

# System Approach of Logistic Costs Optimization Solution in Supply Chain

## Sustavni pristup rješenju optimizacije logističkih troškova u opskrbnom lancu

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### Summary

This paper is focused on the possibility of using the costs simulation in supply chain, which are on relative high level. Our goal is to determine the costs using logistic costs optimization which must necessarily be used in business activities in the supply chain management. The paper emphasizes the need to perform not isolated optimization in the whole supply chain. Our goal is to compare classic approach, when every part tracks its costs isolated, a try to minimize them, with the system (logistic) approach, where the whole supply chain is optimized.

### KEY WORDS

logistics  
logistics optimization  
logistics costs  
producer  
supplier

### Sažetak

Ovaj članak je usredotočen na mogućnost korištenja simulacije troškova u opskrbnom lancu koji su na relativno visokoj razini. Naš cilj je odrediti troškove koristeći optimizaciju logističkih troškova koji moraju biti upotrijebljeni u poslovanju u menadžmentu opskrbnog lanca. Članak naglašava potrebu provođenja neizolirane optimizacije u cijelom opskrbnom lancu. Cilj je usporediti klasični pristup u kojem je svaki dio troškova praćen izolirano da bi se minimizirao, sa sustavnim logističkim pristupom, u kojem je optimiziran cijeli opskrbeni lanac.

### KLJUČNE RIJEČI

logistika  
logistička optimizacija  
troškovi logistike  
dobavljač

### INTRODUCTION / Uvod

Integrating logistics function is well known and appreciated. The importance of logistics is also growing with the development of integrative tendencies when individual regional markets acquire the character of global markets. The possibility of using logistics as an effective tool of a competitive fight by increasing market share is considered as an important factor. Price, quality, advertisement of comparable products do not differ in many ways. The difference possibilities are focused on the field of customer service providing and costs reduction associated with the management and implementation of goods and information flows. The way to achieve the mentioned objectives is logistics.

Logistics plays a key role in the economy in two basic ways:

- *logistics is one main items of enterprises' expenditures, thereby affecting other economic activities and is determined and influenced by these activities.*
- *logistics supports the movement and fluent flow of many economic transactions, is a necessary activity by sale of any product.*

To understand this role from system point of view we have to realize the fact that when goods will not come in time, customers

will not be able to buy it. If the goods do not arrive at the right place, or in the right (intact) state, no sales can be made. By the disruption of logistics functions, any economic activity (and subject) in the logistics chain suffers.

By the acceptance of these principles in the business conditions, we can conclude that the alleged logistics has an impact not only on the part of costs that we call logistic, but also create indirect pressure on the economy of the enterprise. Applied logistics tries this pressure to be the most favourable. If the basic idea of the whole economy is the assessment of used means, then undertaking is the way to its achievement. Environment that allows it is the market with its backbones of present business principles and endeavours of all kinds:

- *with customers, their satisfaction as an aim of this endeavour,*
- *with solution complexity.*

All the methods of modern business management despite the differentiation and necessary specifications in their goal orientation and approaches are based on them (for example: methods of TQM, marketing work system, management accounting, etc.).

Customer as the first pillar and obvious condition of the undertaking (without the customer there would not be any business) can be characterized as follows:

- *customer and logistics (from the logistic view, the business logistic chain starts and also ends by the customer),*
- *customer in economy (at the present stage of society development, the customer and his desire are determinants of economic movement),*
- *Customer and cash flow (a little outside the box and simply we can say that the payment of the customer is the initial impulse, initiation of the final financial flow of the company; comes from him the main flow of money into the company that allows possible additional economic and existential motion).*

Complexity, as the second pillar represents the existence and present application of several methods, the perfect interplay of business functions in one entity at the same time. Condition for achieving this synergy is the conception of complexity as:

- *present synchronized application,*
- *its horizontal and vertical impact with subsequent application in its entirety of organizational units*

Complexity thus represents the basic element of searched know-how of general principle of problems solution such as logistics, quality, marketing and economic.

Based on the present development and knowledge of mentioned issue we can claim that:

- *logistic costs attributable to the final unit with the division of labour still relatively and absolutely grow and also will continue growing,*
- *modern enterprise management concept is based on so called accountability principles (definition of competences and responsibilities, criteria determination, analysis of deviations and so on)*

In terms of pure logistic costs it is required that individual cost flows should be as clear as possible, precisely targeted according to the origin, destination and payment.

It is about:

- a) the precise definition of the scope, method of classification and tracking:
  - logistic performance in the enterprise,
  - logistic services provided by the enterprise.
- b) the precise location of (and consumption) logistics costs.

*From the logistic point of view:*

- locations of logistic performance occurrence can be only elements of supply chains,
- there, where logistic performance originate (activity connected to logistic services providing) cause the existence of logistic costs.

*Economic view tracks:*

- there should be all costs, including logistic planned and budgeted, assessed, calculated (registered), invoiced, paid and also analyzed,
- that mentioned requirements should be harmonized according to the accepted way of enterprise economic management.

## LOGISTIC COSTS CLASSIFICATION / *Klasifikacija logističkih troškova*

In this context, it will be a logical arrangement of logistic costs so that we could register and divide them in accordance with the

needs and requirements for their management. The condition to the fulfilling of this task is presumption completion, that each logistic performance, logistic service must be properly defined.

From the analytic aspect we can differ following cost types:

1. *Costs associated with the realization of logistics performance.* According to the type of business logistics we mention these performances:

- a) inbound logistics performances:
  - goods reception and check,
  - function of entry stores,
  - part of an intra traffic from material landing to manufacturing disposition
  - planning, management and check of information and material flows from input parts to manufacture,
- b) production logistics performances:
  - optimal manufacturing of production and material flows,
  - creation of favorable material conditions,
  - ensuring the rational use of land and premises,
  - high flexibility in the use of basic parts of LTA (buildings, structures and equipment),
  - planning and management of intra company transport,
  - operational planning batches,
  - operational tasks related to the storage of semi-products,
  - inventory planning in the manufacturing process,
  - workshop planning,
  - coordination of sales planning, production and supply,
  - other activities.
- c) distribution logistics performance:
  - selection of optimal distribution stores locations,
  - commission activities including container management,
  - goods output and loading ensuring,
  - goods transport to customer.

*By logistic cross sections are the following performances:*

- d) performance of transport systems:
  - external transport systems,
  - internal transport systems,
- e) performance of storage and commission systems:
  - storage activity of full range by ensuring of economic harmonization of different dimensioned material flows,
  - commission activity serving to the conversion from the stored goods to good for consuming,
- f) to h) logistic management performance.

These will correspond with the position and size of enterprise and it is necessary to take into account:

- structure of suppliers and customers (market structure),
- production structure,
- goods structure,
- existence of logistic management, lower function and workers in logistics,
- professional and general education of staff for logistics needs,

g) controlling performance in logistics

Costs incurred by them could be recorded along with the performances of logistic management. Since this is a specific high-impact activity, it will be better to be monitored separately in larger enterprises separately.

- 2. *Costs associated with binding capital funds in stocks*
- 3. *Financial logistic costs:*
  - interests,

- insurance,
  - leasing payments and so on.
4. *Alternative costs:*
- opportunity costs.
5. *Other logistic costs:*
- losses related to logistic activities realization,
  - costs of non-compliance of customer requirements and other.

In the field of the current state assessment of the topic in the Slovak Republic, we can point out the following facts:

- *current state of tracking and evaluation of logistic costs is insufficient,*
- *intra-company accounting system does not detect and become independent logistic costs, thereby becoming uncontrollable in terms of management,*
- *it is not possible to apply logistics operations efficiency control and use the concept of the lowest total logistic costs analysis.*

### Practical study of logistic costs optimization / *Praktična studija optimizacije troškova logistike*

In this case, we are considering the supply in logistic chain as follows: supplier → carrier → manufacturing company. The supplier represents the semi-product producer. The aim of this study is to compare classic approach, when every part tracks its costs isolated a try to minimize them, with the system (logistic) approach, where the whole supply chain is optimized.

Values for calculation:

$Q = 90\,000$  u/y - total volume of supplied semi-products,

$f_1$  - frequency (per year) of supplies,

$f_2$  - frequency of supplies according to carrier,

$f_3$  - frequency of supplies according to producer,

$n_d = 40$  € - supplier's costs to the expedition of one supply,

$s_d = 0,8$  € - store costs per unit per year by supplier,

$n_v = 18$  € - producer's costs to order one supply,

$s_v = 1$  € - store costs per unit per year by producer,

$l = 40$  km - distance from producer to supplier,

$n_t = 0,32$  €/km - transport rate,

$A = 54\,080$  €/y - yearly amortisation of procurement costs of transport system by  $f_2=1$ .

### Isolated optimization - supplier / *Izolirana optimizacija - dobavljač*

By the supplier we are talking about costs to procure semi-products supply and their storage. If we mark the volume in one supply  $q_d$ , then supplier's costs  $N_d$  equal:

$$N_d = \frac{Q}{q_d} \cdot n_d + \frac{q_d}{2} \cdot s_d, \text{ or according to frequency: } f_1 = \frac{Q}{q_d}$$

$$N_d = f_1 \cdot n_d + \frac{Q}{2 \cdot f_1} \cdot s_d$$

We can determine the optimal supply frequency from the annulated first derivation:

$$\frac{dN_d}{df_1} = 0$$

$$n_d \frac{Q}{2f_1^2} \cdot s_d = 0$$

$$f_1 = \sqrt{\frac{Q \cdot s_d}{2 \cdot n_d}} = \sqrt{\frac{90000 \cdot 0,8}{2 \cdot 40}} = 30$$

### Isolated optimization – carrier / *Izolirana optimizacija - prijevoznik*

The carrier performs particular transport system with an optimal frequency. There are two opposite items in the transport costs. By high frequency, vehicles with small item capacity are used. They will be used effectively but will ride a lot of kilometres. In the case of small volume of supplies, high-capacity vehicles will ride less kilometres but capacities will not be used sufficiently. It will cost higher costs  $\frac{A}{f_2}$ . This situation is explained by cost function:

$$N_t = \frac{A}{2f_2} + f_2 \cdot l \cdot n_D$$

$$f_2 = \sqrt{\frac{A}{l \cdot n_t}} = \sqrt{\frac{54080}{40 \cdot 0,32}} = 65$$

### Isolated optimization – producer / *Izolirana optimizacija - proizvođač*

The producer wants the supplement to be connected with minimal costs of order and semi-products storing:

$$N_v = f_3 \cdot n_v + \frac{Q}{2f_3} \cdot s_v$$

$$f_3 = \sqrt{\frac{Q \cdot s_v}{2 \cdot n_v}} = \sqrt{\frac{90000 \cdot 1}{2 \cdot 18}} = 50$$

It is obvious that the calculated optimal frequency differ ( $30 \neq 65 \neq 50$ ). This is the reason, why the isolated optimization cannot be performed. The economically strongest subject will enforce his interest and the others must accept it. In our case, there are three possible alternatives:

- The economically strongest is the supplier ( $f_1 = f_2 = f_3 = 30$ )

$$N_d = f_1 \cdot n_d + \frac{Q}{2f_1} \cdot s_d = 30 \cdot 40 + \frac{90000}{2 \cdot 30} \cdot 0,8 = 2\,400$$

$$N_v = \frac{A}{f_2} \cdot f_2 \cdot l \cdot n_t = \frac{54080}{30} + 30 \cdot 40 \cdot 0,32 = 2\,186,68$$

$$N_v = f_3 \cdot n_v + \frac{Q}{2f_3} \cdot s_v = 30 \cdot 18 + \frac{90000}{2 \cdot 30} \cdot 1 = 2\,040$$

Total costs of the whole supply chain are in this case 6 266,68 €.

- The economically strongest is the carrier ( $f_1 = f_2 = f_3 = 65$ )

$$N_d = f_1 \cdot n_d + \frac{Q}{2f_1} \cdot s_d = 65 \cdot 40 + \frac{90000}{2 \cdot 65} \cdot 0,8 = 31\,523,85$$

$$N_v = \frac{A}{f_2} \cdot f_2 \cdot l \cdot n_t = \frac{54080}{65} + 65 \cdot 40 \cdot 0,32 = 1\,664$$

$$N_v = f_3 \cdot n_v + \frac{Q}{2f_3} \cdot s_v = 65 \cdot 18 + \frac{90000}{2 \cdot 65} \cdot 1 = 1\,862,31$$

Total costs of the whole supply chain are in this case 6 680,16 €.

- The economically strongest is the producer ( $f_1 = f_2 = f_3 = 50$ )

$$N_d = f_1 \cdot n_d + \frac{Q}{2f_1} \cdot s_d = 50 \cdot 40 + \frac{90000}{2 \cdot 50} \cdot 0,8 = 2\,700$$

$$N_v = \frac{A}{f_2} \cdot f_2 \cdot l \cdot n_t = \frac{54080}{50} + 50 \cdot 40 \cdot 0,32 = 1\,721,6$$

$$N_v = f_3 \cdot n_v + \frac{Q}{2f_2} \cdot s_v = 50 \cdot 18 + \frac{90000}{2 \cdot 50} \cdot 1 = 1800$$

Total costs of the whole supply chain are in this case 6 221,6 €.

### Logistic optimization (minimizing costs of whole chain) / Optimizacija logistike (minimiziranje troškova cijelog lanca)

If there is a willingness to cooperate and trade relations arise, it is possible in accordance with logistical approach to find an optimal solution for the whole chain, where the most effective is the compromise, when all subjects of supply chain have some advantage. The costs of the whole supply chain can be explained as follows:

$$N_{log} = f \cdot n_d + \frac{Q \cdot s_d}{2f} + \frac{A}{f} + f \cdot l \cdot n_t + f \cdot n_v + \frac{Q \cdot s_v}{2f}$$

Optimal frequency of transport will be:

$$f_{opt} = \sqrt{\frac{Q(s_d + s_v) + 2A}{2(n_d + l \cdot n_t + n_v)}} = \sqrt{\frac{90000(0,8 + 1) + 2 \cdot 54080}{2(40 + 40,8 + 18)}} = 18,90$$

### CONCLUSION / Zaključak

After mentioned calculations, total costs of the whole supply chain by the logistic optimization are 5 306,31 €.

This study shows that cost optimization of the whole supply chain has better result than any other solution based on partly optimization.

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### REFERENCES / Literatura

1. Cisko, Š., Klieštík, T. (2009). *Finančný manažment podniku I.* (1st ed., p. 559). Žilina: EDIS Publishers.
2. Cisko, Š., Klieštík, T., „Finančný manažment podniku II“, EDIS: Publishing, Žilina 2013, 774 pp., ISBN 978-80-554-0684-8.
3. Demidenko, E. (2007). Sample size determination for logistic regression revisited. *Statistics in Medicine*, 26(18), 3385-3397. Retrieved from www.scopus.com
4. Friedman, J., Hastie, T., & Tibshirani, R. (2000). Additive logistic regression: A statistical view of boosting. *Annals of Statistics*, 28(2), 337-407.
5. Musa, A., Gunasekaran, A., & Yusuf, Y. (2014). Supply chain product visibility: Methods, systems and impacts. *Expert Systems with Applications*, 41(1), 176-194.
6. BASL, Josef; BLAŽÍČEK, Roman. *Podnikové informační systémy: podnik v informační společnosti. 2., výrazně přeprac. a rozš. vyd.* Praha: Grada, 2008. 283 s. ISBN 978-80-247-2279-5
7. KRÁLOVENSÝ, J., GNAP, J., POLIAK, M., KONEČNÝ, V.: *Ekonomika cestnej a mestskej dopravy 1.* Žilina : EDIS. 2008. 302 s. ISBN 978-80-8070-831-3.

