ujęciu wartościowym

Marking	Producer inventory (HUF)	Supplier's inventory (HUF)
1242917	17.775	447.125
1289041	53.086	189.280
1293679	41.011	793.856
1334939	13.828	84.000
98001640	0	916.416
98001641	46.080	654.240
Total	171.780	3.084.917

Source: own computations [2016]

Evidently, the supplier inventory represents several times the value of the producer inventory. The producer inventory with zero-value in Table 3 makes sense in Table 5 as the latter suggests that the supplier inventory has a considerable value. When it is needed for production purposes, it will be immediately available. In this case, the value of producer inventory shows that the savings of the company in terms of the six types of packaging materials amount to approximately 3.084.917 HUF due to the VMI process. It is the supply chain cost the company could minimize instead of spending it on raw materials inventory holding, and should carry payments following continuous call-offs and receivings at the rate of call-offs.

The comparison between the supplier and producer inventories suggests that the savings represent almost 18 times the value of the producer inventory. However, as mentioned above, the situation can also arise where, for some reason, the company fails to call off the manufactured raw materials within the contract period. In this case, the supplier ships out the remaining inventory for the company in one batch and the company shall pay its equivalent in one sum. These are called frozen stocks (idle inventories). This situation may arise where an order is cancelled, or the production

of a particular product is discontinued. In such cases, packaging materials pose the risks of high losses for the company, as other raw materials can be integrated into the production of other products, whereas it is impossible for packaging materials. The company will store these materials in its idle inventory and later destroy it by special procedures. It means cutting up the materials to make them unusable for illegal practices, so as to prevent abuse of the investigated brand. Waste paper is transported for re-use and the revenue generated in this way minimizes the losses, although its value represents only a fraction of the original value of packaging materials.

CONCLUSIONS

This research revealed the current distribution-side supply chain management practice, pinpointed the shortcomings and the potential directions of development. The obtained results draw the attention of Hungarian and international enterprises to the importance of conscious supply chain management and the wide range of tools which are available for the development of supply chain efficiency, thereby achieving a higher level of customer service.

The companies may be able at the lowest possible capital tie-up to provide adequate quantity and composition of inventory for the production and marketing activity. Inventory management has to create a balance in the inventory of the production system in order to meet customer needs more efficiently and completely paying attention to costs as well. The implementation of the strategy makes it necessary to find the proper suppliers and to integrate them in to a supply chain.

This research found that the investigated company could save considerable amounts on packaging materials. In this study we examined six high-volume packaging materials to identify the amount of potential savings. Regarding the six packaging materials, on the basis of the supplier inventory statements, this amount equals to 3.084.917 HUF. This is the value of raw materials in the vendor's warehouse at the time of the investigation, which is always available for the company, although it is not paid by the vendor. The vendor inventory represented approximately 18 times the value of the producer inventory. It is recommended for the company to maintain the process in the future; moreover, to expand it in the circle of new suppliers as well. The company should seek the opportunities to keep trust with its suppliers to strengthen excellent future cooperation. However, the company must take care to determine the requirements of production without exception, and in this way to eliminate the problem of manufacturing surplus raw materials and the resulting losses.

The other investigated method for the minimization of inventory levels was the consignment procurement process. It can be concluded that this is the best method to reduce the examined costs. The company must take all the necessary steps to find the applicable legal framework to re-introduce the process. The company may realize substantial savings by this method. In the case of the investigated company, this amount would be approximately 14.571.872 HUF if the company used the consignment method. This amount is equivalent to the value of raw materials not included in the inventory. Moreover, this approach offers another tremendous benefit that is an explicit argument in its re-introduction. In the event of the application of

this method, stocks are located at the company premises, making it possible for the producer to save transportation and manufacturing time. It is subject to the precise assessment of production needs. It is especially true of materials with long procurement times. If the company can re-introduce this process, it is recommended to develop an even more accurate method of forecasting to prevent new disputes with suppliers, such as in the period when the process is withdrawn from procurement policy of the company.

REFERENCES

- Andel T., 1996. Manage inventory, own information. *Transport and Distribution*, 37(5), 54-58.
- Barna Gy., 2005. The future of supply chains. *Logistics*, 1(10), 14-26.
- Bányainé Á., Bányai T., Cselényi J., 2002. When and to whom to establish a consignment warehouse. Miskolc, Hungary.
- Borade A.B., Govindan K., Satish V.B., 2013. Analytical hierarchy process-based framework for VMI adoption. *International Journal of Production Research*, 51(4), 963-978.
<http://dx.doi.org/10.1080/00207543.2011.650795>
- Chen, L.T., Wei, C.C., 2012. Multi-period channel coordination in vendor-managed inventory for deteriorating goods. *International Journal of Production Research*, 50(16), 4396-4413.
<http://dx.doi.org/10.1080/00207543.2011.592159>
- Chikán A., 1983. *Készletezési modellek. Közgazdasági és Jogi Könyvkiadó, Budapest, 1983.*
- Chikán A., 2001. *Enterprise Economics. Budapest, Hungary: Aula Press.*
- Chikán A., Demeter K., 2004. *The management of value-added (creating) processes. Budapest, Hungary: Aula Press.*

- Chopra S., Meindl P., 2001. *Supply Chain Management: Strategy, Planning, Operation*. 1st ed. Upper Saddle River: Prentice Hall.
- Claassen M.J., Van Weele A.J., Van Raaij E.M., 2008. Performance outcomes and success factors of vendor managed inventory (VMI). *Supply Chain Management: An International Journal*, 13(6), 406-414. <https://doi.org/10.1108/13598540810905660>
- Clark T.H., Hammond J.H., 1997. Reengineering channel reordering processes to improve total supply chain performance. *Production and Operations Management*, 6(3), 248-265. <http://doi.org/10.1111/j.1937-5956.1997.tb00429.x>
- Disney S.M., Potter A.T., Gardner B.M., 2003. The Impact of Vendor Managed Inventory on Transport Operations. *Transportation Research Part E*, 39(5), 363-380. [https://doi.org/10.1016/S1366-5545\(03\)00014-0](https://doi.org/10.1016/S1366-5545(03)00014-0)
- Devika K., Jafarian A., Hassanzadeh A., Khodaverdi R., 2016. Optimizing of bullwhip effect and net stock amplification in three-echelon supply chains using evolutionary multi-objective metaheuristics. *Annals of Operations Research*, 242(2), 457-487. <http://doi.org/10.1007/s10479-013-1517-y>
- Dong Y., Dresner M., Yao Y., 2014. Beyond Information Sharing: An Empirical Analysis of Vendor-Managed Inventory. *Production and Operations Management*, 23(5), 817-828. <http://doi.org/10.1111/poms.12085>
- Forrester J.W., 1958. Industrial dynamics: a major breakthrough for decision makers. *Harvard Business Review*, 36(4), 37-66.
- Forrester J.W., 1961. *Industrial Dynamics*, Cambridge: MIT Press, Cambridge, UK.
- Gelei A., 2002. Questions of supply chain management, issue 27, Workshop study. Budapest, Hungary: Budapest University of Economics and Public Administration.
- Ghuri P., Gronhaug K., 2011. *Research Methodology in Business Sciences*. Budapest, Hungary: Publishing House of the Hungarian Academy of Sciences.
- Govindan K., 2013. Vendor-managed inventory: a review based on dimensions. *International Journal of Production Research*, 51(13), 3808-3835. <http://dx.doi.org/10.1080/00207543.2012.751511>
- Kulp S.C., Lee H.L., Ofek E., 2004. Manufacturer benefits from information integration with retail customers. *Management Science*, 50(4), 431-444. <http://doi.org/10.1287/mnsc.1030.0182>
- Majoros P., 1997. *Research Methodology, or how to write easily, quickly good thesis?* Budapest, Hungary: National Textbook Publisher.
- Mantzer J.T., Dewitt W., Keebler J.S., Min S., Nix N.W., Smith C.D., Zacharia Z.D., 2001. Deffining Supply Chain Management. *Journal of Business Logistics*, 22(2), 1-25. <http://doi.org/10.1002/j.2158-1592.2001.tb00001.x>
- Nagy J., 2010. Types of supply chains and means of their management - an empirical analysis. Budapest Doctoral Dissertation, Budapest Corvinus University, Doctoral School of Management and Business Administration.
- Némón Z., Sebestyén L., Vörösmarty Gy., 2005. *Logistics, processes in the supply chain*, Budapest, Hungary: Commercial and Turism Postgraduate Training Training Ltd.
- Niranjan T.T., Wagner S.M., Nguyen S.M., 2012. Prerequisites to Vendor-Managed Inventory. *International Journal of Production Research*, 50(4), 939-951. <http://dx.doi.org/10.1080/00207543.2011.556153>
- Oláh J., Vad V., 2015. Characteristics of the consignment inventories in the supply chain. *Budapest Management Review*, 8(46), 67-74.
- Prezenszki J., 2007. *Logistics II*. Budapest, Hungary: Logistics Development Center.
- Simchi-Levi D., Simchi-Levi E., Kaminsky P., 1999. *Designing and managing the supply*

- chain: Concepts, strategies, and cases. New York: McGraw-Hill.
- Simon, Herbert A., 1952. On the application of servomechanism theory to the study of production control, *Econometrica*, (20), 247-268.
- Tarikere T.N., Stephan M.W., Stephanie M.N., 2012. Prerequisites to vendor-managed inventory. *International Journal of Production Research*, 4(50), 939-951. <http://dx.doi.org/10.1080/00207543.2011.556153>
- Towill Denis R., 1982. Dynamic analysis of an inventory and order based production control system. *International Journal of Production Research*, 20(6), 671-687. <http://dx.doi.org/10.1080/00207548208947797>
- Udenio M., Fransoo J.C., Peels R., 2015. Destocking, the bullwhip effect, and the credit crisis: empirical modeling of supply chain dynamics. *International Journal of Production Economics*, 160, 34-46. <https://doi.org/10.1016/j.ijpe.2014.09.008>
- Yu Y., Chu F., Chen H., 2009. A Stackelberg game and its improvement in a VMI system with a manufacturing vendor. *European Journal of Operational Research*, 192(3), 929-948. <https://doi.org/10.1016/j.ejor.2007.10.016>
- Waller M., Johnson M.E., Davis T., 1999. Vendor managed inventory in the retail supply chain. *Journal of Business Logistics*, 20(1), 183-203.
- Williams B.D., Toker T., 2008. A review of inventory management research in major logistics journals: Themes and future directions. *International Journal of Logistics Management*, 19(2), 212-232. <https://doi.org/10.1108/09574090810895960>

METODY ZARZĄDZANIA ZAPASEM W CELU ZMINIMALIZOWANIA POZIOMU ZAPASU SUROWCÓW W OBRĘBIE ŁAŃCUCHA DOSTAW

STRESZCZENIE. Wstęp: Każda międzynarodowa organizacja producenta dąży do ukształtowania swoich procesów tak, aby zminimalizować koszty i zmaksymalizować zysk. Głównym celem jest utrzymanie zapasów na możliwie najniższym poziomie w celu zminimalizowania kosztów. W obrębie organizacji poddanej analizie istnieje kilka różnych procesów. Jednym z nich jest system VMI (Vendor Managed Inventory), w obrębie, którego dostawca zarządza zapasem klienta. Innym systemem jest proces zarządzania zapasem konsygnacyjnym, w którym dostawca przechowuje zapasy w lokalizacji klienta. Celem tej pracy jest analiza czy zastosowanie obu tych metod umożliwia obniżkę kosztów w analizowanej organizacji i jeśli tak, to, w jakim rozmiarze.

Metody: W ramach pracy przeprowadzono analizę przypadku (case study) u producenta na terenie Węgier, w regionie północnym kraju. Analizy przeprowadzono na podstawie odpowiednich danych otrzymanych z systemu SAP, dostarczonych przez analizowane przedsiębiorstwo. Okres poddany analizie trwał od 1 do 14 lipca 2016.

Wyniki: Uzyskane wyniki umożliwiły opisanie efektu wzmocnienia w obrębie łańcucha dostaw oraz zademonstrowanie możliwości jego zmniejszenia. W trakcie badań wykazano, że analizowane przedsiębiorstwa jest w stanie zaoszczędzić istotną wartość w obrębie materiałów opakowaniowych. Analizie poddano pozycje z tej grupy o dużych wolumenach w celu określenia potencjalnych oszczędności. Proces ten został zarekomendowany przedsiębiorstwu do stosowania w przyszłości, również dla nowych dostawców. Drugą analizowaną metodą minimalizacji poziomów zapasów był proces zakupu konsygnacyjnego. Wykazano, że proces zakupu konsygnacyjnego jest najlepszą metodą obniżki analizowanych kosztów.

Wnioski: Badania zaprezentowały obecny system zarządzania łańcuchem dostaw, jego wady oraz potencjalne kierunki rozwoju. Uzyskane wyniki zwróciły uwagę zarówno węgierskim jak i międzynarodowym przedsiębiorstwom na istotę spójnego zarządzania łańcuchem dostaw oraz szeroki wachlarz dostępnych narzędzi dla zwiększania efektywności łańcucha dostaw, a dzięki temu do zwiększenia poziomu obsługi klienta.

Słowa kluczowe: zarządzanie zapasem po stronie odbiorcy, zarządzanie zapasem przez konsygnację, łańcuch dostaw, dostawca, zapas surowców

METHODEN FÜR DIE GEZIELTE BESTANDSFÜHRUNG ZWECKS DER MINIMALISIERUNG VOM NIVEAU DES VORRATSBESTANDES VON ROHMATERIALIEN INNERHALB EINER LIEFERKETTE

ZUSAMMENFASSUNG. Einleitung: Jede internationale Produktionseinrichtung strebt eine solche Ausgestaltung ihrer Prozesse an, die die Kosten minimalisieren und den Gewinn erhöhen lässt. Das Hauptziel dessen ist es, die Vorräte auf einem möglichst niedrigen Niveau zwecks der Minimalisierung von Kosten aufrechtzuerhalten. Innerhalb der gegebenen Produktionsorganisation wurden einige Prozesse einer Analyse unterzogen. Einer der Prozesse ist das VMI (Vendor Managed Inventory)-System, innerhalb dessen der Lieferant die Kundenbestände führt. Ein anderes System beläuft sich auf den Prozess der Führung eines Konsignationsbestandes, bei welchem der Lieferant die Bestände im Standort des Kunden hält. Das Ziel der Arbeit beruht auf der Analyse, ob die Anwendung der beiden Methoden in der betreffenden Produktionsorganisation die Minimalisierung von Kosten - wenn ja, dann in welchem Ausmaß - ermöglicht.

Methoden: Im Rahmen der vorliegenden Arbeit wurde ein Studienfall (case study) bei einem Produzenten im nördlichen Teil Ungarns durchgeführt. Die betreffenden Analysen wurden anhand der vom SAP-System gewonnenen und vom untersuchten Unternehmen bereitgestellten Daten vorgenommen. Der Zeitraum der Analyse belief sich auf die Tage 1-14. Juli 2016.

Ergebnisse: Die erzielten Ergebnisse ermöglichten die Beschreibung des Verstärkungseffektes innerhalb der Lieferkette und die Projizierung von Möglichkeiten dessen Verminderung. Während der Untersuchungen wurde nachgewiesen, dass das analysierte Unternehmen imstande ist, einen beachtlichen Bestandwert von Verpackungsmaterialien einzusparen. Zwecks der Bestimmung der potenziellen Einsparungen wurden die betreffenden Positionen aus der Gruppe umfangreicherer Bestände einer Analyse unterzogen. Der Prozess wurde dem Unternehmen für die Zukunft, auch für neue Lieferanten, empfohlen. Die andere analysierte Methode für die Minimalisierung von Lagerbeständen stellte der Prozess eines konsignationsartigen Einkaufs dar. Es wurde nachgewiesen, dass der Prozess eines Konsignationseinkaufs die beste Methode für die Kostenverminderung ist.

Fazit: Die Forschungen zeigten das gegenwärtige System des Lieferketten-Managements, dessen Nachteile und mögliche Entwicklungstrends auf. Die erzielten Forschungsergebnisse machten sowohl die ungarischen, als auch die internationalen Unternehmen auf das Wesen eines kohärenten Managements der Lieferkette und auf die breite Palette von brauchbaren Tools für die Effizienzerhöhung innerhalb einer Lieferkette, und dadurch auch zur Verbesserung des Kundenservices, aufmerksam.

Codewörter: Bestandsführung aufseiten des Empfängers, Bestandsführung mittels Konsignation, Lieferkette, Lieferant, Vorratsbestand von Rohmaterialien

Judit Oláh
Debrecen University
Faculty of Economics and Business
Debrecen, **Hungary**
e-mail: olah.judit@econ.unideb.hu

Zoltán Lakner
Szent István University
Faculty of Economics and Social Sciences
Gödöllő, **Hungary**
e-mail: lakner.zoltan@etk.szie.hu

Dávid Hollósi
Erste Bank Hungary Zrt.
Budapest, **Hungary**
E-mail: david.hollosi@erstebank.hu

József Popp
Debrecen University
Faculty of Economics and Business
Debrecen, **Hungary**
e-mail: popp.jozsef@econ.unideb.hu