



SITUATION OF COSTS IN THE LOGISTIC PROCESS OF ENTERPRISES

Leonid Shvartsburg¹, Tadeusz Zaborowski², Piotr Cyplik³

1) Moscow State University of Technology STANKIN, Moscow, **Russia**, 2) Poznań University of Technology, Poznan, **Poland**, 3) Poznań School of Logistics, Poznań, **Poland**

ABSTRACT. Background: Costs in the logistics process play an important role. Searching for opportunities to reduce them, leads to improved management and innovative solutions. That is why it is so important to record them and then to analyze them in detail. The aim of this research was to find an answer whether there are common determinants having influence on costs of logistics processes in companies, operating on markets of different countries. The research was conducted in Poland and in Russia.

Methods: The research was carried out in selected Polish and Russian companies based on questionnaires, sent to these companies. The results of the study were analyzed by statistical analysis using Excel.

Results: The comparison of indicators in such areas like the availability of products, the value of customer service, the quality of customer service, logistics costs as well as inventory of finished goods in surveyed companies such a lot of similarities between Polish and Russian companies but also different approaches to some areas of business processes.

Conclusions: The strategy for managing and managing an enterprise can be different, but it requires constant analysis of generic costs to ensure that the company goes in the right direction. Research has shown that, despite many differences in the way they drive and choose the right decisions, the companies can be a profitable one.

Key words: logistic processes, costs, cost analysis, profitability.

INTRODUCTION

The fact is that logistic costs are not always deducted from the cost of operating the business. And yet they are the sum of the costs of storage, internal and external transport, production, and distribution. They are the basis of the account in the economic evaluation of the efficiency of the enterprise. Therefore, logistic costs should be determined taking into account criteria such as cost center, cost share, layout of costs, fixed and variable costs, and cost carriers [Abt, 1996; Blaik, 1997; Naider, 1997]. It is therefore possible to adopt the principle of place of costing as important for their evaluation.

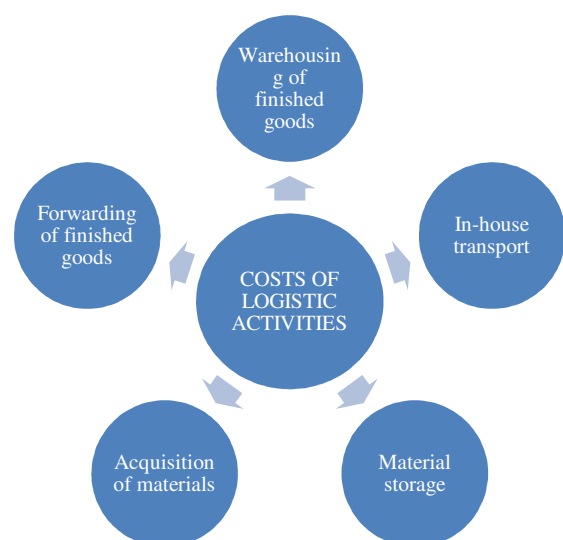


Fig. 1. Significant elements of logistic costs
Rys. 1. Istotne elementy kosztów logistycznych

Therefore, the organizational units of the company and the phases of the manufacturing process should be taken into account. Therefore, it is necessary to determine their origins and to take into account the various stages of the company's logistics activity, as shown in Fig.1.

It is obvious that apart from the essential elements of these costs [Ciesielski, Gołemska, 1999; Czubała, 1996; Wojciechowski, 1995] it is necessary to know the analytical positions in the generic system. These analytical items should take into account the components that are presented in Fig. 2.

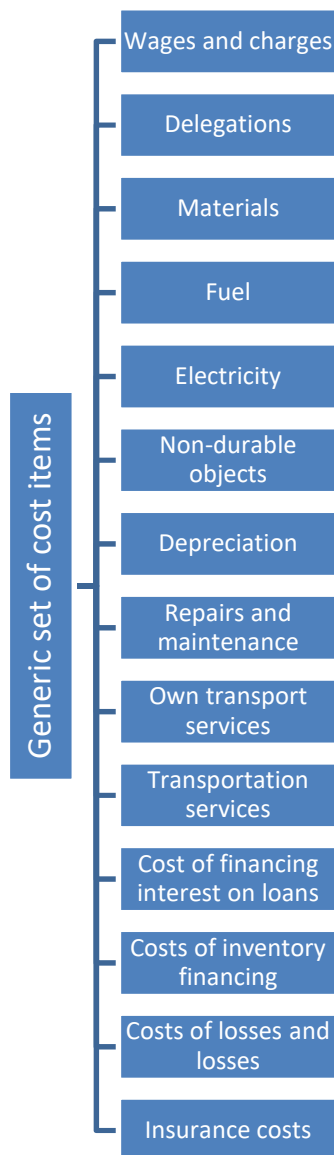


Fig. 2. Cost carriers in generic
Rys. 2. Nośniki kosztów

Generic cost cross-section of the costs should be based on logistic services provided to individual products manufactured and sold by the company.

With regard to inventory costs [Ciesielski, 1997, Kempny 1993, Młoczkowski 2003, Sołtysik 1993], two types of accounts should be used, namely:

- current account of inventory costs and according to the type and location of their inventories,
- hypothetical account including potential cost analysis, difficult to measure, variable costs.

Costs can often be found in the inventory costing system [Christopher 1996, Skowronek 1995, Biernacki, Kowalak 2015]:

- creating stocks,
- maintenance of stocks,
- supply
- exhaustion of stocks,
- keep stocks in transit.

Correct functioning of the logistic system forces the company to confront transport costs with the costs of keeping inventory in transit, as this has an impact on logistical security. Hence, companies often use the Direct Product Profit (DPP) method [Ciesielski, Gołemska 1999], which covers capital, storage, transport, and internal costs. Therefore, the storage costs can be calculated according to the following formula:

$$\sum_{i=0}^n K_m / P_s = K_p$$

where:

K_m – total storage costs [PLN]

P_s – Storage area [m²]

K_p – Storage cost of m² of warehouse space

The possibilities of calculations are obvious, however, the obtained results of research from the companies DPP method will not replace. Therefore, it was decided to conduct research of Polish companies and Russian companies in order to analyze the results of the research and obtain the necessary

knowledge about logistic costs and their structure [Abt 1996, Ciesielski, Gołemska, 1999, Biernacki, Kowalak 2015, Skowronek 1995].

For this reason, small companies in Poland and Russia were selected to compare the logistic costs of the enterprises and to evaluate the effects of the logistics solutions on this basis.

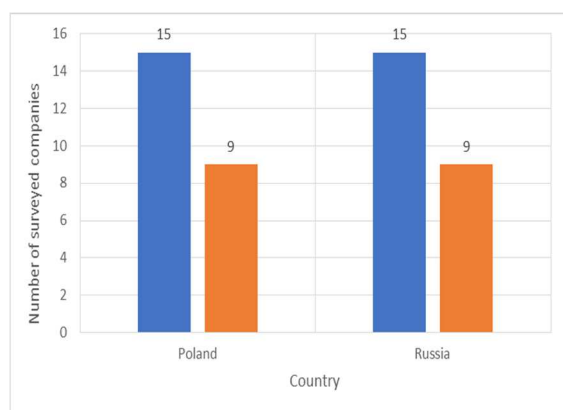
MATERIALS AND METHODS OF RESEARCH

The study included small companies in Poland and Russia, and for comparison, a random sample of 30 companies was established, ie 15 companies in Poland and 15 companies in Russia producing machinery and equipment.

Selected questionnaires were sent to selected companies in which they explained what they served and what their purpose was.

The results of the study were analyzed by statistical analysis using Excel.

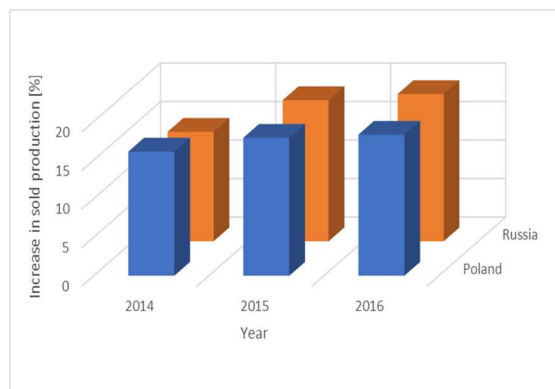
Sales value for Russian companies was converted from PLN rubles using the tables of the National Bank of Poland. The study covered three years and thus 2014-2016.



Source: own research

Fig. 3. Number of sent and received questionnaires
Rys. 3. Liczba wysłanych i otrzymanych ankiet

Of the 18 questionnaires surveyed, 60% of respondents were surveyed (Figure 3). For selected research companies, the increase in sold production was also assessed, as shown in Figure 4.



Source: own research

Fig. 4. Results of the increase in output sold to the surveyed enterprises

Rys. 4. Wyniki wzrostu obrotów badanych przedsiębiorstw

According to the obtained results, the greater dynamics (1.9%) in the surveyed companies in Poland was in 2014, while in 2015 the growth rate in the enterprises of Russia was 0.4% and in the year 2016 by 0.8%. Sales figures for the years 2014-2016 for individual companies are shown in Table 1 and average values in Table 2.

Table 1. Sales value in the surveyed companies [millions of PLN]

Tabela 1. Wartość sprzedaży w badanych przedsiębiorstwach [w mln PLN]

2014		2015		2016	
Poland	Russia	Poland	Russia	Poland	Russia
3,34	2,05	3,69	2,69	4,01	3,1
4,08	3,1	4,39	3,44	4,98	4,01
3,95	2,9	4,15	3,21	4,65	3,99
4,52	3,2	4,98	3,86	5,25	4,35
3,98	3,4	4,57	3,96	4,89	4,37
3,19	2,9	3,79	3,38	4,11	4
3,61	2,7	4,03	2,98	4,47	3,42
3,15	3,4	3,78	3,91	4,1	4,33
4,21	3,52	4,75	4,11	4,96	4,89

Source: own research

Table 2. Average values of sales of the surveyed enterprises [millions of PLN]

Tabela 2. Średnia wartość sprzedaży w badanych przedsiębiorstwach [w mln PLN]

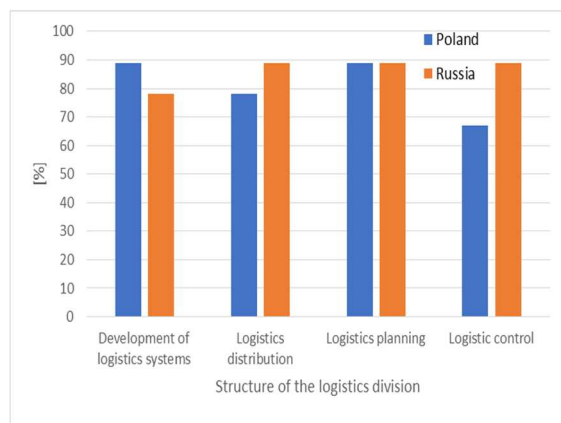
2014		2015		2016	
Poland	Russia	Poland	Russia	Poland	Russia
3,78	3,02	4,24	3,5	4,6	4,05

Source: own research

From the assessment of the average sales value (Table 2), Polish companies have higher sales value than Russian companies, the average for the analyzed years for Polish companies is PLN 4.21 million and for Russian companies it is 3.52 million.

The surveyed companies were also asked about the existence of a logistics division within their structure. The responses indicate that 67% of Polish enterprises have a separate division of logistics and in Russian companies such separation of the logistics division has 78% of the surveyed enterprises.

Interesting is also the organizational structure of such a vertical structure, the structure of which is illustrated in Figure 5.



Source: own research

Fig. 5. Structure of logistics division of the surveyed enterprises

Rys. 5. Struktura działów logistyki w badanych przedsiębiorstwach

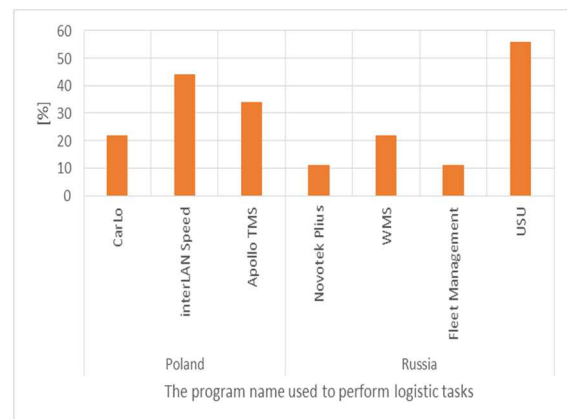
Research has shown that Polish companies pay more attention to the development of logistics systems, while Russian companies stress logistics control (Figure 5).

The hardware and software companies tested are 67% for Polish companies and 89% for Russian companies.

Internet and Intranet play an important role in order to communicate properly. Research shows that in the case of the Internet, all companies have access to 100%, whereas in the case of the Intranet, Polish companies have access to 89% and Russian companies 100%.

When using Intranet in the logistic system, 67% of Polish companies use this solution, whereas in the Russian company it is used 100%.

Special software to control logistics processes is used by 89% of Polish companies and 100% of Russian companies. The types of software used for logistic tasks are shown in Figure 6.



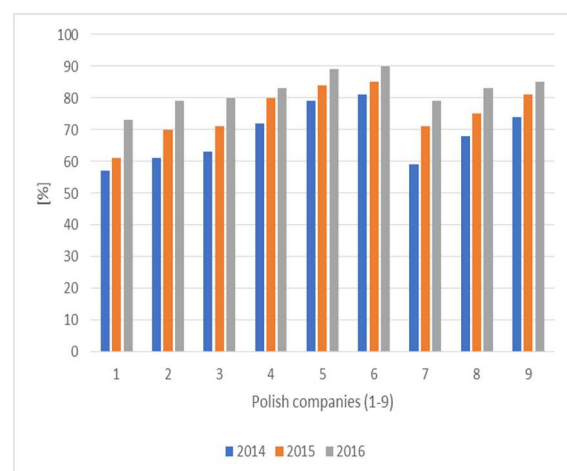
Source: own research

Fig. 6. Logistic programs used by the surveyed companies

Rys. 6. Oprogramowanie logistyczne stosowane przez badane przedsiębiorstwa

RESEARCH RESULTS

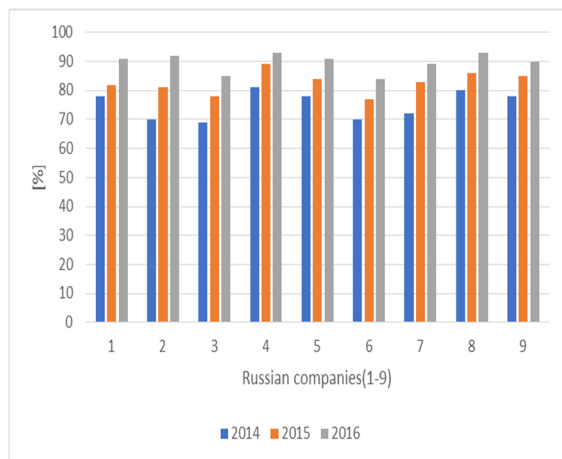
The availability of products in Polish companies (Fig. 7) and Russian (Fig.8).



Source: own research

Fig. 7. Availability of products in Polish enterprises

Rys. 7. Dostępność produktów w polskich przedsiębiorstwach



Source: own research

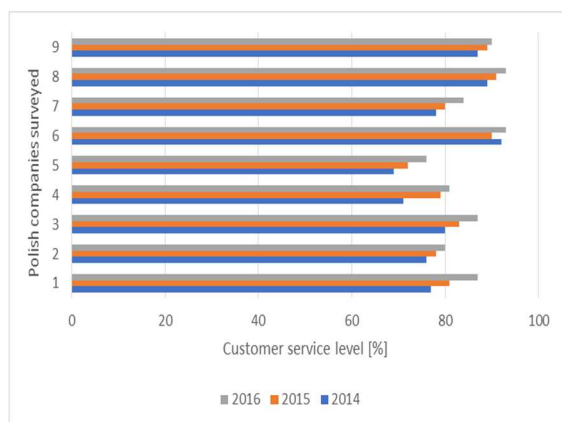
Fig. 8. Availability of products in Russian companies

Rys. 8. Dostępność produktów w rosyjskich przedsiębiorstwach

Research has shown that the average availability of products in Russian companies for the period under review was higher than in Poland by 7.3%.

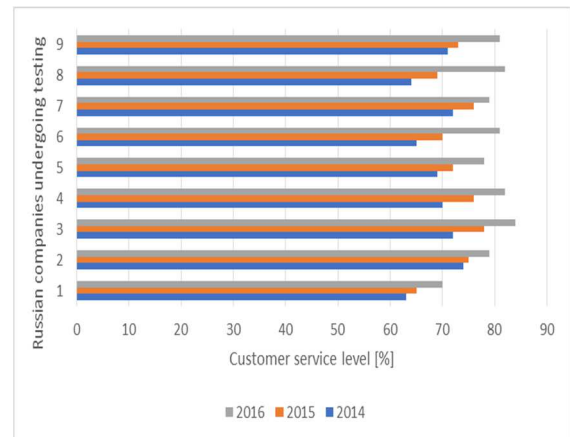
The value of customer service (Fig. 9, Fig. 10) was also assessed by the companies. It turned out that Polish companies were operating at a higher level and the average over a three year period showed that this level was higher by 9%.

The quality of customer service for Polish and Russian companies was also investigated, as shown in Fig. 11 and Fig. 12.



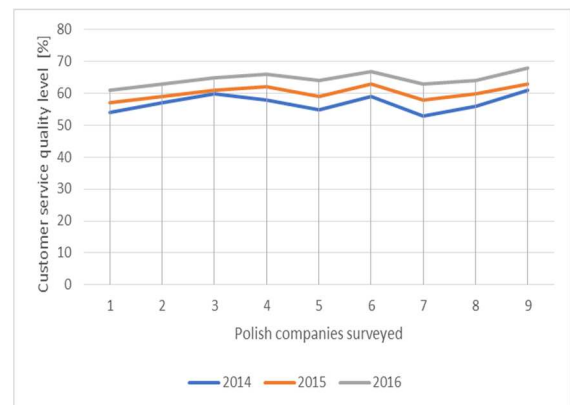
Source: own research

Fig. 9. Level of customer service by Polish companies
Rys. 9. Poziom obsługi klienta w polskich przedsiębiorstwach



Source: own research

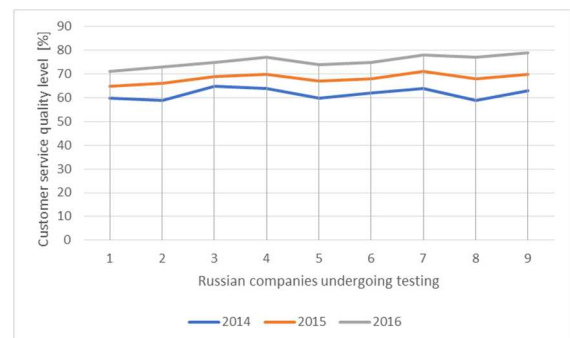
Fig. 10. Level of customer service by Russian companies
Rys. 10. Poziom obsługi klienta w rosyjskich przedsiębiorstwach



Source: own research

Fig. 11. Level of customer service quality by Polish companies

Rys. 11. Poziom obsługi klienta w polskich przedsiębiorstwach



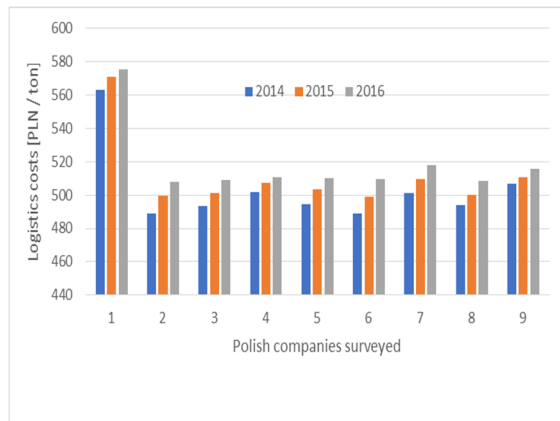
Source: own research

Fig. 12. Level of customer service by Russian companies
Rys. 12. Poziom obsługi klienta w rosyjskich przedsiębiorstwach

Analysis of the average quality rating and average value for the period under review

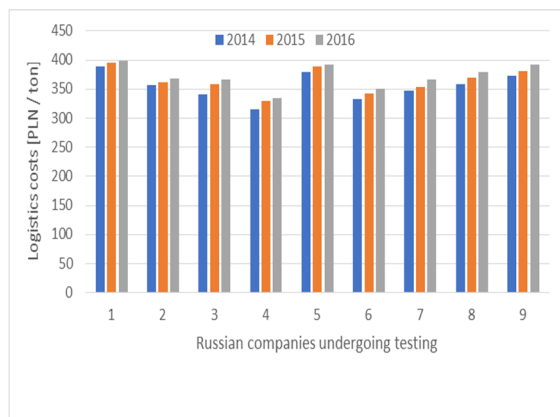
showed that the Russian customer service quality was 7.24% higher.

Logistics costs of Polish and Russian companies are presented in Fig. 13 and Fig. 14.



Source: own research

Fig. 13. Logistic costs of Polish companies
Rys. 13. Koszty logistyczne w polskich przedsiębiorstwach



Source: own research

Fig. 14. Logistic costs of Russian companies
Rys. 14. Koszty logistyczne w rosyjskich przedsiębiorstwach

Comparison of the average logistic costs of the surveyed Polish and Russian companies over the period analyzed showed that logistic costs of Russian companies were lower by PLN 147.51 [PLN/ton]. Thus, lower logistics costs created more favorable conditions for the development of Russian companies.

An important part of the cost is also the number of days covering the stock of finished goods, which in the companies studied was set

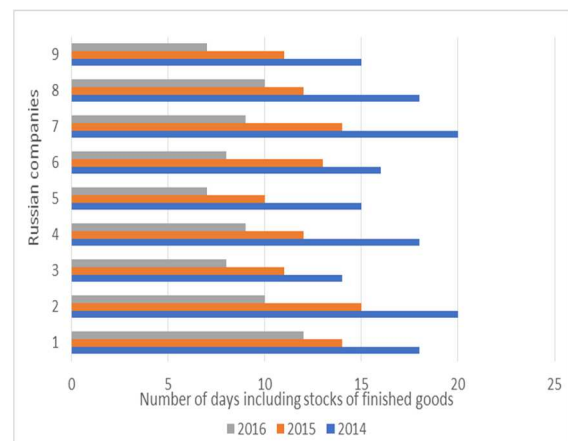
for 5 days. Fig. 15 and Fig. 16 show the results of the inventory of finished goods being the responsibility of the companies.



Source: own research

Fig. 15. Stocks of finished goods in Polish companies

Rys. 15. Zapas wyrobów gotowych w polskich przedsiębiorstwach

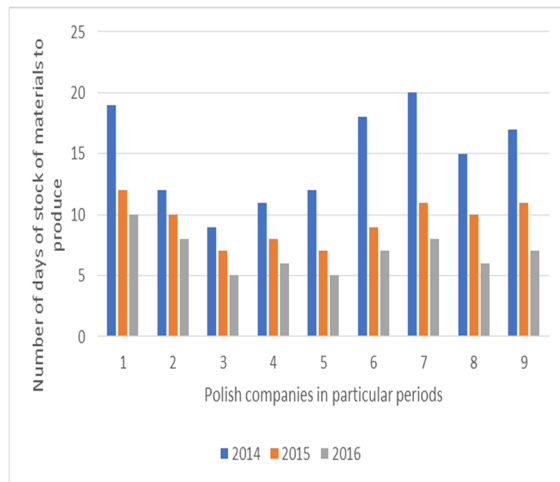


Source: own research

Fig. 16. Stocks of finished goods in Russian companies

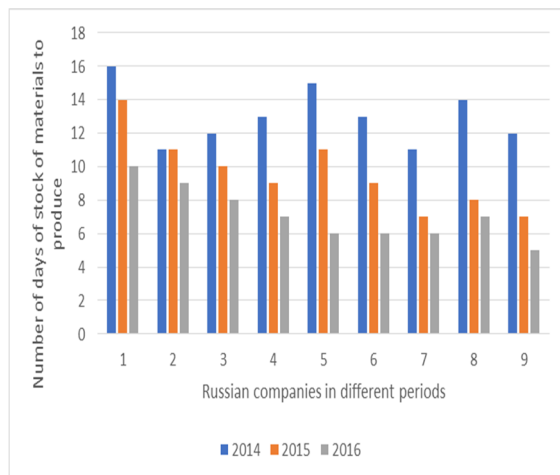
Rys. 16. Zapas wyrobów gotowych w rosyjskich przedsiębiorstwach

It turns out that the stock of finished goods in Russian enterprises is shorter by 6.1 days and this means that these companies bear lower costs. If that's the case then you need to stock up on materials for production. The companies surveyed indicated that the stock had been set for five days. Thus, the number of days of stock of material for production was analyzed. The results of this analysis are presented in Fig. 17 and Fig. 18.



Source: own research

Fig. 17. Number of days of stock of materials for production in Polish companies
Rys. 17. Liczba dni zapasu materiałów produkcyjnych w polskich przedsiębiorstwach

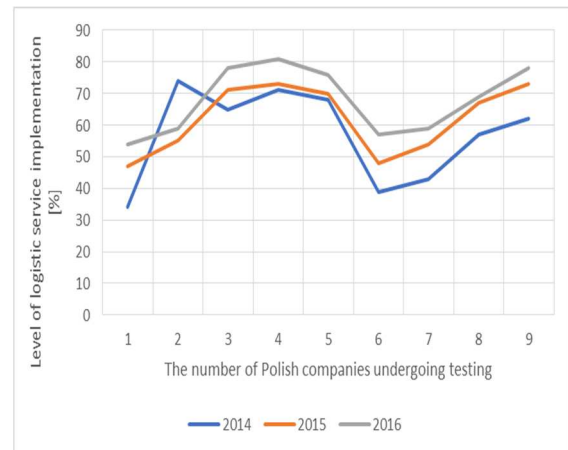


Source: own research

Fig. 18. Number of days of stock of materials for production in Russian companies
Rys. 18. Liczba dni zapasu materiałów produkcyjnych w rosyjskich przedsiębiorstwach

According to the evaluation of the data obtained from the conducted studies, the average number of days of stock of materials for production in Poland was 10.4 and that of Russian enterprises was 9.9, ie 0.5 days less.

Costs related to the level of logistic service are also important, as illustrated in Fig. 19 and Fig. 20. Different definitions exist in academic of its 2011].



Source: own research

Fig. 19. Level of realization of logistic services by Polish companies
Rys. 19. Poziom realizacji usług logistycznych przez polskie przedsiębiorstwa

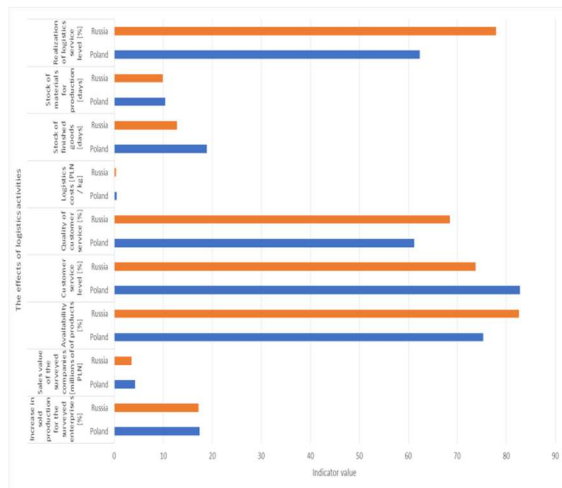


Source: own research

Fig. 20. Level of realization of logistic services by Russian companies
Rys. 20. Poziom realizacji usług logistycznych przez rosyjskie przedsiębiorstwa

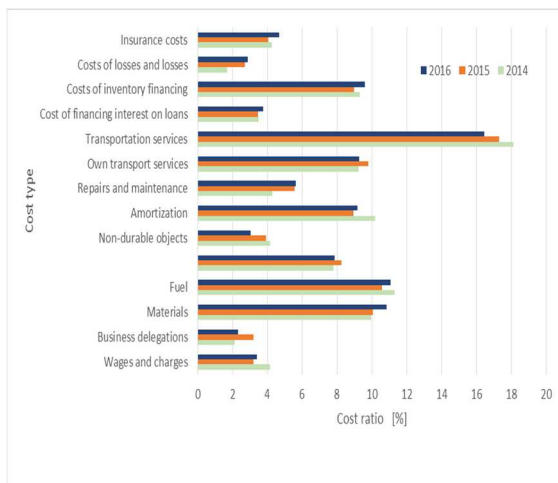
It is obvious that the level of logistic service is important to the customer. The higher the level (95%, for example), the better, but unfortunately it increases with the cost. In the case of the surveyed enterprises, it turned out that the level of customer service in Polish companies was 62.3% and for Russian companies 77.9% (average for the whole period examined). Research results indicate that the level of logistic service is low and the difference is 32.7% for Polish companies and 17.1% for Russian companies. Investigated companies still have to spend significant money to increase the level of logistic service.

The cost of generic and, in particular, their analytical system is an important element in the assessment of activity. That is why an analysis and comparison of generic costs in the analytical system was carried out, as illustrated in the drawings below for the surveyed companies from Poland and Russia (Figure 21-22).



Source: own research

Fig. 21. Generic Analytical Costs for Polish Firms
Rys. 21. Analiza generyczna kosztów dla polskich przedsiębiorstw



Source: own research

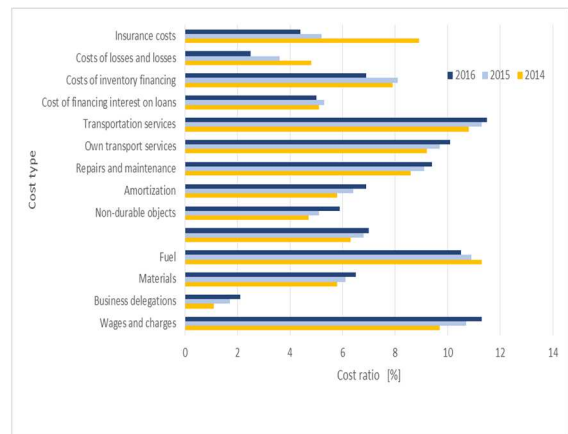
Fig. 22. Generic Analytical Costs for Russian Firms
Rys. 22. Analiza generyczna kosztów dla rosyjskich przedsiębiorstw

Analysis of generic costs in an analytical system for Polish companies showed (Fig. 21) that during the period under consideration, transportation services accounted for 16.4-

18.14% in the analyzed period and 10.59-11.3% costs.

In the case of Russian companies (Figure 22), the costs of transport services accounted for 10.8-11.5%, wages and charges 9.7-11.3% and fuel 10.5-11.3%. This means that Russian companies have spent more than about 6-8% on Polish wages and surpluses from Polish companies.

To further assess the analytical costs, they were further analyzed by comparing the costs of generic Polish companies (PC) and Russian companies (RC) for the periods studied, as shown in the figures below (Figures 23, 24 Fig. and 25 Fig.).



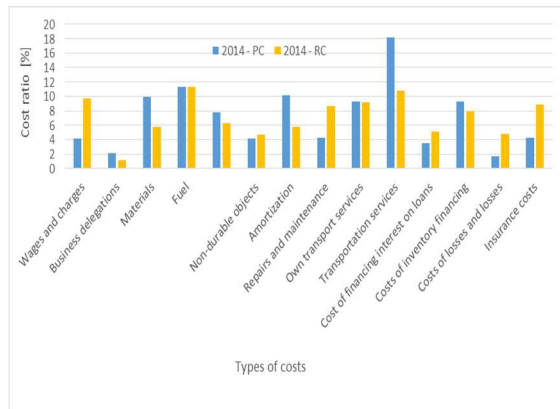
Source: own research

Fig. 23. Share of generic costs in total costs of the surveyed Polish and Russian companies
Rys. 23. Udział kosztów generycznych w kosztach całkowitych badanych polskich i rosyjskich przedsiębiorstw

The comparison of generic costs between Polish (PC) and Russian (RC) companies for 2014 (Figure 23) showed that foreign transport services were significantly higher in PC than in RC. Wages and overheads, in turn, were higher in RC than in PC, which indicates a higher salary of employees employed in RC. Inventory costs in the surveyed companies showed a similar value, while insurance costs were higher in RC by about 1/3.

In 2015, wages and surcharges in RC increased by about 30% compared to PC (Figure 24), while PC increased transport costs of external services. In addition, in the RC, expenditure on delegations and the costs

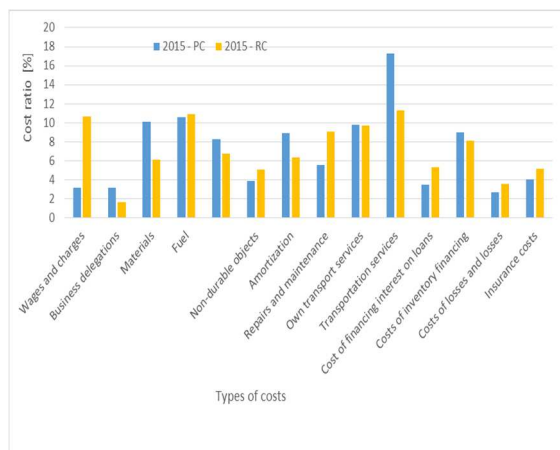
of inventory financing decreased. The costs of losses and losses and insurance costs increased (as compared to PC) (Fig. 24).



Source: own research

Fig. 24. Share of costs in the surveyed companies for 2014

Rys. 24. Udział kosztów w badanych przedsiębiorstwach w 2014

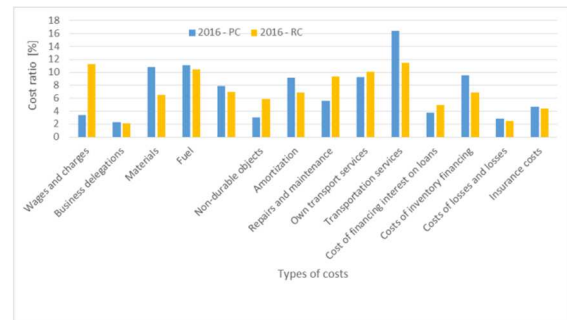


Source: own research

Fig. 25. Share of costs in the surveyed companies for 2015

Rys. 25. Udział kosztów w badanych przedsiębiorstwach w 2015

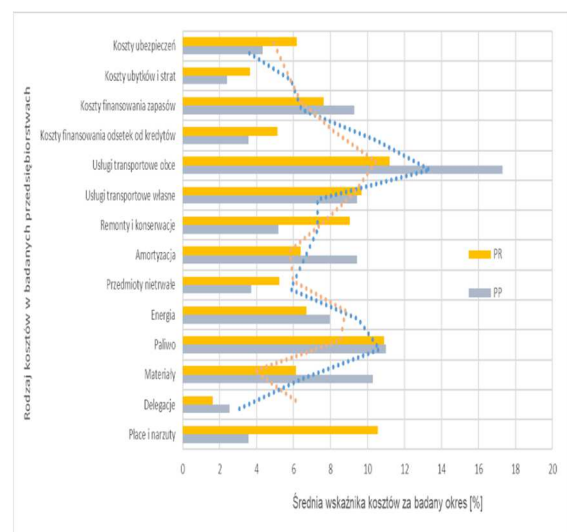
Still in the RC are rising wages and surcharges in relation to PC and their growth in relation to PC is more than 3 times higher. The costs of external transport services in PC (Figure 25, Figure 26) continue to increase, which is about 5% higher than in RC. You can see that in PC some of the generic costs are lower than in RC (Figure 25).



Source: own research

Fig. 26. Share of costs in the surveyed companies for 2015

Rys. 26. Udział kosztów w badanych przedsiębiorstwach w 2015



Source: own research

Fig. 27. Cost index for the period considered in the PC and RC type scheme

Rys. 27. Indeks kosztów dla danego okresu w schemacie PC i RC

For comparison of generic costs, mean values from the study period for PC and RC were calculated and analyzed (Figure 27). It turns out that PC transport services were more than 6% higher than RC in this period. Wages and overheads were also higher in RC than in PC by about 7%. This means that the RC put more emphasis on maintaining and developing human capital than PC (Figure 26). Also, the costs of financing stocks in PC were higher than RC by about 3%. Research shows that RC repairs and maintenance were 4% more expensive than PC, while PC materials cost more than RC by 4% (Figure 26). These differences accurately represent the moving averages for PC and RC (Figure 27).

The difference in approach to logistic costs in the surveyed enterprises is very visible. The fact that RC attaches greater importance to wage growth has in fact led to a better functioning of these companies as opposed to PC. The structure of analytical costs has been different perceived by PC and otherwise by RC. The cost of delegations and materials was higher in PC than in RC. However, the depreciation costs may point to the more modern PC equipment than the RC, which would confirm maintenance and repair costs, the percentage of which is higher in RC than in PC. But already the cost of stock financing was much higher in PC than in RC. There is also no significant difference between the cost of losses and losses in the surveyed companies. Approximate costs in some items allow us to say that RC conditions were more favorable than PC. The effect on this state of affairs was probably the remuneration that made it possible to stabilize work and to work more effectively with PC.

SUMMARY

Comprehensive understanding of the flow of materials and information, such as customer orientation, quality of logistics services, is an important element of the company's business. However, it can not escape from the field of view the cost of this business. Assessing the cost of a company's logistics activities gives you the chance to properly direct cash flows where they are needed. Of course, the strategy for managing and managing an enterprise can be different, but it requires constant analysis of generic costs to ensure that the company is moving in the right direction and logistic costs are constantly being analyzed. This approach enables dynamic and efficient use of cash and also allows synergy effects. Research has shown that, despite many differences in the way they drive and choose the right decisions, they produce products that meet market needs.

REFERENCES

- Bai J., Wei X., Yan J., 2017. Research on the Selection of Business-to-Customer e-commerce Logistics Model Based on Analytic Hierarchy Process Method. In: Qi E., Shen J., Dou R. (eds) Proceedings of the 23rd International Conference on Industrial Engineering and Engineering Management 2016. Atlantis Press, Paris, http://dx.doi.org/10.2991/978-94-6239-255-7_3
- Christopher M., 2011, Logistics&supply chain management, FT Prentice Hall, Harlow.
- Hsieh Ch.T, Huang H.Ch., Lee W.L., 2016. Using transaction cost economics to explain open innovation in start-ups, *Management Decision*, 54, 9, 2133-2156, <http://dx.doi.org/10.1108/MD-01-2016-0012>
- Dilupa Nakandala, Henry Lau, Andrew Ning, 2016. A hybrid approach for cost-optimized lateral transshipment in a supply chain environment, *Business Process Management Journal*, 22 4, 860-878, <http://dx.doi.org/10.1108/BPMJ-08-2015-0122>
- Filipiak B., (ed.), 2013. The Implementation of Accounting Tools in Logistics: The Experiences of Polish, German and Belarusian Companies, Difin, Warszawa.
- Hernández J., García M., Hernández G., 2013, Enterprise logistics, indicators and physical distribution manager, *Research in Logistics& Production*, 3, 1, 5-20.
- Perzyńska A., Witkowski K., 2016. The use of instruments of logistics and marketing in transport enterprises in Lubuskie voivodeship. *LogForum* 12 (3), 307-316, <http://dx.doi.org/10.17270/J.LOG.2016.3.10>
- Sergeyev V., 2016. Logistics controlling as a tool of performance improvement at the russian enterprises, *Transport and Telecommunication*, 2016, 17, 2, 100–110, <http://dx.doi.org/10.1515/tjt-2016-0009>
- Timm I.J., Woelk P.O., Knirsch P., Tönshoff H.K., Herzog O., 2016. Flexible Mass Customisation: Managing Its Information Logistics Using Adaptive Cooperative Multi-agent Systems. In: Pawar K.S., Rogers H., Potter A., Naim M. (eds) *Developments in Logistics and Supply Chain Management*. Palgrave Macmillan, London, http://dx.doi.org/10.1057/9781137541253_18

Toimenceva, Irina Anatolievna and Karpova, Natalia Petrovna and Toymentseva, Angelina and Chichkina, Vera and Efanov, Andrey, *Methods of the Development Strategy of Service Companies: Logistical Approach*, August 4, 2016. *International Journal Of Environmental & Science Education* 2016, 11, 14, 6820-6836. Available at SSRN: <https://ssrn.com/abstract=2848873>

Methods for Supply Chain Decision Makers, Springer-Verlag London Limited, London.

Zimon G., 2016, Accounting tools vs. logistics costs control in a trading company. *LogForum* 1, 2 (2), 155-164, <http://dx.doi.org/10.17270/J.LOG.2016.2.5>

Wu T., Blackhurst J., 2009, *Managing Supply Chain Risk and Vulnerability: Tools and*

KOSZTY W PROCESACH LOGISTYCZNYCH PRZEDSIĘBIORSTW

STRESZCZENIE. Wstęp: Koszty odgrywają istotną rolę w procesach logistycznych. Poszukiwania możliwości ich obniżenia prowadzą do poprawy poziomu zarządzania oraz do wprowadzania innowacyjnych rozwiązań. Z tego też powodu istotnym jest ich monitoring w połączeniu ze szczegółową analizą. Celem artykułu jest odpowiedź na pytanie problemowe czy istnieją wspólne determinanty mających wpływ na koszty procesów logistycznych w firmach działających na rynkach różnych państw. Badania przeprowadzono w Polsce i Rosji.

Metody: Badanie zostało przeprowadzane w wybranych polskich i rosyjskich przedsiębiorstwach w oparciu o badania ankietowe. Otrzymane wyniki poddano analizie statystycznej przy użyciu Excela.

Wyniki: Porównanie takich danych wskaźnikowych jak dostępność produktów, wartość usług, jakość obsługi klienta, koszty logistyczne jak i poziom zapasów wyrobów gotowych w badanych przedsiębiorstwach wykazało wiele podobieństw pomiędzy polskimi i rosyjskimi przedsiębiorstwami ale również różne podejście do niektórych obszarów działalności gospodarczej.

Wnioski: Przedsiębiorstwa mogą realizować w swojej działalności różne strategie zarządzania, ale wspólną cechą jest konieczność analizy kosztów generycznych aby zapewnić dobry kierunek rozwoju przedsiębiorstwa. Przeprowadzona analiza wykazała, że pomimo przyjęcia różnych strategii działania, przedsiębiorstwa mogą podejmować prawidłowe decyzje zapewniające osiągnięcie przez nich zysków.

Słowa kluczowe: procesy logistyczne, koszt, analiza kosztów, zyskowność

KOSTEN DER LOGISTIKPROZESSE IN UNTERNEHMEN

ZUSAMMENFASSUNG. Einleitung: Kosten spielen in Logistikprozessen eine besondere Rolle. Die Suche nach Möglichkeiten deren Minimalisierung führt zur Verbesserung des Managements und zur Einführung innovativer Lösungen. Deswegen ist deren Verfolgung in Verbindung mit einer detaillierten Analyse sehr relevant. Das Ziel des Artikels ist es, die Fragestellung ob es gemeinsame Determinanten gibt, die die Kosten der Logistikprozesse in den auf den Märkten unterschiedlicher Staaten wirkenden Firmen beeinflussen, zu beantworten. Die betreffenden Forschungen wurden in Polen und in Russland durchgeführt.

Methoden: Die Forschungen wurden in ausgewählten, polnischen und russischen Unternehmen anhand von Umfragen durchgeführt. Die gewonnenen Ergebnisse wurden der statistischen Analyse unter Anwendung der Kalkulationstabelle unterzogen.

Ergebnisse: Der Vergleich solcher Kennziffern wie: Verfügbarkeit von Produkten, Wert von Dienstleistungen, Kundenservice, Logistikkosten und Bestandhaltung von Fertigwaren wies in den untersuchten Unternehmen viele Ähnlichkeiten zwischen den polnischen und russischen Unternehmen, allerdings auch eine andere Vorgehensweise in manchen Bereichen ihrer wirtschaftlichen Betätigung, auf.

Fazit: Die Unternehmen können in ihren wirtschaftlichen Betätigung unterschiedliche Managementstrategien anwenden, es besteht aber zwischen ihnen ein gemeinsames Merkmal, d.h. die Notwendigkeit der Analyse von generischen Kosten, um eine gute Ausrichtung für die Entwicklung des betreffenden Unternehmens zu gewährleisten. Die durchgeführte Analyse zeigte auf, dass die Unternehmen trotz der Annahme von unterschiedlichen Wirkungsstrategien richtige Entscheidungen treffen können, die ihnen die Erzielung von Gewinnen gewährleisten.

Codewörter: Logistikprozesse, Kosten, Kostenanalyse, Rentabilität

Leonid Shvartsburg
Moscow State University of Technology STANKIN,
Moscow, **Russia**
e-mail: lesh@stankin.ru

Tadeusz Zaborowski
Poznań University of Technology,
Poznań, **Poland**
e-mail: tadeusz.zaborowski@put.poznan.pl

Piotr Cyplik
Poznań School of Logistics
Poznań, **Poland**
e-mail: piotr.cyplik@put.poznan.pl