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ORIGINAL PAPER

COST DEVELOPMENT IN LOGISTICS DUE TO INDUSTRY 4.0

Dagmar Čámská[1], Jiří Klečka[2]

1) Czech Czech Technical University in Prague, Prague, **Czech Republic**, 2) Czech University of Chemistry and Technology Prague, Prague, **Czech Republic**

ABSTRACT. **Background:** This paper is focused on the development of costs and their structure in logistics companies. Industry 4.0 should trigger significant changes in technologies, business or society where logistics as an area of entrepreneur activity is no exception. Some areas of logistics as storage and warehousing should be even pioneers. It is supposed that human labor has been/will be substituted by other production factors. This substitution should influence economic variables of companies and their overall performance. Challenges of Industry 4.0 will not only be exposed to companies but also to government. It is necessary to monitor the environment and describe changes.
Methods: Using published corporate financial statements the analysis is based on ratio analysis which describes cost structure and time series which show cost development on the level of individual companies operating in logistics. There are analyzed especially analytical indicators of selected cost items in terms of ratios, indicators of total costs and profitability.
Results: The computed cost structure and development were summarized and evaluated by descriptive statistics.
Conclusions: The obtained results show if and how significant there have been any changes in the level and structure of costs and profitability of logistics companies. Coming Industry 4.0 will have serious impact on business, government and individuals. This paper proves if the initiative Industry 4.0 can be already visible on the corporate data and results.

Key words: operating cost, cost structure, Czech Republic, CZ-NACE H, Industry 4.0.

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INTRODUCTION

Industry 4.0 is a term for a new development phase which does not affect only industry as previous industrial revolutions. Industry 4.0 can be characterized as a complex social change that causes changes in the thinking and attitude of the whole society. The term Industry 4.0 is not a world phenomenon [Lasi et al. 2014]. It originally came from Germany and therefore countries with close connections to Germany have taken the term. It is also possible to meet other terms such as smart industry.

At the current moment we are not standing on the edge, but in the center of this new development stage. Industry 4.0 has brought significant changes which do not affect only technologies. It must be emphasized that because of technological core current research has focused mainly on its technical fundamentals [Kiel et al. 2017]. Industry 4.0 is driven by nine technological shifts [Rüßmann et al. 2015], specifically Autonomous robots, Simulation, Horizontal and vertical system integration, The Industrial Internet of Things, Cybersecurity, The cloud, Additive manufacturing, Augmented Reality, Big data and analytics. These technological shifts are mainly connected with huge amount of

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investment mitigating the risk of losing competitive advantage. On one hand there are enormous costs and expenses, on the other hand it seems that the economic discussion is still in its infancy [Kiel et al. 2017]. It is still not discussed and investigated in detail although more and more companies have already implemented new technologies [Romberg 2016].

Many researchers base their works on general estimations published by Rüßmann et al. [2015] or Mckinsey Global Insititute [2015] or on case studies. Quantitative research is still rare in the area of productivity, accuracy or flexibility in manufacturing and related branches. There can be found pioneers as Dalenogare et al. [2018] using regression analysis and proving that some emerging technologies are more promising than the others in the case of the Brazilian companies, Brendel's [2015] effort to find evidence that the benefits of Industry 4.0 outweigh its costs or Erdei [2018] focusing on impact of new technologies, especially industrial robots, on productivity, employment and value added.

The consequences and impact on profit or value added are hardly in general focus. It should be changed because changes and technological shifts should be implemented because of their consequences and influence on business goals fulfilling. There is a serious risk that small and medium sized enterprises (SMEs) have not caught a wave of change and they will become victims [Sommer 2015]. Arcidiacono et al. [2019] proves that implementation of industry 4.0 is uneven among SMEs in the automotive industry.

A research gap has been clearly detected. There are not enough researches focusing on the impact of Industry 4.0 on economic variables and overall companies' performance. This paper should contribute to closing this gap in the area of logistics. The specific verified idea will be introduced in the following chapter which will also distinguish between Industry 4.0 and Logistic. 4.0. The following chapter is dedicated to indicators used for an analysis and description of a data sample. Obtained values of the selected indicators will be represented in chapter Results. Then part Conclusion contains discussion, limitations and possible future research tendencies.

LOGISTIC 4.0 AND PAPER IDEA

The previously presented technological changes of Industry 4.0 are mostly connected with investment in fixed assets tangible as well as intangible [Bettenhausen et al. 2010] and as well as in the area of logistics these investments are significant [Jereb 2017]. In the area of logistics these investments lead especially to RFID (Radio Frequency Identification), RTSL (Real Time Locating Systems), Cyber-Physical Systems, Internet of Things and Services and Big Data [Cyplik et al., 2019]. According to Acimovic et al. [2019] supply chain is affected by technologies of Industry 4.0 in the following areas: communication (real time interaction), merchandise manipulation (robotics and sensors), origin track (blocking technology), distribution of goods (self-driving vehicles) and off course data mining enabling Big data usage. Müller et al. [2018] sees positive effect from Industry 4.0 on Supply Chain in the form of flexibility, decreasing documentation efforts, usability of data, cost savings, traceability or decreasing of incorrect delivery.

There can be found authors as Cyplik et al. [2019] who distinguishes between Industry 4.0 and Logistics 4.0. Changing of providing logistic services is a response of Logistics 4.0 to Industry 4.0 [Maslaric et al. 2016]. Krykavsky et al. [2019] demonstrates the relevance of the implementation of Industry 4.0 into the practical activities which are complex. Therefore these activities consists of manufacturing, trading, logistic which are interconnected by networking in the process of delivering goods or services to their final customers. There are similarities of both concepts (Industry 4.0 and Logistics 4.0) but the obstacle is that it prevails thinking that Industry 4.0 is connected with production in a narrow sense and therefore logistics seems excluded. On the other hand Logistics 4.0 still remains less raised topic [Cyplik et al. 2019].

The aforementioned technological shifts and changes cause replacement of human labor [Rotman et al. 2013]. In other words part of

workers' duties is transferred to modern machines [Barreto et al. 2017]. These machines are and will be more autonomous and it enables the increase of the quality of produced products and provided services [Gubán 2017]. On the other hand it leads to changes of labor market [Kergroach 2017] and wages inequalities [Moenning et al. 2019]. Majority of researchers justly only state that new technologies in logistics enable improvement in manufacturing, delivering time, cost effectiveness etc. leading to greater profit [as Acimovic et al. 2019]. Unfortunately they do not provide any proof for their statements as in the area of general Industry 4.0.

This paper's effort can be described as a proof of replacement labor by new technologies leading to higher profits. This kind of substitution has been and will be important to maintain and strengthen enterprise competitiveness. It is crucial for companies which belong to areas in which Industry 4.0 has emerged or will be implemented. The paper verifies on the real data, if the substitution of labor by new technologies has already occurred in the analyzed time period. The main attention is dedicated to economic effects brought by this substitution. The research is carried out on Czech enterprises belonging to storage and warehousing sector.

INDICATORS AND DATA SAMPLE

Using published corporate financial statements the conducted analysis is based on ratio analysis. The ratios of the classical financial analysis are too general and are not able to fulfil our purposes. The substitution of the considered type should be examined. It is necessary to describe cost structure and its development. The indicators used in this analysis combine the ratios of the classical financial analysis and the ratios of partial cost. Selected cost items are personal costs and depreciation plus amortization. Personal costs contain wages, salaries and insurance paid by an employer. The item depreciation and amortization represent adjustments to tangible and intangible fixed assets. If an enterprise grows there will be pressure on cost growth. It must be noted that in this case the costs grow absolutely but there is an enormous effort that their relative growth has to be smaller than the growth of sales. Usage of the ratios solves an issue of the absolute versus relative growth.

Following text has to describe the used ratios because of their specificity. Indicators and input variables are described in table and equations represent computation of the used indicators. Company's growth influences the level of investment. If the company wants to sustain its development it is necessary to restore its property and if they want to grow they have to invest more and increase the value of fixed assets. Equation 1 (indicator A) displays the first ratio called absolute change in depreciation and amortization over sales. Positive value of indicator A proves that the company has invested relatively more than it is the sales growth. The second analyzed cost item is personal costs. Equation 2 (indicator B) shows the second ratio called absolute change in personal costs over sales. Negative value of indicator B proves that the company has paid relatively less on wages than it is the sales growth. It must be noted that it is valid for relative values because wages and salaries increase in absolute values due to the company growth, inflation and labor market situation described as a limited labor supply.

On the one hand there is an effort of the investment on the other hand companies prefer to minimize costs. One possible solution leads to personal costs. Especially in the case of Industry 4.0 which replaces human labor with technology. Equation 3 (indicator C) works with the substitution of personal costs by investment in the fixed assets. It is expressed as the substitution of personal costs by depreciation and amortization over sales. It can be also rewritten as a difference between indicators A and B. Positive value of indicator C means the increasing difference between depreciation costs and personnel costs. The substitution of labor by investments is expressed here in financial terms.

Table 1. Variable specification

Used indicators and their description:
A – absolute change in depreciation and amortization costs over sales
B – absolute change in personal costs over sales
C – substitution of personal costs by depreciation and amortization over sales
D – absolute change in profitability
Used variables and their description:
DaP – depreciation and amortization (in CZK)
Sales – total revenues from selling finished goods, resold goods and services (in CZK)
PersC – personal costs (in CZK)
0 – base period (specifically 2014)
1 – current period (specifically 2017)

Source: own work

The main incentive of the companies for these changes is not Industry 4.0 itself but the fulfilling of the main enterprise goal. The main enterprise goal can be represented by an achieved profit as it is in the case of equation 4 (indicator D). Indicator D is focused on the absolute change in sales profitability caused by analyzed costs.

$$A = \frac{DaA_1}{Sales_1} - \frac{DaA_0}{Sales_0} \quad (1)$$

$$B = \frac{PersC_1}{Sales_1} - \frac{PersC_0}{Sales_0} \quad (2)$$

$$C = \left(\frac{DaA_1}{Sales_1} - \frac{PersC_1}{Sales_1}\right) - \left(\frac{DaA_0}{Sales_0} - \frac{PersC_0}{Sales_0}\right) \quad (3)$$

$$D = (-1) \times \left(\frac{DaA_1 + PersC_1}{Sales_1} - \frac{DaA_0 + PersC_0}{Sales_0}\right) \quad (4)$$

The aforementioned paper idea has to be verified on the real data and real companies. Therefore it is crucial to define a data sample. Branch Logistics consists of many different types of companies. Logistics in the sense of CZ-NACE H contains two main groups Transportation and Storage. Although Industry 4.0 has penetrated into all economic areas transportation is still at the beginning because autonomous vehicles remain pioneers for practice. On the other hand CZ-NACE 52 Storage and warehousing could be further because of automatic storage systems, software solutions, QR codes etc. This branch should be highly influenced by technological changes and the substitution of labor by fixed assets should occur.

The analysis has been conducted for the time period 2014-2017. It has a serious consequence that each company included in the sample must have available financial statements for the aforementioned time period. Czech enterprises are not always willing to publish their financial statements [Strouhal et al. 2014] and therefore the final sample consists of 52 enterprises. These enterprises had total sales in 2017 equal to 20,292,629,000 CZK (approximately 770,704,000 EUR). Following European Commission [2003] rules these companies can be divided according their size. Sales of large enterprises should exceed 50 million Euros (1,316,500,000 CZK). Medium sized enterprises have sales in the range 10 – 50 million Euros (263,300,000 - 1,316,500,000 CZK) and sales of small ones are below 10 million Euros (263,300,000 CZK). Table 2 shows a structure of the analyzed sample. It must be noted that the large enterprises have only 10% share on the sample but they contribute to 60% of total sales. On the other hand small companies create a backbone but their total contribution to sales exceeds only 10%.

Table 2. Structure of the analyzed sample

	Number of enterprises	Share on total sample	Total sales (CZK)	Share of sales on sample
Large enterprises	5	9.62%	11,827,819,000	58.29%
Medium enterprises	9	17.31%	6,150,407,000	30.31%
Small enterprises	38	73.08%	2,314,403,000	11.41%
All enterprises	52	100%	20,292,629,000	100%

Source: own work

RESULTS

This part is dedicated to obtained results. The results will be included in tables and interpreted. The first indicator displays absolute change in depreciation and amortization costs over sales. The results show that more than 25% of all companies without respect to their size (3rd quartile) achieved relative growth in depreciation and amortization to their sales. In the case of medium sized enterprises even more than half of companies (median). It means that these companies relatively massively invested in their fixed assets in the analyzed time period. It must be noted that some companies could already invest before the analyzed time period and that the indicator focuses on the relative growth to sales.

Table 3. Descriptive statistics of absolute change in depreciation and amortization costs over sales

	Full sample	Large enterprises	Medium enterprises	Small enterprises
Mean	-0.0052	0.0275	0.0125	-0.0138
Median	-0.0029	-0.0017	0.0022	-0.0033
Minimum	-0.0827	-0.0292	-0.0280	-0.0827
Maximum	0.1480	0.1480	0.1273	0.1480
1st quartile	-0.0214	-0.0213	-0.0109	-0.0302
3rd quartile	0.0052	0.0910	0.0161	0.0024
St. deviation	0.0392	0.0637	0.0430	0.0289
Trim mean	-0.0068	---	---	-0.0131

Source: own work

In the case of personal costs there are significant decreases measured to sales if we focus on minimum, 1st quartile but upper quartile reaches comparable results as the previous indicator. Cost items such as depreciation + amortization and personal costs should not be analyzed separately for our purpose. These items are interconnected when we talk about of replacement labor by new technologies therefore the indicator C looks at both indicators jointly. It will bring the most significant results.

Table 4. Descriptive statistics of absolute change in personal costs over sales

	Full sample	Large enterprises	Medium enterprises	Small enterprises
Mean	-0.0099	-0.0175	0.0179	-0.0155
Median	-0.0058	0.0021	0.0231	-0.0159
Minimum	-0.2762	-0.1111	-0.0434	-0.2762
Maximum	0.1362	0.0410	0.0909	0.1362
1st quartile	-0.0422	-0.0845	-0.0035	-0.0426
3rd quartile	0.0294	0.0397	0.0280	0.0234
St. deviation	0.0794	0.0589	0.0343	0.0876
Trim mean	-0.0075	---	---	-0.0125

Source: own work

Mean proves that personal costs are substituted by depreciation and amortization massively in the full data sample although median has slight worse results. In total 23 enterprises (3 large, 2 medium and 18 small) achieved positive replacement. The positive replacement ranges from 0.15 to 26.48 percentage points. On the other hand 29 enterprises (56%) show negative substitution that personal costs increased more than depreciation and amortization measured over sales.

Table 5. Descriptive statistics of substitution of personal costs by depreciation and amortization

	Full sample	Large enterprises	Medium enterprises	Small enterprises
Mean	0.0047	0.0450	-0.0053	0.0017
Median	-0.0013	0.0918	-0.0230	-0.0007
Minimum	-0.1861	-0.0402	-0.0860	-0.1861
Maximum	0.2648	0.1070	0.1433	0.2648
1st quartile	-0.0395	-0.0357	-0.0417	-0.0450
3rd quartile	0.0410	0.1023	0.0267	0.0267
St. deviation	0.0835	0.0661	0.0653	0.0877
Trim mean	0.0033	---	---	-0.0004

Source: own work

The negative replacement ranges from -0.04 to -18.61 percentage points. It has several explanations. First these enterprises do not fulfill our expectations of investing in fixed assets and new technologies. Second the labor market development is not helpful because limited labor supply pushes up nominal wages and salaries.

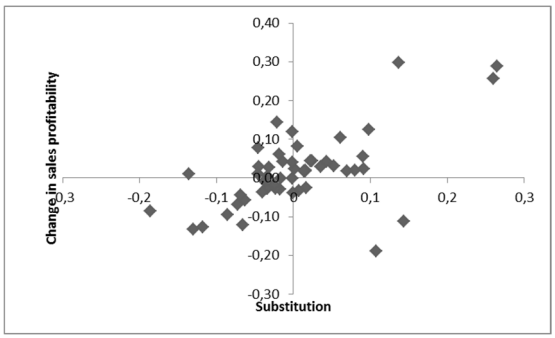
The last indicator D focuses on the profitability change observed in our data sample. Minimum and 1st quartile proves negative impact on the profitability then there is change around mean and medium into positive impact. It is crucial to show the dependency between the discussed replacement and sales profitability. Figure 1 fits our purposes the best.

Table 6. Descriptive statistics of absolute change in sales profitability

	Full sample	Large enterprises	Medium enterprises	Small enterprises
Mean	0.0152	-0.0100	-0.0304	0.0293
Median	0.0174	0.0240	-0.0269	0.0221
Minimum	-0.1891	-0.1891	-0.1113	-0.1336
Maximum	0.2981	0.1246	0.0169	0.2981
1st quartile	-0.0328	-0.1129	-0.0623	-0.0295
3rd quartile	0.0429	0.0759	0.0043	0.0562
St. deviation	0.0934	0.1034	0.0422	0.0966
Trim mean	0.0136	---	---	

Source: own work

The figure displays that positive replacement of labor by investment leads mainly to positive impact on profit. On the other hand the negative replacement leads mainly to negative impact on profit. Specific numbers describing the reality say 19 enterprises of 23 with positive replacement achieved increase of sales profitability and the range was from 1.69 to 29.81 percentage points. 18 enterprises of 29 with negative replacement achieved decrease in profitability whose range was from -0.06 to -13.36 percentage points.



Source: own work

Fig. 1. Absolute change in sales profitability due to substitution of personal costs by depreciation and amortization

CONCLUSIVE REMARKS

This paper verified if the initiative Industry 4.0 can be already visible on the corporate data and achieved profits in the area of logistics. It is not a surprising result that there are more companies with undesired development with the respect to Industry or Logistics 4.0. It just supports findings of the others that the infusion of new technologies in the logistic is not wide and especially small sized enterprises would suffer from this lately. The used indicators described financial sources needed for used human labor or for used machine labor. It leads to the economic reflection of the human labor replacement by machines (robots) and other new technologies. The analysis proved that the enterprises showing the desired development of this replacement can achieve higher profitability. On the other hand the enterprises supporting human labor instead of investments in fixed assets and therefore in new technologies increased their probability of the negative impact on the profitability.

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REFERENCES

Acimovic S., Stajic N., 2019, Digital supply chain: leading technologies and their impact on industry 4.0 [in:] 19th international scientific conference Business Logistics in Modern Management, 75-90.

Arcidiacono F., Ancarani A., Di Mauro, C., Schupp F., 2019. Where the rubber meets the road. Industry 4.0 among SMEs in the automotive sector, IEEE Engineering Management Review, http://doi.org/10.1109/EMR.2019.2932965.

Barreto L., Amaral A., Pereira T., 2017. Industry 4.0 implications in logistics: an overview, Procedia Manufacturing, 13, 1245-1252, http://doi.org/10.1016/j.promfg.2017.09.045.

Bettenhausen K.D., Oesterle M., Zuehlke D., 2010. SmartFactory The intelligent Factory of the Future in the Life Cycle Contributions to the Further Development of Automation [in:] 11th Branch Meeting of the Measurement and Automation Technology - Automation 2010, 257-260.

Brendel T., 2019. Industry 4.0 – More costs than benefits?, Zeitschrift fuer Wirtschaftlichen Fabrikbetrieb, 114(1-2), 68-71, http://doi.org/10.3139/104.112042.

Cyplik P., Oleskow-Szlapka J., Tobola A., Adamczak M., 2019. Building a model for assessing the maturity of Polish enterprises in terms of logistics 4.0 assumption [in:] 19th international scientific conference Business Logistics in Modern Management, 105-120.

Dalenogare L.S., Benitez G.B., Ayala N.F., Frank A.G., 2018. The expected contribution of Industry 4.0 technologies for industrial performance. International Journal of Production Economics, 204, 383-394, http://doi.org/10.1016/j.ijpe.2018.08.019.

Erdei E., Popp J., Oláh J., 2018. Comparison of time-oriented methods to check manufacturing activities and an examination of their efficiency, LogForum, 14(3), 371-386, http://doi.org/10.17270/J.LOG.2018.290.

European Commission, 2003. Commission Recommendation EU 2003/61/ES. Available on the Internet: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:124:0036:0041:EN:PDF (9/28/2019)

Gubán M., Kovács G., 2017. INDUSTRY 4.0 Conception, Acta Technica Corviniensis-Bulletin of Engineering, 10(1), 111-114.

Jereb B., 2017. Mastering logistics investment management, Transformations in Business & Economics, 16(1), 100-120.

Kergroach S., 2017. Industry 4.0: New Challenges and Opportunities for the Labour Market, foresight and gover-nance, 11(4), 6-8, http://doi.org/10.17323/2500-2597.2017.4.6.8.

Kiel D., Müller J.M., Arnold C., Voigt K.I., 2017. Sustainable industrial value creation: Benefits and challenges of industry 4.0, International Journal of Innovation Management, 21(8), http://doi.org/10.1142/S1363919617400151

Krykavskyy Y., Pokhylchenko O., Hayvano-vych N., 2019. Supply chain development drivers in industry 4.0 in Ukrainian enterprises, OECONOMIA COPERNICA-NA, 10(2), 273-290, http://doi.org/10.24136/oc.2019.014.

Lasi S., Fettke P., Kemper H.G., Feld T., Hoffmann M., 2014. Industry 4.0, Business & Information Systems Engineering, 6(1), 239-242, http://doi.org/10.1007/s12599-014-0334-4.

Maslaric M., Nikoličic S., Mirčetic D., 2016. Logistics Response to the Industry 4.0: the Physical Internet, Open Engineering, 6(1), 511-517, http://doi.org/10.1515/eng-2016-0073.

Moenning A., Maier T., Zika G., 2019. Economy 4.0-Digitalisation and Its Effect on Wage Inequality, Jahrbucher fur Natio-nalokonomie und Statistik, 239(3), 363-398, http://doi.org/10.1515/jbnst-2017-0151.

McKinsey Global Institute, 2015. The Internet of Things: Mapping the Value Beyond the Hype, Available on the Internet: http://citeseerx.ist.psu.edu/viewdoc/download;jsessionid=706B4E4BA86659F79206FC558BB5D371?doi=10.1.1.729.7846&rep=rep1&type=pdf (07/15/2019).

Müller J.M., Voight K.I., 2018. The impact of Industry 4.0 on Supply Chains in Engineer-to-Order-Industries – An Explanatory Case Stucy, IFAC PapersOnline, 51(11), 122-127, http://doi.org/10.1016/j.ifacol.2018.08.245.

Romberg A., 2016. The operative implement-tation of industry 4.0 is increasing rapidly in Germany, Productivity management, 21(1), 61-64.

Rotman D., 2013. How Technology Is Destroying Jobs, Technology Review, 116(4), 28-35.

Rüßmann M., Lorenz M., Gerbert P., Waldner M., Justus J., Engel P., Harnisch M., 2015. Industry 4.0: The future of productivity and growth in manufacturing industries, Boston Consulting Group, Available on the Internet: https://www.bcg.com/publications/2015/engineered_products_project_business_industry_4_future_productivity_growth_manufacturing_industries.aspx (08/21/2019).

Sommer L., 2015. Industrial revolution - Industry 4.0: Are German manufacturing SMEs the first victims of this revolution?, Journal of Industrial Engineering and Management, 8(5), 1512-1532, http://doi.org/10.3926/jiem.1470.

Strouhal J., Gurtvis N., Nikitina-Kalamae M., Li T.W., Lochman A.L., Born K., 2014. Are companies willing to publicly present their financial statements on time? Case of Czech and Estonian TOP100 Companies. Proceedings [in:] The 7th International Scientific Conference on Managing and Modelling of Financial Risks Modelling of Financial Risks, 731-738.

ROZWÓJ KOSZTÓW W LOGISTYCE JAKO POCHODNA INDUSTRY 4.0

STRESZCZENIE. **Wstęp:** W pracy poruszane jest zagadnienie rozwoju kosztów oraz ich struktury w przedsiębiorstwach logistycznych. Wdrożenie Industry 4.0 pociąga za sobą istotne zmiany w technologiach, biznesie oraz środowisku dla wszystkich rodzajów firm, w tym również logistycznych. Niektóre obszary logistyki jak magazynowanie powinny być nawet pionierami we wdrażaniu Industry 4.0. Ma to bezpośredni wpływ na zmienne ekonomiczne i ich ogólną kondycję. Wyzwania, jakie stawia Industry 4.0 dotyczą nie tylko firm ale również dla rządu. Niezbędne jest monitorowanie środowiska oraz opis zachodzących zmian.

Metody: Dane do analizy pochodzą z publikowanych zeznań finansowych korporacji. Sama analiza opiera się na analizie porównawczej tych sprawozdań, opisujących strukturę kosztów oraz rozwój kosztów na poziomie indywidualnych przedsiębiorstw działających w branży logistycznej. Szczególnej analizie poddano wskaźniki analitycznej wybranych pozycji kosztowych, jak również dokonano analizy całości kosztów i zyskowności.
Wyniki: Uzyskana struktura kosztów została podsumowana i oszacowana statystyką opisową.

Wnioski: Uzyskane wyniki wskazują czy i jak istotne są zmiany w poziomie i strukturze kosztów oraz zyskowności przedsiębiorstw logistycznych. Nadchodzący Industry 4.0 będzie miał poważny wpływ na biznes, zarówno na poziomie rządu jak i poszczególnych przedsiębiorstw. W pracy udowodniono, że inicjację Industry 4.0 można już zauważyć w wynikach firm.

Słowa kluczowe: koszt operacyjny, struktura kosztów, Czechy, CZ-NACE H, Industry 4.0.

Dagmar Čámská
Czech Technical University in Prague
Prague, **Czech Republic**
e-mail: dagmar.camska@email.cz

Jiří Klečka
University of Chemistry and Technology Prague
Prague, **Czech Republic**