Identification of Bottlenecks in a Selected Company

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***Abstract**: The material flows in global conditions of market functioning is today considerably complicated process for management of production companies and warehouses, therefore the analysis of internal cost reduction while maintaining the customer needs is devoted considerable attention. The possibility of system improvement is a continuous process, which seeks to progress, efficient use of resources and the expectations of the target results of the company. In present time, when we solve bottlenecks in logistics, by the analysis, missing their real introduction by managers to practice. In doing so, the choice of appropriate analysis and its applications, can save considerable resources inefficiently spent on repetitive processes, stocks management, transportation, handling and storage. In our study, by a simple examination of material flows and their optimizations we design solutions that remove distortions in the chain of activities and by the analytical calculations, which were actually tested in practice, we indicate a difference in terms of saving time and resources spent.*

***Keywords:** warehouse management, material flow, material handling*

INTRODUCTION

Methods for determining the material flows are subject to production logistics, but in principle, we use them across the entire spectrum of logistics activities and logistics chain, from transport through the handling of materials to storage. It should be emphasized that increasing traffic volume changes the complexity of transport [1, 9, 2]. Material flow is characterized by frequent crossroads, material flow in an opposite direction, pooling and separation. The other factors which extend this issue include assembly, transfer from larger to smaller type of transport or vice versa, changing of the type of transport and many other factors that significantly affect this process [5, 3, 8]. In our study, we focus on identifying bottlenecks in logistics, where optimization or obtained analytical solutions accelerate the flow of material, together with a reduction in the cost and time of production. Calculations of the data obtained were carried out in a real company with cost savings specified and real recommendations for practice [7, 6, 4].

MATERIAL AND METHODS

The content of this article is a kind of audit manual to specify handling costs, which are part of logistics costs. We have gained the data for solving this issue in SKOB enterprise (name is modified due to sensitive data) and through expert consultations done in a particular establishment.

Our role is:

- to gain knowledge of the flowing stream of information, of using information and communication means in this company (communication via the Internet and software packages), and to demonstrate the benefits of their use;
- to analyze the material flows in the given company by direct observations and discussions with experts in this field;
- to suggest possible solutions for an effective and rational use of existing handling facilities;
- to apply the data gained to the selected methods, to use the graphical representation of these processes, and then to evaluate them;
- on the base of real variables (the use of handling equipment in warehouses and production areas, the management of stocks, storage methods and sub-contracting between this sub-contractor and its main customer), to prepare a concept with respect to costs for the company (of storage and the operation of manufacturing processes).

Our goal has been to optimize the material flows, to reduce the length of transport distances, and to maximize the use of handling equipment. We were able to meet this goal.

RESULTS AND DISCUSSION

The concept of material handling optimization cannot be addressed separately without knowing other logistics costs, as a sharp fall in costs in one area can dramatically increase costs in other areas (e.g. costs in transport can rise with reducing storage costs). Therefore, we try to rationalize the complex logistics costs and their overall reduction.

To calculate the material flow, we have determined the optimum amount of deliveries, which is the amount of stock delivered to store by a single application. It is gradually depleted from the store according to production needs and the intensity of consumption. It was calculated according to Wilson's formula:

$$Q^{*} = \sqrt{\frac{2 \times \lambda \times N_O}{N_S}} \text{, kg/order} \quad (1)$$

where:

Q^{*} – optimum order, kg

λ – intensity of consumption, kg.month^{-1}

N_O – cost of communications, EUR

N_S – cost of storage, EUR

The **optimum length of a delivery cycle** represents a time interval from the arrival of an order to the warehouse until a complete depletion of all stocks. It depends on the size of the ordered quantity of stocks and on the intensity of their withdrawal from the warehouse. Calculation is according to the following formula:

$$T^{*} = \frac{Q^{*}}{\lambda} \text{, time interval} \quad (2)$$

where:

T^{*} – delivery time, month^{-1}

Q^{*} – optimum order, kg

λ – intensity of consumption, kg.month^{-1}

Optimum turnover, i.e. the number of orders made over a certain period, or how many times the purchase of stocks is made until their full putting on the market. Optimum turnover is calculated as**:**

$$V^{*} = \frac{1}{T^{*}} \text{, number of orders/time interval} \quad (3)$$

where:

V^{*} – optimum turnover, number/time interval

T^{*} – delivery time

Optimum average stocks – calculation according to the following equation:

$$\overline{Q} = \frac{Q^{*}}{2} \text{, kg} \quad (4)$$

where:

$\overline{Q}$ – optimum average stocks, kg

Q^{*} – optimum amount of the order, kg

Variable costs – they depend on the volume of production and are calculated using the following equation:

$$N_V = \sqrt{2 \times N_O \times N_S} \text{, EUR} \quad (5)$$

where:

N_V – variable costs, EUR

Total costs – they represent all expense items in ensuring one order. Calculation was carried out as follows:

$$N_C = \lambda \times O_C + \frac{\lambda}{Q^*} \times N_O + \frac{Q^*}{2} \times N_S \text{, EUR} \qquad (6)$$

where:

N_C – total costs, EUR

O_C – costs of purchase, EUR

Table 1. Calculation of optimum parameters for granulate

Situation of stocks (granulate) in store				
Input value	**Index**	**Optimum value**	**Real value**	**Unit**
Intensity of stocks use	λ	42,000	46,583	$kg.month^{-1}$
Storage costs	N_s	0.031	0.028	$EUR.kg^{-1}.month^{-1}$
Acquisition costs	N_o	0.18	0.18	EUR
Purchase price	O_c	1.438	1.438	$EUR.kg^{-1}$
Delivery time	T	0.1	0.1	month
Comparison of real and optimum values				
Calculation	**Index**	**Optimum value**	**Real value**	**Unit**
Amount of delivery	Q	698.39	774	kg
Delivery time	T	0.0166	0.0166	month
Turnover	V	60	62	$times.month^{-1}$
Average stock	Q^*	349.19	387.00	kg
Variable costs	N_v	0.11	0.10	EUR
Total costs	N_c	60,455.45	67,049.93	EUR

Based on the results, we have written into Table 1 the real and optimum values and the situation of granulate in store. Then, we examined the material flow in this company (Fig. 1), its volume, intensity, direction and frequency. By examining various points in the company between which the material is transported, we subsequently determined the priority sites that can be optimized and rationalized. Thus, we can also identify bottlenecks in logistics that we will analyze later.

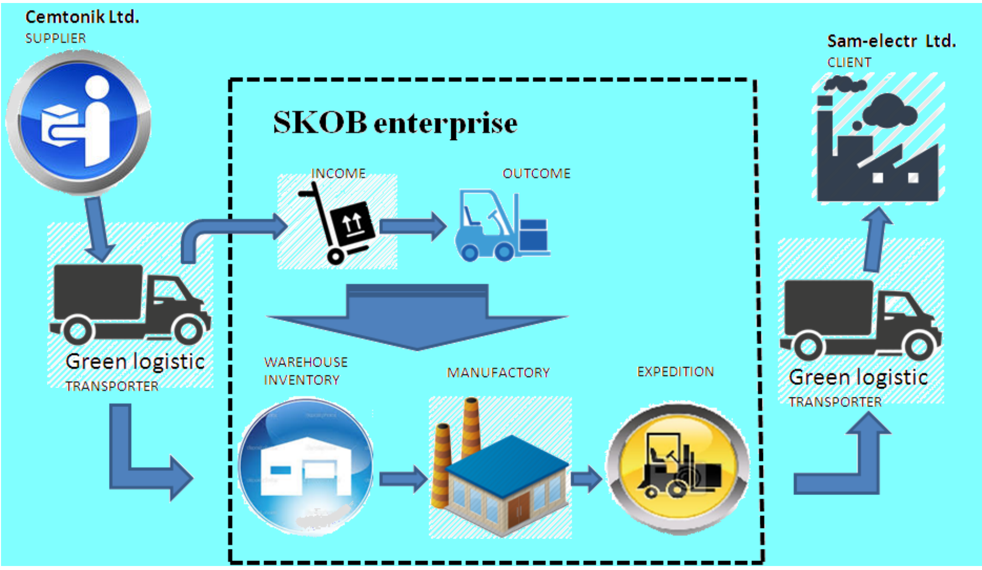

Fig. 1 Scheme of material flow in SKOB enterprise.

For an effective functioning of material flows and reducing the transport and handling costs, we have reconsidered in SKOB enterprise the arrangement of individual workplaces, production facilities, assembly centres and storage facilities. For material flows, it is important to be most effectively placed where the strongest intensity of material flow is.

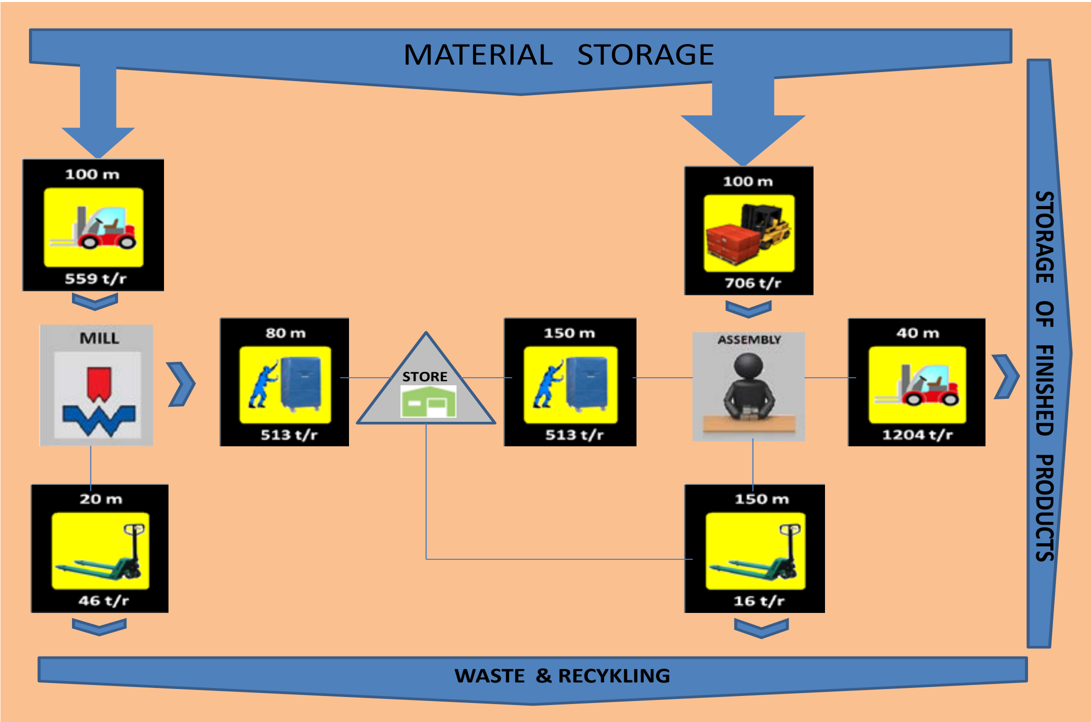

Fig. 2 Scheme of handling equipment for maintaining the material flow

Thus, these workplaces should be located as close as possible to each other. That can be achieved by placing the subjects in a triangular manner. The capacity of individual material flows determines the ability to carry out a certain performance over a certain period of time. In our case, it is the time during which the press is able to press out a raw product. The pressing of a raw bar for our reference model takes 1 minute and 24 seconds at the point C, and the time of completion of a finished product on the assembly line takes 1 minute and 50 seconds at the point D.

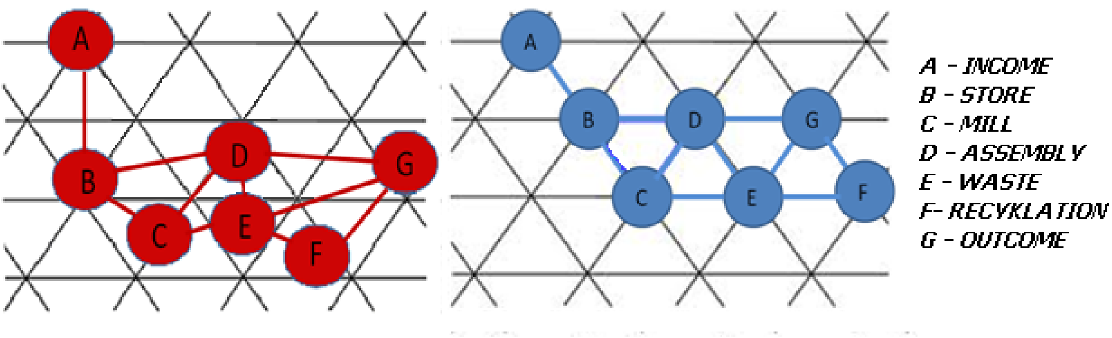

Fig. 3 Modification of workplaces according to the triangle method in SKOB enterprise.

The flow of material from the assembly hall is provided by a forklift with a maximum capacity of 1,500 kg. Areas for the movement of this forklift are unnecessarily large, so there would be possible, in terms of both the capacity and performance as well as in terms of volume, to increase the amount of material flow. We have proposed fork extension sleeves (Figure 4) for an effective use of the forklift. Using the parameters, the payload transport capacity can be expressed as follows:

$$P_d = \frac{d_j}{t_j}, \text{ pcs.h}^{-1} \quad (7)$$

where:

P_d – transport capacity, pcs.h^{-1}

d_j – transport unit, pcs

t_j – time unit, h

When transporting goods in SKOB enterprise in the original way, only one stack could be moved, representing 90 pcs of finished products in 6 minutes. The capacity of goods transport by the forklift was calculated as follows:

$$P_d = \frac{90\,\text{pcs}}{0{,}1\,\text{h}} = 900, \text{ pcs.h}^{-1} \quad (8)$$

According to the method of transporting the goods proposed by us, it was possible to relocate one more stack (i.e. two stacks simultaneously), representing an increase of amount by 100 % (i.e. to 180 pcs), but in the same time of 6 minutes. The capacity of transport is calculated using the following equation:

$$P_d = \frac{180\,\text{pcs}}{0{,}1\,\text{h}} = 1800, \quad \text{pcs.h}^{-1} \quad (9)$$

That has brought to SKOB enterprise time saving in handling the goods using the forklift, and the remaining time can be spent in other warehouse operations (e.g. the preparation of goods for dispatch). We have achieved an efficient use of handling equipment in the given flow.

Fig. 4 The use of traditional and extended forks in the store of SKOB enterprise

CONCLUSION

Identification of bottlenecks in a SKOB enterprise has reduced by means of targeted measures, internal logistics costs. One of the partial objectives was to minimize the total procurement costs of stocks. We have calculated the optimum amount of stocks, and these values were compared with actual indicators. As we did not measure identical numerical parameters, we calculated the amount of cost savings. Since we calculated with one stock item only, we would quantify multiple cost savings for all stock items. The said company decided to accept this proposal. First, they began with a gradual decrease of stocks to the optimum level calculated by us.

Further, we made a more efficient material flow using the triangle method. As the length of these flows affects the continuity of the production process, our goal was to find an optimal solution. We have proposed the substitution of the press by the store of unfinished production. However, we failed to implement it in practice because of continuous company's production activities. The company would consider the implementation of this concept in case of a scheduled outage during the summer months. That would bring to the company a considerable shortening of the flow of stocks, an improved overview of handling processes, and a reduced area used for this handling.

The use of forklift fork extension sleeves in order to increase the amount of flow is also considered an effective concept. We implemented this concept almost immediately in the said store by purchasing the sleeves, which the company was yet lacking. The proposed solution enabled the transport of a double amount of stocks over the same period of time and the same handling costs, by which the company yielded savings of time and funds.

ACKNOWLEDGEMENT

This paper was prepared with the support of the project KEGA No. 044 SPU-4/2014 "Environmental technologies and engineering".

This paper was supported under the project „Development of international cooperation for transfer and implementation of results into research and development of educational programs“ (TRIVE) ITMS project no: 26110230085.

REFERENCES

[1] Goldratt, Eliyahu M. Essays on the Theory of Constraints. [Great Barrington, MA]: North River Press.

[2] Hujo, Ľ., Jablonický, J., Tulík, J., Nikolov, M. I., Hajdák, V Economic indicators evaluation of transport company in terms of individually composite indexes. In Agricultural, forest and transport machinery and technologies. 1, 1, (2014) 17-26.

[3] Hujo, Ľ., Kosiba, J., Jablonický, J., Angelovič, M., Čápora, R. Analysis of the inland goods transportation at the transport company in Slovakia. In Machines, technologies, materials. 7, 6, (2013) 3-5,

[4] Hujo, Ľ., Halenár, M., Kosiba, J., Hajdák, V., Optimalizácia prepravných trás nebezpečného materiálu vytvorením interaktívnej mapy ADR v Trnavskom kraji, Vidiecke stavby v európskych regiónoch II – Architektúra, konštrukcie, technológie, bezpečnosť a logistika - Zborník recenzovaných vedeckých prác, (2014) 126-138.

[5] Jánošová, M., Hujo, Ľ., Jablonický, J., Štulajter, I. Optimalizácia vnútropodnikových manipulačných tokov vo výrobnom procese, Vidiecke stavby v európskych regiónoch II – Architektúra, konštrukcie, technológie, bezpečnosť a logistika - Zborník recenzovaných vedeckých prác, (2014) 147-156.

[6] Jánošová, M., Hujo, Ľ. Optimization of transport and handling processes in the production company. In SED 2013 - Science and higher education in function of sustainable development. Uzice: High business-technical school of Uzice (2013)10 - 17.,

[7] Lenďák, P., Jablonický, J., Hujo, Ľ., Kosiba, J. Methodology for improving the performance of emission inspection of gasoline engines with on-board diagnostics OBD. In Deterioration, dependability, diagnostics. Brno: Vysoké účení technické. (2013) 289-297.
[8] Majdan, R., Tkáč, Z., Čápora, R., Kangalov, P. G., Szabó, M., Angelovič, M., Tulík, J. Optimisation of transfer process in selected company. In Agricultural, forest and transport machinery and technologies. 1, 1, (2014) 33-39.
[9] Óno, T. Toyota Production System: Beyond Large-Scale Production, Productivity Press, (1988)

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