



EFFICIENCY ESTIMATION OF PROCESSES IN SUPPLY CHAIN MANAGEMENT OF PULP AND PAPER PRODUCTION

Tatiana Tereshkina

St. Petersburg State Technological University of Plant Polymers, St. Petersburg, Russia

ABSTRACT. Background: The identification of the impact of complex content characteristics on the effectiveness of supply chains cannot be conducted without a thorough analysis of logistical costs. Pulp and paper industry offers a large variety of products and thus has some specifics of manufacturing. It is characterized by high capital intensity and materials consumption, sophisticated technology and machinery processes domination, and producing a large number of by-products.

Methods: The method of efficiency calculation of logistical processes is used. It is based on the analysis of the logistical cycle parts duration. The logistical cycle duration is divided into periods depending on their increasing or not increasing of the value for the consumer. The analysis of fixed and variable logistic costs in main functional logistic spheres is carried out and the logistic costs influence on operational and financial leverages is estimated.

Results and conclusions: Using the approaches offered to evaluate the effectiveness of logistical processes, the method of calculation logistic leverage and analysis of logistic costs will allow passing on to the definition of given result in the supply chain and to the quantitative evaluation of the total value for the consumer.

Key words: efficiency of logistical processes, value based management, value chain, fixed logistic costs, variable logistic costs, logistical leverage, operational leverage, financial leverage.

It is impossible to identify the impact of complex content characteristics on the ultimate effectiveness of supply chains without a thorough analysis of logistical costs. In the process of analysis, it is worth researching structural and analytical typology of factors affecting logistical costs activating, as well as presenting in a structured fashion industry characteristics of product costs evaluation distinguishing the logistic component.

The aim of this study was to find a method of the evaluation of the effectiveness of logistical processes and the customer value, which is possible to obtain.

Pulp and paper industry (PPI) is the industry sector, which offers a large variety of products and thus has some specifics of manufacturing. It is characterized by high capital intensity and materials consumption, sophisticated technology and machinery processes domination, and producing a large number of by-products [Hong et al. 2011, Hamalainen, Tapaninen, 2011]. The expenditure levels and methods of product costs evaluation are influenced the following industry characteristics:

- availability of product groups, characterized by a homogeneous special manufacturing method. The stages of reprocessing (rework) in each group are feasible;
- a great diversity of homogeneous products by type, brand, grade, and size;
- availability of recyclable and non-recyclable waste, by-product group, and heat sources;

- much water utilization, power capacity, heat capacity and mass capacity of production which requires a great deal of auxiliary services, large areas, and maintenance of an in-plant and out-plant transport;
- large amount of information on the primary accounting of reworks, types of production, as well as division of accounting data on the main and auxiliary industries of principal products, by-products, and wastes;
- logistical costs activating of individual product groups for the entire range of reworks distinguishing the costs of each type or brand;
- ability to use either normative and parametric methods of product costs evaluation and value analysis of product costs or methods of direct account of costs when planning and sorting out the costs by type of product.

It should be emphasized that the management of logistical costs as a separate part of production management in Russia is almost nowhere included into the management system. Moreover, pulp and paper industry, in general, refers to a group of industries the least actively implementing the principles and approaches of logistic management as well as taking into account the logistics component of company's costs [Pati, Vrat 2010, Khanduja, Tewari, Chauhan, 2011].

To study the quantity and structure of logistical costs of pulp and paper industry we took Kamenska Paper and Cardboard Factory (PCF). This factory produces 31 grades of paper, 53 and 33 grades of cardboard and corrugated cardboard respectively. The company has established business relations with several hundreds of customers exporting products in different ways. All these characteristics are the evidence of high importance of the logistic component in the factory activities, so the organization of an effective accounting and logistical costs management will give it an additional competitive advantage. The analysis of logistical costs carried out at Kamenska PCF showed that the lion's share of these costs falls on transportation (75%). The remaining costs are the storage ones. Order processing costs and stock management of pulp and paper products are not considered. That is why it is possible to evaluate their significance indirectly only.

Nowadays it is important to ensure accuracy of accounting of both logistical costs and outcomes by type of product, packaging, by various distribution channels, fractions of market, customer groups, individual orders, cost centers and so on. In this respect, there is a problem of reasonable fixed logistical costs sharing according to the units of accounting. The problem under discussion has become more urgent these days, where fixed logistical cost share in the structure of product costs is rising in almost all industries, including pulp and paper industry. The analysis of fixed costs, carried out at Kamenka PCF, showed that almost 70% of all the costs are logistic ones.

Visualization of the structure of the total fixed logistical costs of Kamenska's PCF with decomposition of logistic component is shown in Fig. 1.

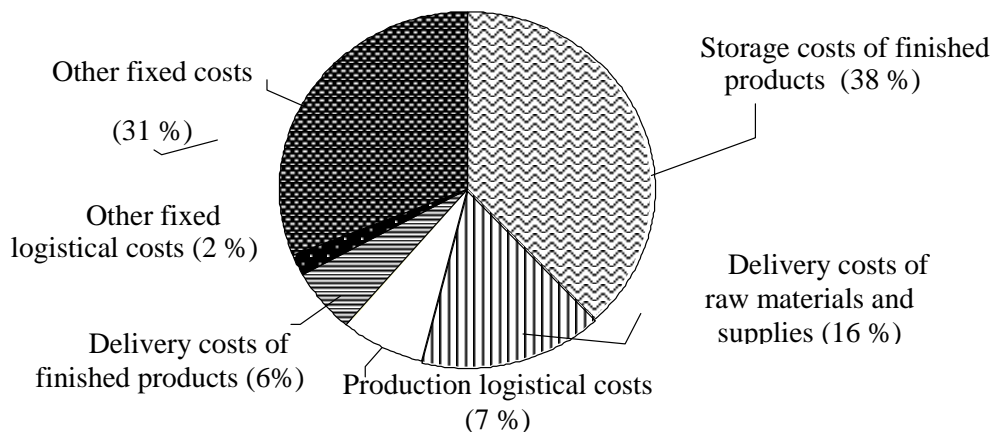


Fig. 1. The structure of fixed costs with logistic component [1 Tereshkina 2009]

Rys. 1. Struktura kosztów stałych związanych z logistyką [Tereshkina 2009]

High ratio of the logistic component of fixed costs demonstrates the significant impact of logistics on the level of operating leverage and, hence operational risk. In order to analyze how logistic costs (LC) influence the level of operational leverage, it is suggested to calculate the following economical indicators:

- S1 - the share of fixed logistic costs in fixed costs of the enterprise and S2 -the the share of fixed logistic costs in total logistic costs:

$$S1 = \frac{LFC}{FC} \quad (1); \quad S2 = \frac{LFC}{LFC+LVC} \quad (2);$$

LFC - fixed logistic costs,

LVC - variable logistic costs,

FC - fixed costs.

- PFC - the ratio of net profit (NP) to fixed costs and PLFC -the ratio of net profit to the fixed logistical costs:

$$PFC = \frac{NP}{FC} \quad (3) \quad PLFC = \frac{NP}{LFC} \quad (4)$$

Operating leverage (OL) shows the degree of sensitivity of profit to changes in the volume of output in natural units. After transformations of OL formula, one can see that the degree of operating leverage depends on ratio of fixed costs and operating profit. A similar ratio can be defined for the fixed logistical costs, provided that the ratio wherein the numerator is separated into logistical and non-logistical fixed costs. Thus, we can reveal the impact of logistics on the operational risk of the enterprise. By analogy with operating leverage it is possible to determine the influence of logistics on financial risk, which is defined by financial leverage (FL).

The level of financial leverage is much influenced by amount and turnover of inventories. These indicators of Russian pulp and paper mills are less than the same in developed countries. Table 1 shows significant immobilization of capital stock, as their turnover of inventories ranges from 38 to 60 days (but according to foreign pulp and paper mills, it should take from 15 to 22 days). The level of financial risk increases when volume-related capital is rising. Hence, it is necessary to reduce the cost of capital invested in current assets of all the supply chain.

Table 1. Turnover of inventories (average indicators for the period of 2005 - 2008)

Tabela 1. Rotacja zapasów (średnie wskaźniki za okres 2005-2008)

Indicator	'Nemansky Pulp and Paper Plant'	'Kotlassky Pulp and Paper Plant'	'Kamenska paperboard plant'	'Saint-Petersburg cardboard mill'
1. Share of current assets in total assets (%)	70	46	44	41
2.Share of inventories in current assets (%)	46	25	22	43
3. Inventories turnover in days	60	38	35	50

Enterprises should draw up a "map" of asset flow, which shows the volume of capital and period of freezing of current assets at each stage (Table 2). Using such schemes one can see what steps could

lead an enterprise to improve processes and reduce costs and, consequently, to decrease in the debt capital for working capital, and so to reduce financial risk.

Table 2. Analyses of significance of immobilization of capital stock at PC 'Kotlassky Pulp and Paper Plant' [Tereshkina 2009]

Tabela 2. Analiza istotności zamrożenia kapitału akcyjnego w firmie 'Kotlassky Pulp and Paper Plant' [Tereshkina 2009]

Indicators	Purchase of raw materials and supplies	Production	Storage of finished products	Transportation	Accounts receivable
Inventories turnover, days	23	3	12	2	25
Capital, millions of rub.	100,9	12,5	48,6	130,7	146,0
Volume of immobilized capital, millions of rub.	6,44	0,09	1,56	0,72	10
Opportunity to reduce the costs (volume of immobilized capital/inventories turnover), millions of rub.	0,28	0,03	0,13	0,36	0,40

Logistical factors highly influence the operational and financial leverages because of the following reasons:

- a high share of logistic component of fixed costs demonstrates the significant impact of logistics on the level of operational risk;
- logistic component of the financial leverage is expressed primarily in amount and turnover of inventories. The higher these factors, the more the debt capital for working capital of an enterprise, thus the more the financial risk;
- the worse the relationship with suppliers and customers, amount and turnover of inventories. the more the of receivables and payables. This influence directly the structure of source of finance, that is, the financial leverage;
- to manage the operational and financial leverages and, hence, the risk involved, and to identify the influence of logistic factors, first of all, means to control the dynamics of this indicators and to ensure the safety margin in terms of excess marginal income over the level of fixed costs.

A leverage ratio that summarizes the combined effect of the degree of operating leverage (OL), and the degree of financial leverage (DFL) is called degree of combined leverage (DCL). It is calculated as a results of multiplication of OL and FL.

Here is the formula for calculating the level of logistic leverage (LL), which is the modified formula of degree of combined leverage [Tereshkina 2009]:

$$LL = \frac{\left(P - \frac{LVC + OVC}{Q}\right) * Q}{\left(P - \frac{LVC + OVC}{Q}\right) * Q - (LFC + OFC) - N} \quad (5)$$

where:

P - unit price,

Q - volume of production,

N - interests,

OFC and OVC - other (non-logistic) fixed and variable costs.

When defining the level of logistic leverage, it is more important to analyze the rate of change indicators than its values. In such a manner, using the proposed indicators one can define the impact of logistics on the operational and financial risks of an enterprise. Identification and analysis of the amount and structure of logistical costs, when dividing them into fixed and variable, along with ensuring accuracy of accounting of both logistical costs and outcomes by type of product, packaging, by various distribution channels, fractions of market, customer groups, individual orders, and cost centers will allow to move to evaluation of effectiveness of supply chains. To do that, it is essential to evaluate critically every process and every activity in the supply chain and answer the following question: 'Does such type of activity increase the value of the goods or of the costs?'

Each element and each relation of the logistics chain should be carefully examined with respect to values and costs created by them. By value in this context, we mean customer loyalty, i.e. contribution into improving the product benefits or special offers to the clients, which make them, be happy and return to purchase again.

It should be noted that a considerable part of time spent on customer satisfaction is excessive and its reduction would increase consistency and reliability of services, and thus increase public image.

The difference between the time that increases the value and the time, which does not add value, is key to understanding the possibilities for the improvement of logistics processes. [Kristofer 2004]. A Table 3 illustrates the analysis of duration of the logistical cycle of production and sales of products of goffered at Kamenska paperboard plant.

Table 3. Logistical cycle duration of production of products of goffered at Kamenska paperboard plant
Tabela 3. Okres cyklu logistycznego produkcji w zakładzie Kamenska

Logistical cycle components	Logistical cycle duration, days		
	Total	which includes	
		increasing value	not increasing value
Transportation of raw materials and supplies	3	3	-
Inventories of raw materials and supplies	22	-	22
Production	2	2	-
Inventories of unfinished production	4	-	4
Production	1	1	-
Inventories of finished products	9	-	9
Transportation of finished products to the customer	2	2	-
TOTAL	43	8	35

As can be seen from this table the overall time of the process is equal to 43 days, and the added value is created only for 18,6% of the duration of this period. Efficiency of logistical processes (ELP) is defined as the time increasing value (T_v) to the total time of duration of the logistical cycle (T_{total}), expressed as a percentage.

$$ELP = \frac{T_v}{T_{total}} * 100 \% \quad (6)$$

So, most of the time the goods in the supply chain do not provide the increase in value. To improve this efficiency indicator, above all, it is necessary to achieve full understanding of the processes and activities related to the companies forming the supply chain, and this should be possible in case of drawing up a scheme of the supply chain. Such a scheme is a reliable tool for logistical re-engineering.

The data presented in Table 3 give an idea only on duration of the individual components of the logistical process, though, a quantitative evaluation of this "value" is not presented.

SUMMARY

Using the approaches offered to evaluate the effectiveness of logistical processes and analysis of logistic costs will allow passing on to the definition of given result in the supply chain and to the quantitative evaluation of the total value for the consumer.

REFERENCES

- Hämäläinen E., Tapaninen U., 2011, Accuracy of forecasting in A Nordic paper mill's supply chain: A case study. *Norsk Geografisk Tidsskrift, Norwegian Journal of Geugraphy*, 65, 2, 2011.
- Hong S., Choi Y., Kim K., Kang J., Oh G., Hur T., 2001, Material flow analysis of paper in Korea. Part I. Data calculation model from the flow relationships between paper products. *Resources, Conservation and Recycling*, 55, 12, 1206-1213.
- Khanduja R., Tewari P.C., Chauhan R.S., 2011, Performance modelling and optimization for the stock preparation unit of a paper plant using genetic algorithm, *International Journal of Quality & Reliability Management*, 28, 6, 688-703.
- Pati R.K., Vrat P., 2010, Economic paper blending optimization model with competing materials, *Management of Environmental Quality: An International Journal*, 21, 5, 602-617.
- Tereshkina T.R., 2009, Value-oriented concept of mezologistic systems management: theory and methodology, mechanisms of realization, St. Petersburg, 312.
- Kristofer M., 2004, Logistics and supply chain management/under edition of Lukinsky V.S.- St. Petersburg: Piter, 316.

OCENA EFEKTYWNOŚCI PROCESÓW W ZARZĄDZANIU ŁAŃCUCHEM DOSTAW W PRODUKCJI CELULOZY I PAPIERU

STRESZCZENIE. Wstęp: Identyfikacja wpływu złożonych charakterystyk na efektywność łańcucha dostaw nie może być przeprowadzona bez dogłębnej analizy kosztów logistycznych. Przemysł drzewny i papierniczy charakteryzuje się dużą ilością oferowanych wyrobów oraz pewną specyfiką produkcji. Charakteryzuje się on wysoką kapitałochłonnością oraz dużym zużyciem materiałów, skomplikowaną technologią oraz dużą ilością produktów ubocznych.

Metody: Przedstawiono metodę obliczania efektywności procesów logistycznych, opartą na analizie czasu trwania logistycznych części cyklu. Logistyczny czas trwania cyklu został podzielony na okresy w zależności od ich udziału w zwiększaniu lub nie zwiększaniu wartości konsumenckiej. Wykonano analizę stałych i zmiennych kosztów logistycznych w głównych funkcjonalnych obszarach logistyki oraz zdefiniowano wpływ kosztów logistycznych na dźwignie operacyjne i finansowe.

Wyniki i wnioski: Zastosowanie metody proponowanej do obliczania efektywności procesów logistycznych, metody obliczania dźwigni logistycznej oraz analizy kosztów logistycznych pozwala na ocenę uzyskanych wyników dla łańcucha dostaw oraz na ilościową ocenę całkowitej wartości konsumenckiej.

Słowa kluczowe: efektywność procesów logistycznych, wartościowe zarządzania, łańcuch wartości, stałe koszty logistyczne, zmienne koszty logistyczne, dźwignia logistyczna, dźwignia operacyjna, dźwignia finansowa.

BEWERTUNG DER EFFEKTIVITÄT DER PROZESSE IM LIEFERKETTENMANAGEMENT IN DER CELLULOSE- UND PAPIERHERSTELLUNG

ZUSAMMENFASSUNG. Hintergrund: Die Identifizierung des Einflusses komplexer Charakteristika auf die Effektivität der Lieferketten kann nicht ohne eine tiefere Analyse der Logistikkosten durchgeführt werden. Die Holz- und Papierindustrie zeichnet sich durch eine hohe Vielzahl der angebotenen Erzeugnisse und Produktionsspezifika. Charakteristisch für diese Industrie sind: die hohe Kapitalintensität, großer Materialverbrauch, komplizierte Technologie und eine Vielzahl von Nebenprodukten.

Methoden: Es wurde eine Methode zur Ermittlung logistischer Prozesse dargestellt, die auf Analyse des Logistik-Zeitzyklus basiert. Der Logistik-Zeitzyklus wurde in Perioden, abhängig von deren Teilnahme an der Steigerung oder Nichtsteigerung des Kundennutzens, aufgeteilt. Es wurde die Analyse fixer und variabler Kosten in den grundsätzlichen funktionellen Logistikbereichen durchgeführt und der Einfluss der Logistikkosten auf den operativen und finanziellen Hebel definiert.

Ergebnisse und Fazit: Die Anwendung der Methode zur Ermittlung der Effektivität logistischer Prozesse, der Methode zur Berechnung des Logistikhebels und Analyse der Logistikkosten ermöglicht die Beurteilung der erzielten Ergebnisse für die Lieferketten sowie eine mengenbezogene Beurteilung des gesamten Kundenwertes.

Codewörter: Effektivität logistischer Prozesse, Wertkette, fixe und variable Logistikkosten, Logistikhebel, finanzieller Hebel.

Tatiana Tereshkina

Dr. sc., Professor

Dean of Economics and Management Faculty,

Head of Marketing and Logistics Department

St. Petersburg State Technological University of Plant Polymers

St. Petersburg, Russia

e-mail: ttp_big@mail.ru