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The Implementation of Industry 4.0 Elements as a Tool Stimulating the Competitiveness of Engineering Enterprises

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Abstract

The article deals with the implementation of Industry 4.0 elements in Czech engineering companies in connection with the impact of this trend on the relationship between supplier and customer. The implementation of Industry 4.0 elements can have a positive effect on the relationship between supplier and customer through higher labour productivity, higher product quality as well as shorter production or delivery times. Industry 4.0 brings great opportunities for companies, which can mean greater efficiency and competitiveness; on the other hand, there are questions about whether companies are ready for it, i.e. whether there is sufficient infrastructure necessary to put Industry 4.0 into practice. The aim of this article is to identify the specifics of supplier-customer relationships in engineering which respond to the current trends and to find out how Czech engineering companies have implemented specific elements of Industry 4.0. No study of this kind has ever been conducted in the environment of Czech engineering companies. Based on the analysis of primary data obtained from 236 Czech engineering companies, the current trends in the management of relations between suppliers and customers are described; Czech engineering companies can use our results to increase their competitiveness. Emphasis is placed on Industry 4.0, planned investments in this infrastructure and the implementation of individual elements. Of the elements of Industry 4.0, Czech engineering companies mostly use tools and methods ensuring data security, automation of technological equipment and processes, cloud computing, mass customization and introducing sensors into production. Our results show that the investment in the necessary infrastructure is mainly related to the size of the company, with almost half of the large companies surveyed planning to invest in the infrastructure necessary to implement Industry 4.0 elements, while 46% of micro-enterprises do not plan to invest in Industry 4.0 elements.

Keywords: supplier-customer relations, engineering companies, Industry 4.0, competitiveness
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1. INTRODUCTION

Enterprises in engineering face changes in the form of growing trade globalization, new information technologies, the computerization of trade, new customer relationship management (CRM) concepts as well as supply chain management (SCM) issues. According to Soosay & Hyland (2015), those dynamic changes in the environment require more integration and collaboration among supplier chains. Trstenjak & Cosic (2017) point out that the implementation of Industry 4.0 elements can have a positive effect on supplier-customer relationships through greater labour productivity, higher product quality as well as shorter manufacturing or supply time.

The fourth industrial revolution has brought enterprises great opportunities which can mean greater efficiency and competitiveness (see, for example, Wang & Wang, 2016; Trstenjak & Cosic, 2017; Confederation of Industry in the Czech Republic, 2019). However, questions remain as to whether enterprises are prepared for these changes and whether there is adequate infrastructure necessary for the introduction of Industry 4.0 in practice. Those questions are important to ask mainly in the context of the size of an enterprise, as this factor may play a role in the extent to which the enterprises are able react to the changes in the business environment as well as in the extent to which the enterprises use elements of Industry 4.0. The size of an enterprise in the context of the Industry 4.0 revolution has been scrutinised, for example, by Trstenjak & Cosic (2017) and by Müller et al. (2018). Trstenjak & Cosic (2017) have stated that for bigger enterprises (often internationalised), it is easier to accept the concept of Industry 4.0. In connection to this, the main research question in this paper addresses how the size of an enterprise influences its knowledge of the concept of Industry 4.0 and, furthermore, to what extent Czech engineering enterprises plan to invest into new technologies.

Czech industrial associations (as, for example, Confederation of Industry in the Czech Republic) support the use of elements of Industry 4.0 and digital transformation in manufacturing enterprises, as this could play an important role in gaining long term competitiveness. According to research conducted by the Confederation among 105 Czech manufacturing enterprises, about half of the respondents wish to invest into digital transformation and into the implementation of the elements of Industry 4.0. (Confederation of Industry in the Czech Republic, 2019).

Despite the growing literature on Industry 4.0 and its impact in general on businesses and economics, there is still lack of detailed empirical studies focused on specific sectors or on factors which might play a role in implementing particular elements of Industry 4.0. such as the size of an enterprise or its international business orientation. This paper is focused on the engineering industry, one of the traditional manufacturing sectors in the Czech Republic and also one of the most export-oriented industries. In accordance with this, the paper also deals with the role of internationalisation processes and their impact on the use of elements of Industry 4.0. Could foreign business partners push Czech engineering enterprises towards the greater use of elements of Industry 4.0? How might the implementation of the elements of Industry 4.0 affect the relationship between supplier and customers? To fill this research gap, these topics are also addressed in this paper.

The aim of this article is to identify the specifics of supplier-customer relationships in engineering which respond to the current trends as well as to determine how Czech engineering enterprises have implemented specific elements of Industry 4.0.

2. THEORETICAL BACKGROUND

Supplier-customer relationship management has in recent years become a widely discussed phenomenon. Sehgal (2009) defines the supplier chain as the flow and management of resources within an entire enterprise for the purpose of maintaining trading operations and profit. According to Christopher (2010), it is important that the main task of manufacturing and purchase is the creation of this material flow into and from the enterprise. This is ensured by the relevant information and coordination processes which guarantee the smooth, effective and rapid meeting of customer requirements. Supply Chain Management has been defined by Stock & Boyer (2009), who have suggested an integrated definition of SCM based on 166 definitions of this concept which have appeared in academic as well as in practically-focused papers. According to these authors, SCM is defined as "The management of a network of relationships within a firm and between interdependent organizations and business units consisting of material suppliers, purchasing, production facilities, logistics, marketing, and related systems that facilitate the forward and reverse flow of materials, services, finances and information from the original producer to final customer with the benefits of adding value, maximizing profitability through efficiencies, and achieving customer satisfaction" (Stock & Boyer, 2009). The introduction of supplier-customer chain management (SCM) is an issue that is not being addressed just by big enterprises, but also small and medium enterprises. This issue has been dealt with, for example, by Schulze-Ehlers et al. (2014), Vuolle (2016) and Chin et al. (2012), the latter of which describe how big companies are usually aware of the advantages of SCM, but small and medium enterprises often lag behind; in particular, smaller firms do not adequately appreciate how integration of the supplier chain may bring major changes in trading processes, nor are they aware of the positive results integration brings in terms of better quality services, cost-cutting, and increases in performance. Electronic trading as a consequence of the development of information technologies is also having a great impact on supplier-customer relationship management. One consequence of the transition to computerization is the standardization of the forms of documents as well as purchase and storage flow. With computerization comes systems of electronic data interchange (EDI) which facilitate the flows between the customer and supplier. Electronic data interchange speeds up the flow of information and reduces administrative error. Koch (2009) points out that it should be taken into account that invoices transmitted as attachments in e-mails are not regarded as full electronic invoices. The reason is that information transferred in this way is not suitable for automatic data collection by payment systems. Moreover, Koch (2009) has quantified results showing that the transition from paper to electronic invoicing brings administrative savings of 60% to 80% with a payback period of 0.5-1.5 years. The switch to digital invoicing brings increased security, although as stressed by Machková (2015) it is a more costly data transmission method. Nevertheless, according to Zhu et al. (2006), corporate management often perceives the high intensity of EDI as a relative advantage, attributing an important role to it in strategic corporate management. International studies point to the fact that the inability to respond quickly enough to technological innovation often brings higher comparative costs as part of the supplier-customer chain, and therefore a rise in the competitive disadvantage of an enterprise. As stated for example by Anjani & Dhanapal (2011), technological innovation does not bring changes only in the method of work, but also in the organisational structure and labour relationships. In recent years, there has also been

growing pressure for vertical integration between the supplier and customer. This issue has also been dealt with, for example, by Guan & Rehme (2012) and Acemoglu et al. (2010), who point to the fact that one of the main problems in considering the level of vertical integration is the availability of information about control, both within the firm as well as neighbouring activities affecting the entire manufacturing chain. The development of the concept of customer relationship management is associated with customer globalisation. According to Pichanič (2004) globalization acts on three levels, i.e. on the customer, trade and manufacturing. Another trend that needs to be mentioned in connection with internationalization and globalization which has an impact on the supplier-customer relationship management is the creation of strategic alliances. This has been dealt with for example by Lavie & Rosenkopf (2006), Rothaermel & Deeds (2006), Lin et al. (2009) and Nielsen & Gudergan (2012).

The integration tendencies in the supplier-customer relationships bring with them the need of the optimization of processes in the supplier chain in order to create the required values for the customer, which according to (Sehgal, 2009) requires problem-free connection of external suppliers. Supplier chain management system integration is also a subject of discussion in professional literature. Given that an organization tries to develop a partnership and more effective information ties with trading partners, then, according to Power (2005), internal processes mutually interconnect and bridge the traditional company boundaries. Another trend that has an impact on the supplier-customer relationships is the more intensive use of outsourcing. Kakabadse & Kakabadse (2005) stress two main reasons for outsourcing: costs and focus on the main corporate competencies. According to those authors, enterprises pay greater attention to the existing trend of effective relationship management with key trustworthy suppliers and clearly define the relationship between outsourcing, effectiveness and growth of productivity.

Innovations in enterprises within Industry 4.0, which are associated with the gradual introduction of digitalization, have been taking on turbulent speed in recent years. This is also the seen in supplier-customer relationships. Wang & Wang (2016) claims that an enterprise applying the elements of Industry 4.0 is better at satisfying the needs of customers as far as the functionality of product is concerned, quality and life of services which increases the competitiveness of the enterprise. Tjahjono et al. (2017) states that in the context of Industry 4.0, the factory of the future will enable interconnection between machines and people in cyber systems (Cyber-Physical-Systems, CPSs) and these new systems then direct their resources to the introduction of intelligent products and industrial processes which enable the industry to face up to rapid changes in purchase models. For example, Ungerman et al. (2018) deal in detail with the impact of innovative marketing on corporate competitiveness in the context of Industry 4.0 and point to the fact that, for example, Gupta et al. (2016) carried out a survey which showed the connection between marketing innovations in an enterprise and an increase in competitiveness of brand. He also emphasizes that many authors such as Kamp & Parry (2017) showed that modern innovative marketing has a positive impact on the increase of sales and cost-cutting, which improves competitiveness. The positive effect of the implementation of the elements of Industry 4.0 is also described by Trstenjak & Cosic (2017). These authors also state that the world, facing the fourth industrial revolution in recent years, requires a rapidly

changing work environment with the hope that in the future, it will bring major advantages – standard manufacturing processes are automated and connected with other activities within the company and utilization of technological and human improvements sees an expectation of higher productivity, product quality and receipt with a shorter delivery (manufacturing) time and product price, which positively affects supplier-customer relationships. Trstenjak & Cosic (2017) also mention that big international companies that use concepts of constant improvement and have high standards for research and development will accept the concept of Industry 4.0 easily and be even more competitive in the market. In contrast, small and medium enterprises often cannot keep up with changes and requirements of the market, therefore, it is very important for them to promptly develop their own strategy for the implementation of Industry 4.0. Brettel et al. (2014) state that Industry 4.0 affects a company's sales network, its communication with customers and suppliers. According to these authors, products become so-called "intelligent products" which carry information and knowledge and are able to provide feedback from the user or customer to the manufacturing system of which data is analysed and optimised.

3. RESEARCH OBJECTIVE, METHODOLOGY AND DATA

The aim of the article is to identify the specifics of supplier-customer relationships in engineering which respond to the current trends and determine how Czech engineering enterprises implement specific elements of Industry 4.0.

Primary data using a survey questionnaire were obtained among engineering enterprises in order to meet the aim of this article. The survey questionnaire was carried out electronically and the questionnaire was created using Umbrela software (this is software developed at Mendel University in Brno for the purpose of conducting marketing surveys). A pretest was carried out before the data collection whose purpose was to verify the accuracy, comprehensibility and meaningfulness of the questions. Data collection took place in February and March 2017, companies were contacted via emails. Contacts to engineering enterprises were obtained from the Amadeus database, the licence for which was bought by Mendel University in Brno. For the purposes of the survey, the companies were selected on the basis of the following criteria: known financial situation, registered office in the Czech Republic, economic activity classified based on the Statistical classification of economic activities used in European countries called as NACE – only enterprises whose main trading activity falls under NACE 25-30 and 33 were interviewed. From the contacts available, 6,217 companies were selected according to the quota symbol (size of the company according to the number of employees). The main limitation of the database was the malfunction of some contacts, 20% of electronically addressed contacts returned as undeliverable. It was, therefore, necessary to find contact information directly on the websites of the entities concerned. In the final number, 4,950 Czech engineering companies were contacted. The total return of the questionnaire survey was, therefore, 4.8%. After the elimination of companies with the main business activity, which did not fall into engineering, 236 correctly completed questionnaires remained available. Basic characteristics of Czech engineering enterprises are included below in Table 1. Given the focus of the article on the supplier-customer relationships, the effort during data collection was to obtain answers from the persons responsible for corporate trading activity (the percentage of enterprises according to the position of the respondent is shown in the Table 1 below).

The questionnaire comprises a total of 16 questions. Some of them were identification questions, the factual ones (about 8 of them) and most of the questions use a scale. For example, the question concerning the impact of changes in the business environment on the enterprise was scrutinised via a question which uses a scale from 1 to 10 while "1" means a negligible impact and "10" means an extreme impact on enterprise.

Descriptive statistics and the testing of hypotheses of the independence of nominal characters are used for processing primary data. The square contingency – Chi-squared test indicator will be used to test hypotheses on independence between two nominal characters (Hendl, 2012). According to Johnson & Kuby (2011), the Chi-squared test is based on a comparison of ascertained frequencies and expected (theoretical) frequencies. A 5% significance level was determined for testing the hypotheses. The hypothesis of the independence of nominal characters is rejected when the calculated p-value is lower than the selected significance level. The strength of the relationship between two nominal characters will be considered based on the Cramer contingency coefficient. In case that the coefficient acquires the value 0, there is no relationship between variables, however, the closer to the value 1 the higher the relationship (connection).

According to Friendly & Denis (2008), a useful way to display multivariate observations with an arbitrary number of variables is a spider chart (radar chart) used for data visualisation. StatSoft Statistica 12 software is used for processing primary data by means of the above statistical methods. Several interviews were also conducted with the representatives of engineering enterprises, which provides a deeper insight into the issues of the supplier-customer relationships in engineering.

Tab. 1 – Selected characteristics of engineering enterprises. Source: Survey questionnaire

Characteristics of enterprises	Categories	%
Size of the enterprise according to the number of employees	Microenterprises (1–9 employees)	27.5%
	Small enterprises (10-49 employees)	37.7%
	Medium enterprises (50-249 employees)	18.6%
	Big enterprises (250 and more employees)	16.2%
Main economic activity according to CZ-NACE	25 Manufacture of fabricated metal products, except the machinery and equipment	28.4%
	26 Manufacture of computer, electronic and optical products	3%
	27 Manufacture of electrical equipment	10.2%
	28 Manufacture of machinery and equipment n.e.c.	23.3%
	29 Manufacture of motor vehicles, trailers and semi-trailers	4.2%
	30 Manufacture of other transport equipment	3%
	33 Repair and installation of machinery and equipment	7.2%
	Other	20.7%

Internationalisation *	Internationalised enterprises	89%
	Non-internationalised enterprises	11%
The degree of internationalisation **	0-25 %	39.4%
	26-50 %	17.4%
	51-75 %	20.3%
	76-100 %	22.9%
Position of the respondent	Purchase	30.0%
	Sales	33.3%
	Logistic	9.9%
	Other (manager of the enterprise, project manager, R&D)	26.8%

*Internationalization of enterprises is assessed according to the character of its business operations – enterprises which sell or purchase products abroad are described as internationalized enterprises; enterprises operating in the domestic market only are described as non-internationalized enterprises
** The share of foreign sales in the total sales of the enterprise is regarded as a degree of internationalization

4. RESULTS

This part of the article presents the basic outputs of the processing of primary data. The article aims to identify current trends in supplier-customer relationships of engineering enterprises in the Czech Republic, while emphasis is placed on Industry 4.0 and the effect on the introduction of the elements of this concept on corporate trading relationships.

The major event that affected the business environment and supplier-customer relationships not just in the engineering sector was the Czech Republic's entry into the European Union in 2004. In the survey questionnaire, Czech engineering enterprises were asked about the impact of various changes in the corporate environment on their trading relationships. The engineering enterprises rated the size of the impact of changes in the business environment on their supplier-customer relationships in a total of 21 changes, which are apparent in the business environment in the last decade. These changes were identified based on research of professional literature and after being discussed with representatives of engineering enterprises. The most significant changes in the business environment that are seen in supplier-customer relationship management in the engineering sector and their summary are shown in Table 2 below. The biggest impact on the corporate environment is the already mentioned Czech Republic's effect in the European Union (average impact of 5.8), the onset of new information technologies and trade globalisation also have a significant effect on engineering enterprises (according to the rating of enterprises, both factors have an average impact of 5.4). Further major changes in the business environment which substantially affect the relationships with suppliers and customers and require a higher rate of integration of the supplier chain and cooperation through the entire chain are included in Table 2 presented below.

Tab. 2 – Most significant changes in the business environment. Source: Survey questionnaire

Changes affecting the supplier-customer relationships of enterprises	Average impact
C1 Effect of the Czech Republic in the European Union	5.8
C2 Trade globalisation	5.4
C3 New information technology	5.4
C4 Expansion of the portfolio of manufactured products	5.3
C5 Strengthening foreign competition	5.2
C6 Strengthening orientation on quality using standards	5.2

The sensitivity of engineering enterprises to changes in the business environment may, to a certain extent, be affected by their size, therefore, hypotheses were tested to verify this thought. The null hypothesis was stated as follows:

H01: There is no dependence between the size of the enterprise and its sensitivity to changes (C1-C6) affecting trade in the engineering sector

Six changes were selected with the highest average impact on the supplier-customer relationships for the purposes of testing hypotheses. The null hypothesis is rejected in favour of the alternative hypothesis on the existence of dependence given that all six p-values are less than the determined level of significance. Moderate dependence exists between the size of the enterprise and sensitivity to changes in the surrounding business environment, as arises from the Cramer contingency coefficient. More detailed results of hypothesis testing are shown in Tab. 3 below and the state claims are also confirmed by Figure 1 below which presents the sensitivity of engineering enterprises according to their size to changes in the business environment. An interesting fact is also that bigger enterprises rate the impact of monitored changes as being more significant than small enterprises and microenterprises do.

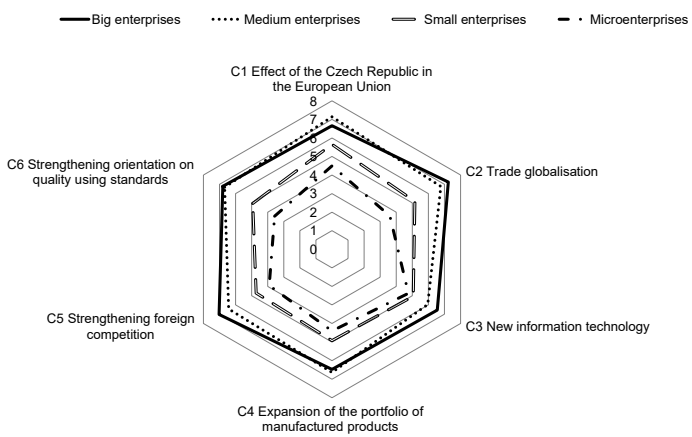

Fig. 1 – Rating of the impact of changes of the business environment on the supplier-customer relationships of engineering enterprises (rating 1 = negligible impact, 10 = extreme impact) Source: Survey questionnaire (2017), n = 236

Tab. 3 – Results of hypotheses testing. Source: Survey questionnaire

Changes affecting the supplier-customer relationships of enterprises	P-value	Cramer coefficient
C1 Effect of the Czech Republic in the European Union	0.0009	0.2709
C2 Trade globalisation	0.0000	0.3345
C3 New information technology	0.0094	0.2566
C4 Expansion of the portfolio of manufactured products	0.0003	0.2691
C5 Strengthening foreign competition	0.0000	0.3169
C6 Strengthening orientation on quality using standards	0.0001	0.3077

As Table 2 shows, trade globalisation plays a relatively significant role in business in the engineering sector. It is important to note that the engineering sector is significantly export-based and the share of imports from abroad is considerable. The obtained primary data show that most respondent enterprises are internationalised, i.e. they buy or sell products from/to other countries. Only 26 enterprises are not internationalised, i.e. have no trading partners abroad (11%). Over 80% of enterprises export their products abroad, while about 65% of enterprises import from abroad. As for territorial representation of foreign trading partners, the most important trading partner is Germany for suppliers and customers. This can be confirmed according to official data on foreign business transactions of engineering enterprises. Besides Germany, other states of Western Europe, and also Slovakia and Poland, are among the most important supplier countries for the respondents of the survey questionnaire. The situation is similar among foreign customers where Germany is followed by Slovakia, other states of Western Europe and Poland. The sample of respondents was represented by a minimum of business partners from Asia, which is surprising since China is a relatively important trading partner in the engineering sector immediately after Germany (as data from the Czech Statistical Office show).

As arises from the survey questionnaire, some enterprises are an active initiator of the introduction of elements of Industry 4.0, others are still at the stage of getting to know this concept. Knowledge of the concept of Industry 4.0 by Czech engineering enterprises is listed in Table 4. About two-fifths of enterprises have an active approach to the concept of Industry 4.0, which means that they either directly use its elements, try to introduce them in practice or show an active interest in the concept (this involves a total of 105 enterprises, i.e. about 44% of respondents). About three-fifths of enterprises considering the concept of Industry 4.0 to be only an attractive slogan, have heard of this concept, but do not imagine anything specific under it or have not heard of this concept. This concerns a total of about 131 enterprises, which is about 56% of respondents.

Tab. 4 – Knowledge of the concept of Industry 4.0. Source: Survey questionnaire

Knowledge of the concept of Industry 4.0	Absolute frequency	Relative frequency (in %)
Active use of elements	22	9.3
Introduction of elements	33	14.0
Interest in elements (tries to find out as much as possible about Industry 4.0)	50	21.2
For enterprises, Industry 4.0 is only an attractive marketing slogan	49	20.8
Knowledge of the concept, but there is a lack of what is meant under the concept	30	12.7
No knowledge of the concept of Industry 4.0	52	22.0
Total	236	100.0

Hypotheses were tested to verify whether the knowledge of the concept of Industry 4.0 is associated with the size of the enterprise, while the null hypothesis was determined as follows:

H02: There is no dependence between the size of the enterprise and knowledge of the concept of Industry 4.0

According to the resulting p-values (0.0000), we reject the null hypothesis and it can be stated that a relationship exists between knowledge of the concept of Industry 4.0 and the size of the enterprise. This relationship is moderately strong based on the Cramer contingency coefficient (0.2898).

Figure 2 below shows that in big enterprises (250 and more employees) active use of elements of Industry 4.0 predominates (36.8%). Medium and small enterprises are interested in the industry concept. In contrast, microenterprises so far are not responding to this trend, given that only about 1.5% of microenterprises actively use elements of Industry 4.0. The most microenterprises (about 35.4%) do not even know the concept of Industry 4.0.

As a result, this perhaps reflects the fact that the government of the Czech Republic is focusing at this stage an according to the Industry 4.0 Initiative document above all on big enterprises, on so-called proactive players who can then show the way to others. A research and experimental environment called the Testbed was created for strengthening the development of the concept of Industry 4.0 which works like a sample workplace at which parties interested in the new technology can examine the elements of the industrial revolution in practice. One such workplace is at the Czech Technical University's Czech Institute of Informatics, Robotics and Cybernetics (ČVUT CIIRC) (Strojirenstvi.cz, 2019).

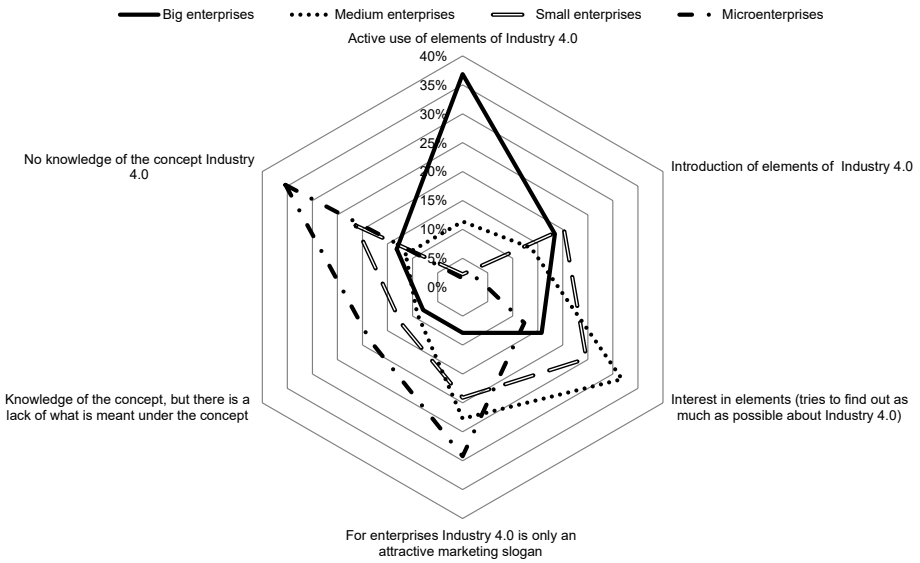

Fig. 2 – Knowledge of Industry 4.0 by Czech engineering enterprises. Source: Survey questionnaire

However, the introduction of the elements of the fourth industrial revolution requires considerable investments in digitalisation, automation or IT systems. According to the results of the survey questionnaire, about three-quarter of all respondents consider investments. Of course, their planned investments take a different form. Almost 18% of enterprises have a proactive approach when planning investments for the support of competitive advantage against other enterprises. About 17% of enterprises investments will remain at the same level as now. Most enterprises, almost 42% of respondents, will decide about investments according to the market trend. Only 23.3% of enterprises are not planning to invest in the infrastructure necessary for implementing elements of the fourth industrial revolution. To a certain extent, the size of the enterprise may influence the enterprise's decision. The null hypothesis was tested for the purpose of the statistical verification of this assertion:

H03: There is no dependence between the size of the enterprise and planned investments in the infrastructure

According to the results, testing of the hypotheses (p-value = 0.0000) and the level of the Cramer contingency coefficient (0.2898), it can be summed up that there is a moderate dependence between the size of the enterprise and planned investments into the infrastructure.

The analysis of the contingency tables shows that big enterprises try to implement a proactive approach and regard investments in infrastructure as a necessity in the competitive struggle (47.4%). Medium and small enterprises are binding their time and will decide according to the further market trend. And as was already mentioned, microenterprises are not planning to invest (46.2%) to introduce elements of Industry 4.0 and they often have no idea what this concept means. The stated results are listed in Table 5.

Tab. 5 – Knowledge of the concept of Industry 4.0. Source: Survey questionnaire

Investments	Categorisation of enterprises			
	Big enterprises	Medium enterprises	Small enterprises	Microenterprises
Yes, so we can exploit the competitive advantage	47.4%	13.7%	15.7%	6.2%
Yes, but investments will remain at the same level as so far	18.4%	29.5%	13.5%	12.3%
The further market trend will decide about investments	31.6%	50.0%	47.2%	35.4%
No, we do not plan to invest	2.6%	6.8%	23.6%	46.1%

It is apparent from Figure 3 below that the elements and tools of Industry 4.0 are used by Czech engineering enterprises. Respondents on a scale from 1 to 5 rated which elements they use. Figure 3 also shows five of the most used elements of Industry 4.0 in engineering.

The risk of data misuse goes hand in hand with the development of new technologies and greater interconnection of equipment with the internet. Enterprises are aware of this fact given that they consider the tools and methods ensuring data security to the main pillar of Industry 4.0. The automation of technological equipment and processes is apparent, for example, in sales departments where this trend is seen in fully automated systems in the form of automatic orders or enquiries. Trade is also affected increasingly by computerization when special auction systems, EDI, catalogue order, etc. are beginning to be used. Entire enterprises, including purchase and sales departments are switching to automatic technological equipment and processes. These generate huge quantities of data, so-called Big Data which require special programmes on the internet, i.e. through Cloud Computing, which is also used by Czech engineering enterprises. Mass Customisation means effective manufacturing according to the individual needs of customers and is used particularly by big engineering enterprises (see the figure below).

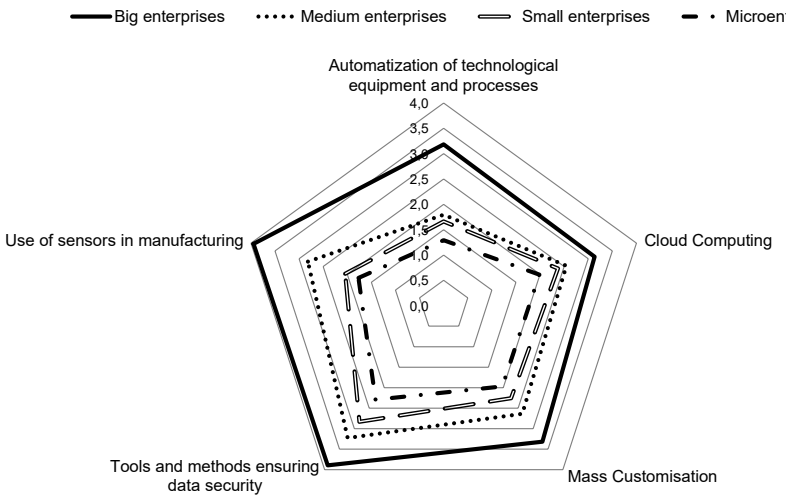

Fig. 3 – Most common elements and tools of Industry 4.0 used by Czech engineering enterprises. Source: Survey questionnaire

The above Figure 3 shows that the bigger the enterprise the greater average use of elements of Industry 4.0. All categories of enterprises are engaged to a lesser or greater extent in the use of tools and methods ensuring data security. While big and medium enterprises focus on the use of sensors in manufacturing, small enterprises prefer using Cloud Computing (using storage, services and programmes through the internet). Dependence between the rate of use of elements of the fourth industrial revolution and degree of corporate internationalisation was verified by hypothesis testing. The null hypothesis was determined as follows:

H04: There is no dependence between the degree of internationalisation and the rate of use of elements of Industry 4.0

The stated hypothesis was analysed using a sample of the five most-used tools of Industry 4.0, with results summed up in Table 6 below:

Tab. 6 – Results of tested hypotheses. Source: Survey questionnaire

Tools and Elements of Industry 4.0	P-value	Cramer coefficient
Automatization of technological equipment and processes	0.0538	-
Cloud Computing	0.0001	0.2387
Mass Customisation	0.0155	0.1812
Tools and methods ensuring data security	0.0008	0.2233
Use of sensors in manufacturing	0.0204	0.1816

Based on the p-values stated in the table above, it can be declared that the rate of use of all elements of Industry 4.0 relate to the rate of corporate internationalisation. This may indicate the fact that Czech engineering enterprises may be motivated towards a greater rate of use of elements

of Industry 4.0 by the pressure of trading partners or international owners. Pressure from trading partners has been stated as one of the motives that may lead enterprises to generally introduce elements of the fourth industrial revolution (see study on the Industry 4.0 Initiative, MIT, 2017). According to the Cramer Contingency Coefficient, in all cases this is a weak dependence, i.e. this dependence is not manifested merely between the degree of internationalisation and automation of technological equipment and the processes which enterprises are likely to engage in, regardless of the rate of their involvement in international business transactions.

5. DISCUSSION

The main outputs of the primary data analysis will now be confronted with similarly focused studies. The factor of globalisation and the development of new information technologies is presented by the authors Soosay & Hyland (2015) as a significant factor which places demands on corporate SCM and requires their greater integration and cooperation at all levels of the supplier chain. Our survey carried out among Czech engineering enterprises shows that they attempt to respond to these changes in the environment, and the development of new information technologies allow them greater connection of systems with customers, the computerization of demands, the replacement of traditional auctions with e-auctions, as well as the use of sophisticated and more modern ERP systems. These changes affect not just trade, but also logistics, within which it is possible to use new GPS technology, packaging technology, etc. Strengthening trade globalisation then leads to a greater rate of interconnectivity when Czech enterprises establish new foreign branches, for example.

Besides globalisation, the introduction of the elements of Industry 4.0 poses other relatively major challenges for Czech engineering enterprises. According to the authors Trstenjak & Cosic (2017), the implementation of the elements of Industry 4.0 can positively affect the supplier-customer relationships through the achievement of higher labour productivity, higher product quality as well as shorter manufacturing or delivery time. Wang & Wang (2016) even claim that the introduction of the elements of Industry 4.0 may increase corporate competitiveness. The question then arises of how prepared Czech engineering enterprises are for the introduction of the elements of Industry 4.0. Are they aware of and do they apply the concepts of Industry 4.0?

The results of our survey among Czech companies revealed that the active use of elements of Industry 4.0 by large enterprises predominates, with only about 1.5% of microenterprises actively using elements of Industry 4.0, and about 35.4% of microenterprises not even being aware of the concept of Industry 4.0. These results are in accordance with the findings of Trstenjak & Cosic (2017), who state that bigger, often international enterprises find it easier to accept the concept of Industry 4.0 in comparison with smaller enterprises, for which, however, it is also very important to attempt to apply this concept in an effort to maintain their own competitiveness.

The concept of Industry 4.0 involves the extensive use of new manufacturing technologies such as 3D printing and additive manufacturing. It is not just manufacturing in which changes are taking place; logistics is also affected. Enterprises are beginning to move towards the use of autonomous handling equipment such as fully automated lorries and trucks. Increasing attention is being directed at a fully integrated supplier chain, i.e. Logistics 4.0. Entire enterprises, including

purchase and sales departments, are moving towards automatic technological equipment and processes. These systems generate huge quantities of data, so-called Big Data, which require special programmes and databases for effective storage and processing. Data storage can also work through programmes on the internet, i.e. through Cloud Computing. The Internet of Things is used for the greater interconnection of equipment built-in to the internet. So that these data are not misused, it is necessary to ensure appropriate tools and methods to provide data security. Of course, many enterprises do not recognize this concept although it has become a primary focus of interest for professional engineering publications as well as exhibitions and trade fairs.

The conclusions of a study carried out in mid-2018 by Ernst & Young (2018) concerning the issue of Industry 4.0 in Czech manufacturing enterprises show that Czech enterprises as of yet do not know how to exploit the potential of the fourth industrial revolution. At present they choose to introduce partial solutions rather than to make full use of new technologies for the entire transformation of corporate processes. The results presented in this article show that for Czech engineering companies, not only the knowledge of the term Industry 4.0, but especially the active introduction and use of elements of Industry 4.0 depends on the size of the enterprise. While most large companies are actively implementing or have begun using the elements and methods of Industry 4.0, medium and small businesses are still only coming to know the concept and what it entails.

6. CONCLUSION

The article is devoted to the specifics of supplier-customer relationship management in the context of the adaptation of engineering enterprises to elements of Industry 4.0. The engineering sector is a traditional processing sector in the Czech Republic, and international trade plays an important role in Czech engineering design, production and distribution. It can therefore be expected that a significant portion of trading partners are associated with international firms, which to a certain extent may determine the specifics of supplier-customer relationships as well as create pressure to introduce elements of Industry 4.0 in practice.

In line with these conditions, supplier-customer relationship management should respond to the current trends in the business environment, which in recent years includes the introduction of elements of Industry 4.0, particularly in manufacturing-based sectors. Likewise, a number of other events in the business environment have made it necessary for enterprises to respond to these developments. For Czech engineering enterprises, the Czech Republic's effect within the European Union has been the predominant factor, although changes associated with the institution of new information technologies as well as the strengthening of trade globalisation has also play a part. Enterprises have felt the need to come to terms in various ways and to varying degrees. Large Czech enterprises have been affected to the greatest extent by strengthening trade globalisation and related internationalisation, while the Czech Republic's evolving role within the European Union has a the largest effect on medium and small enterprises.

The most discussed trend in terms of a positive effect on supplier-customer relationships is the fourth industrial revolution. The pioneering country is Germany, where the Industry 4.0

Initiative was declared back in 2011. The response of the Czech government has come with a certain delay; finally the document the Industry 4.0 Initiative (MIT, 2016) was issued in 2016. Increasing competitive pressure to introduce elements of Industry 4.0 can be expected, even with regard to the fact that Germany remains an important trading partner of Czech engineering enterprises.

Nevertheless, many Czech engineering companies still do not realize the fundamental implications of Industry 4.0. The results of this article indicate the fact that the size of an enterprise and its awareness and institution of the elements and methods of Industry 4.0 are related. While most large enterprises actively use or are introducing Industry 4.0 concepts, medium and small enterprises are only just beginning to become acquainted with them. In the Czech environment, engineering enterprises use elements of the fourth industrial revolution the most, particularly the tools and methods of ensuring data security, the automation of technological equipment and processes, Cloud Computing, Mass Customisation, and introduction of sensors into manufacturing. Still, for all these elements to work well together the necessary infrastructure must be created, which requires certain investment in digitalisation, automation and new information systems. This government objective, however, has no support from enterprises, as only a fifth of respondents plan to invest in Industry 4.0 to ensure competitive advantages over other enterprises. Most respondents will invest according to what situations present themselves and according to market trends (41.9%). Related to results described above, the proclivity to invest in infrastructure also relates to the size of the enterprise, with 47.2% of large enterprises planning to invest, but 46.2% of microenterprises having no plans to do so.

One limitation of our study is the quantitative approach which was used exclusively for the data collection. Another limitation is the small sample size of respondents (response rate less than 5%). The representativeness of the survey might be improved for example by selecting the engineering enterprises to investigate according to size or particular economic activity according to CZ-NACE. Notwithstanding the study limitations, the data collection has in fact brought primary data from 236 Czech engineering enterprises, which has allowed us to describe specifics of the supplies-customer relationship in the context of the adoption of elements of Industry 4.0. A further advantage is that this theme has not been addressed in any other empirical studies, thus our research establishes a target and a methodology that may be duplicated and expanded upon both within the Czech environment as well as internationally.

In further research, the enterprises which implement some elements of Industry 4.0 could be scrutinised. And in more detail, the effect of implementation of those elements on the performance and competitiveness in long term should be researched. In this context, not only the quantitative approach, but also qualitative approach could be used.

Industry 4.0 does not merely affect manufacturing, but also determines trends in logistics and trade. Thanks to technologies, it establishes a new concept of the supplier-customer relationships. It brings enterprise an opportunity in the form of prompt interception of trends. It will be up to them how they take up the challenge and exploit it to increase their competitiveness thanks to the integration of supplier-customer chains. A higher flexibility of manufacturing and more flexible responses to customer demand through the use of elements and tools of Industry 4.0 can optimise their manufacturing and business processes.

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