

THE CONCEPT OF AN INTELLIGENT ENTERPRISE AS A RESULT OF THE CONVERGENCE OF LOGISTICS MEGATRENDS

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Abstract: The convergence of logistics megatrends, including transformations in logistics models, the growing influence of modern, innovative and intelligent technologies, the use of ICT technology and global competition (e-trade and e-purchasing development, mobile services expansion) have led to a new concept known as the “Intelligent Enterprise”. This concept is a relatively young field in modern business management. As physical assets are given a digital voice, the Intelligent Enterprise allows businesses to run operations more efficiently and make better decisions with improved real-time visibility. Achieving greater enterprise asset intelligence offers businesses a sense of what is happening in their operations, provides them with a way to quickly analyse the information and gives them a platform to act on it to reach higher levels of growth, productivity and service. The aim of the paper is to describe of the concept of an Intelligent Enterprise and provide the specification of its characteristics. The objective is to be achieved through analysing the author's surveys results carried out in 2018. The studies were conducted on a group of 80 people – managers in manufacturing companies responsible for supply chains management.

Keywords: logistics management, supply chain, intelligence, intelligent enterprise, megatrend.

1. Introduction

The word ‘enterprise’, in its original introduction from French, is understood as a noun to describe commercial undertakings between people, it then broadened to become almost a synonym for a business or a company (Gray, 1998). There are many types of enterprises – corporations, government agencies, start-ups, nonprofits, and universities, which share four fundamental characteristics. Firstly, an enterprise consists of people who generate value for others, by producing a product and/or performing a service of some kind. Secondly, an enterprise is a whole system that has a purpose, a ‘reason for being’ (Nightingale, and Rhodes, 2015). This purpose is evident in the enterprise’s strategy, stated or implied. Thirdly, an enterprise benefits from being part of its larger ecosystem, the living environment in which

it exists and operates. Fourthly, each enterprise must periodically undergo transformation as it evolves and adapts to an ever-changing world (Nightingale, 2009). The notion of enterprise involves a complete business and it consists of: functions, divisions and other components used to accomplish specific objectives and defined goals. It is a group of people with common goals and it has certain resources at its disposal to achieve that goals. These resources are the assets of an enterprise that are assigned to activities and used in the process of producing an output, product or services (Murthy, 2008).

What is more, most enterprises strive to become more efficient and agile in reacting to the changing demands of their customers, and the changing dynamics of the business environment (Srinivasan, 2016). Therefore, enterprises are continually evolving, being involved in the significant changes within organisational structures and managing systems. This is driven particularly by the convergence of logistics megatrends. Megatrends refer to trends that are global and call for strategies for adaptation, rather than strategies for change to the trends themselves (Retief et al., 2016). They have a potential for existence up to 50 years and are characterised by long-term changes (Pillkahn, 2007). Surprisingly, because of their global character, they are able to overcome any economic interruptions. Megatrends are also considered as a strong form of a trend as many other issues are attributed to them (Wicker, 2010). Logistics megatrends represent the way logistics business entities operate. Megatrends directly apply to the manner of business operating and their existence on the market. They appear globally and influence on particular aspects of organisation (Gröhn, 2006). Most important megatrends are: transformations in logistics models (location of business centres in Asia, Africa and Eastern Europe), globalisation and the growing influence of modern, innovative and intelligent technologies, use of ICT technology, global competition (e-trade and e-purchasing development, mobile services expansion), increasing concern about natural environment (necessity of sustainable development in building business strategies), changes inside corporations and significant demographic and cultural transformations (Galińska, 2018). All mentioned megatrends play a significant role nowadays, as they influence logistics and its domains, including enterprises, which are eventually a crucial element of each logistics chain. Consequently, the convergence of logistics megatrends has led to a new concept known as the 'Intelligent Enterprise'.

Yet, this concept of an 'Intelligent Enterprise' is a relatively young field of modern business management. It is an expansion of Knowledge Management. The intelligent organisation constructs a more advanced form of the learning organisation (Mikuła, 2001). The term 'intelligent enterprise' refers to a management approach that applies technology and new service paradigms to the challenge of improving business performance. The concept posits that intellect is the core resource in producing and delivering services (Quinn, 1992). The concept responds with adequate reaction immediately to the signals from the market. Therefore, it has the ability to gain knowledge and develop it, to learn from the experience and constantly improve employees' competences and other processes inside the company. Also, by the constant

learning process, the enterprise is able to stay ahead of the other companies on the market, especially those who learn slower or do not acquire any knowledge at all (Pedler, and Aspinwall, 1999; Revans, 1998).

In addition, the intelligent enterprise includes the collection of people, knowledge, infrastructure and information processes that deliver critical knowledge (intelligence) to the consumers. This enables them to make accurate, timely, and wise decisions to accomplish the mission of the enterprise. The intelligent enterprise exists to produce intelligence goods and service – knowledge and foreknowledge to decision and policy-making customers. It is a production organisation whose prominent infrastructure is an information supply chain. As in any business, it has a ‘front office’ to manage its relations with customers, with the information supply chain in the ‘back office’. The intellectual capital of this enterprise includes sources, methods, workforce competencies and the intelligence goods and services produced. As in virtually no other business, the protection of this capital is paramount, and therefore security is integrated into every aspect of the enterprise. An effective, intelligent enterprise requires more than just these components; the people require a collaborative culture, integrated electronic networks require content and contextual compatibility and the implementing components must constantly adapt to technology trends to remain competitive (Waltz, 2003).

The intelligent enterprise is also defined as a learning organisation which is able to create, obtain and share knowledge in order to increase its competitiveness on the global markets (Schwaninger, 2006). Thus, it constitutes the more advanced form of the classical learning organisation, due to its adaptation capabilities or even by anticipation of the future changes and active shape of the emerging environment (Brett, 2002). The intelligent enterprise takes advantages of its employees' intelligence; hence it enables effective performance not only with the clients, but with the other partners as well (Mikuła, and Ziębicki, 2000). Using the company's experience, keen observation of the other practises within different companies and an ability to draw correct conclusions are all key elements in developing a competitive edge in the market.

This paper is the first article of the series dedicated to the issue of intelligent supply chain. It was preceded by the article titled ‘Logistics Megatrends and Their Influence on Supply Chains’ which introduced the most important logistics megatrends and their influence on supply chains changes. The aim of the paper is to describe the concept of an ‘Intelligent Enterprise’ and provide the specification of its characteristics. The objective is to be achieved through analysing the author's surveys results carried out in 2018. The studies were conducted on a group of 80 people – managers in manufacturing companies responsible for supply chain management.

The article aims to complement some cognitive research concerning intelligent enterprise. While there are publications presenting the concept of the Intelligent Enterprise (Thannhuber, 2005; Wiig, 2007; Choo, 1995; Gupta, and Sharma, 2004), they still lack empirical data on particular features and areas of the enterprise's intelligence.

The paper is divided into five sections. The first one contains definitions of Enterprise and Intelligent Enterprise. The second section presents the methodology and the scope of empirical research, enabling objective of the studies. The characteristics of the study data are also provided. The third section contains the results of the research and brings to light the characteristics of the ‘Intelligent Enterprises’. The final conclusions are presented in the fourth section of the paper. Finally, the paper is supplemented by a list of references (fifth section).

2. Methodology and the Scope of Empirical Research

In order to implement all of the research objectives i.e. description of an Intelligent Enterprise concept and its characteristics, empirical research was performed in 2018. The research was based on exploratory data analysis. Data was collected on the basis of a survey questionnaire.

Considering the specificity of the research and the necessity to reach the wide range of respondents, such method proved to be a reasonable solution. In addition, survey questionnaires are characterized by having a clear and friendly form and respondent anonymity. In order to minimise research limitations, i.e. low return of the completed questionnaires and possible difficulties with comprehension of some questions, the survey was carried out by a professional market research agency.

The participants were deliberately selected based upon familiarity with the issue of an ‘Intelligent Supply Chain’. The first screening question concerned this issue in particular. If the answer to the question was negative, it resulted in the end of the survey (further questions were not asked, the interviewer passed onto the next respondent).

The study population consisted of 80 respondents. All were of company manager level and represented enterprises of different sizes. Pursuant to the Law (Commission Regulation (EC) No 70/2001), wherein: large companies employ more than 250 employees; medium companies employ up to 250 employees; and small companies (including micro-companies) employ up to 50 employees, the breakdown of participants and the size of the organization they represent are as follows (Table 1):

Table 1.
Size of the Companies and Their Representatives

Size of the company	Number	Percentage
Small	32	40
Medium	32	40
Large	16	20

Source: author's own research.

The abovementioned enterprises are all with a different legal status and are viable business enterprises of varied legal status (in accordance with The Polish Classification of Activity). Most respondents represented limited liability companies operating in the field of industrial processing (manufacturing enterprises and manufacturing and service companies) (Table 2; Table 3).

Table 2.
Enterprise Legal Status

Legal status	Number	Percentage
Limited liability company	42	52,5
Registered partnership	18	22,5
Joint stock company	13	16,25
A natural person conducting a business activity	4	5
Other form: cooperative	1	1,25
Other form: civil law partnership	1	1,25
Limited partnership	1	1,25

Source: author's own research.

Table 3.
Socioeconomic Activities of the Enterprises

Nature of business activity	Number	Percentage
Industrial processing	70	87,5
Wholesale and retail trade	6	7,5
Construction	2	2,5
Other service activities	1	1,25
Information and communication	1	1,25

Source: author's own research.

Most of the companies whose respondents participated in the research, have been in business for over 20 years (more than 66%), (Table 4).

Table 4.
Period of Market Existence

Period of market existence	Number	Percentage
Up to 5 years	2	2,5
5-10 years	4	5
10-15 years	10	12,5
15-20 years	11	13,75
20-25 years	27	33,75
More than 25 years	26	32,5

Source: author's own research.

These are progressive enterprises that operate internationally (65% of all enterprises), mainly in the European Union market (60%).

The empirical data collected from the respondents enabled the analysis of three main problem areas:

- the features of the Intelligent Enterprise,
- areas of the Intelligent Enterprise,
- information and communication technologies which support Intelligent Enterprises.

Research data (empirical data) was analysed quantitatively using the spreadsheet Microsoft Excel and the Statistica 12 programme.

To extract the greatest amount of information from the raw data, a number of various statistical parameters have been applied (Table 5).

Table 5.
Statistical Parameters Used to Mine the Raw Data Survey

Statistical parameter	Characteristics
Arithmetic mean	The arithmetic mean (average) is the sum of a series of numbers divided by the count of that series of numbers.
Median	A median number, value, or amount is in the middle of a series of numbers, values, or amounts: The median is a simple measure of central tendency. To find the median, we arrange the observations in order from smallest to largest value. If there is an odd number of observations, the median is the middle value. If there is an even number of observations, the median is the average of the two middle values.
Mode	Term that refers to the most frequently occurring number found in a set of numbers. The mode is found by collecting and organizing data in order to count the frequency of each result.
Frequency table	A frequency table is constructed by arranging collected data values in ascending order of magnitude with their corresponding frequencies.
Score Min/Max	The lowest/the highest result obtained in data set.
First quartile	The first quartile, also called the lower quartile, is the median of the lower half of the set (the numbers must be listed in increasing order). About 25 percent of the numbers will be smaller than the first quartile while about 75 percent will be larger.
Upper quartile	The upper quartile (sometimes called Q3) is the number dividing the third and fourth quartile. The upper quartile can also be thought of as the median of the upper half of the numbers. The upper quartile is also called the 75th percentile; it splits the lowest 75% of data from the highest 25%.
Standard deviation	Standard deviation is a measure that is used to quantify the amount of variation or dispersion of a set of data values.

Source: author's own research.

To ensure more detailed analysis of the research data, further statistical analyses have been performed i.e.:

- Kruskal-Wallis non-parametric test (compares more than two sample means),
- U Mann-Whitney non-parametric test (compares two, not equal sample means).

The non-parametric Kruskal-Wallis test enables a comparison of the indicated features (respondents' answers) regarding such nominal variables as:

- the size of the enterprise,
- legal status of the enterprise,
- The Polish Classification of Activity of the enterprise,
- nature of business activity,
- period of market existence.

Whereas U Mann-Whitney test was used to compare respondents' answers regarding nominal variables such as:

- information concerning export (if they export or not),
- kind of export market entered into (European/ global).

3. Results of the research

The conducted studies identified the main features of Intelligent Enterprises, their areas of intelligence and also the information and communication technologies that support their functioning. Based on the raw data obtained and literature research, Intelligent Enterprises can be defined as enterprises that utilize technology to monitor and react quickly to any incentives or signals received. They have nervous systems and minds similar to living beings. Also, they are characterised by holding various features that distinguish them from classical enterprises.

The respondents indicated the most important features of the Intelligent Enterprises: rapid response and flexibility in performance (median 5, frequency 70%), ability to manage acquired knowledge (median 5, frequency 58%) and holding the ability to obtain economic benefits based on the acquired knowledge (median 5, frequency 58%). On the other hand, the least important feature recognised by the respondents appeared to be the ability to create and develop this knowledge (median 4, frequency 48%), (Table 6). Non-parametric tests of Kruskal-Wallis and U Mann-Whitney have not indicated any differences in the respondents' answers regarding nominal variables (respondents provided the same answers, regardless of the nominal variable).

Table 6.
Features of the Intelligent Enterprises

Feature	Mean	Median	Mode	Frequency	Min	Max	First Quartile	Upper Quartile	SD
Rapidity and flexibility in performance	4,69	5	5	70%	3	5	4	5	0,49
Ability to observe the market environment	4,40	5	5	53%	3	5	4	5	0,70
Ability to response to signals from the market	4,35	5	5	55%	0	5	4	5	0,90
Ability to rapidly respond to changes in the environment	4,46	5	5	54%	3	5	4	5	0,64
Ability to create and develop the knowledge	4,30	4	5	48%	0	5	4	5	0,85
Ability to implement new solutions based upon the knowledge acquired	4,39	5	5	53%	3	5	4	5	0,72
Ability to manage the acquired knowledge	4,50	5	5	58%	3	5	4	5	0,64
Ability to derive economic benefits based on the acquired knowledge	4,48	5	5	58%	2	5	4	5	0,69

Source: author's own research

The issue of the intelligence in the enterprise may be appreciable, not only in the aspect of the internal environment, but in the external as well. Such areas of intelligence distinguish the enterprise from the others and create added value. In the author's opinion, there are eight main areas that should be distinguished, i.e.:

- information intelligence (employees' ability to obtain information and respond rapidly to them),
- marketing intelligence (ability to create a market, to recognise clients' needs and to acquire new clients),
- social intelligence (acting in the best interest of the employees, improvement of working conditions, delegation of powers willingness),
- organisational intelligence (rapid adaptation to new duties, ability to develop skills and knowledge appropriate to the job),
- financial intelligence (proper funds management, cost-effective spending on ongoing activities and investments),
- ecological intelligence (concern of natural environment, reduction of pollutant emission, thinking green),
- innovative intelligence (search for innovative solutions, demonstration of employee creativity),
- technological intelligence (application of adequate technologies to enable production of goods of highest quality).

As a result of the studies, respondents indicated the most important areas of Intelligent Enterprises: financial intelligence (median 5, frequency 66%), technological intelligence (median 5, frequency 53%) and organisational intelligence (median 5, frequency 51%). Regarded as the least important areas of intelligence are: ecological (median 4, frequency 39%) and marketing (median 4, frequency 41%), (Table 7). Non-parametric tests of Kruskal-Wallis and U Mann-Whitney found no differences regarding nominal variables.

Table 7.
Areas of Enterprises' Intelligence

Area of intelligence	Mean	Median	Mode	Frequency	Min	Max	First Quartile	Upper Quartile	SD
Information intelligence	4,16	4	5	46%	1	5	4	5	0,99
Marketing intelligence	4,08	4	5	41%	1	5	3	5	0,96
Social intelligence	4,11	4	4	46%	2	5	4	5	0,83
Organisational intelligence	4,43	5	5	51%	2	5	4	5	0,67
Financial intelligence	4,59	5	5	66%	1	5	4	5	0,69
Ecological intelligence	3,99	4	4	39%	0	5	4	5	1,11
Innovative intelligence	4,19	4	5	48%	0	5	4	5	1,01
Technological intelligence	4,39	5	5	53%	2	5	4	5	0,74

Source: author's own research

One of the main areas wherein Intelligent Enterprises stand out is in the technological area. There are various information and communication solutions which support the logistic management of the enterprise e.g. in terms of production, warehouse management or order management. Therefore, by means of data processing, the author of the paper recognises that the most important areas that support Intelligent Enterprises are: customer relationship systems

(median 5, frequency 59%) and supplier relationship systems (median 4, frequency 49%), as well as automatic identification methods such as bar codes or RFID technology (median 5, frequency 51%). Finally, the least important information and communication technologies have been recognised: 3D printers (median 2, frequency 28%), advanced analytical and reporting systems (Business Intelligent BI) (median 3, frequency 30%) and finally, data processing models (cloud computing) (median 3, frequency 31%), (Table 8).

Table 8.
ICT Solutions which Support Intelligent Enterprises

ICT solution	Mean	Median	Mode	Frequency	Min	Max	First Quartile	Upper Quartile	SD
Automatic identification methods (bar codes, RFID)	3,91	5	5	51%	0	5	3	5	1,44
Computer Aid Manufacturing systems (CAM)	3,95	4	5	44%	0	5	3	5	1,27
Supply Chain Management systems (SCM)	4,16	4	4	43%	0	5	4	5	0,96
Enterprise Resource Planning systems (ERP)	4,18	4	5	44%	0	5	4	5	1,03
Customer Relationship Management systems (CRM)	4,39	5	5	59%	1	5	4	5	0,92
Supplier Relationship Management systems (SRM)	4,33	4	5	49%	1	5	4	5	0,81
Advanced Planning Systems (APS)	3,91	4	4	46%	0	5	3,5	5	1,07
Product Life Cycle Management systems (PLM)	3,59	4	4	33%	0	5	3	5	1,36
Manufacturing Execution Systems (MES)	4,18	4	5	46%	0	5	4	5	1,12
Warehouse Management Systems (WMS)	4,15	4	4	44%	0	5	4	5	0,92
Communication Technologies (wired, wireless, hybrid)	3,91	4	4	41%	0	5	3	5	1,05
Database	3,66	4	4	35%	0	5	3	5	1,23
Satellite positioning systems (GPS, Galileo, Glonass)	2,78	3	3	36%	0	5	2	4	1,53
Advanced analytical and reporting systems (Business Intelligent BI)	3,05	3	4	30%	0	5	2	4	1,64
Data processing model (cloud computing)	3,05	3	3	31%	0	5	2	4	1,60
Internet of Things (IoT)	3,40	4	4	36%	0	5	3	4,5	1,57
3D printers	1,99	2	0	28%	0	5	0	3	1,62

Source: author's own research.

Non-parametric Kruskal-Wallis and U Mann-Whitney tests indicated various differences in respondents' answers regarding nominal variables. For example, opinion on ICT system potential, namely WMS system, differs significantly among the companies, depending on the size of the company (Figure 1). Herein medium-size company representatives consider this

solution as very significant (median 5), while those representing either small or large companies did not regard it as a valid factor (median 4).

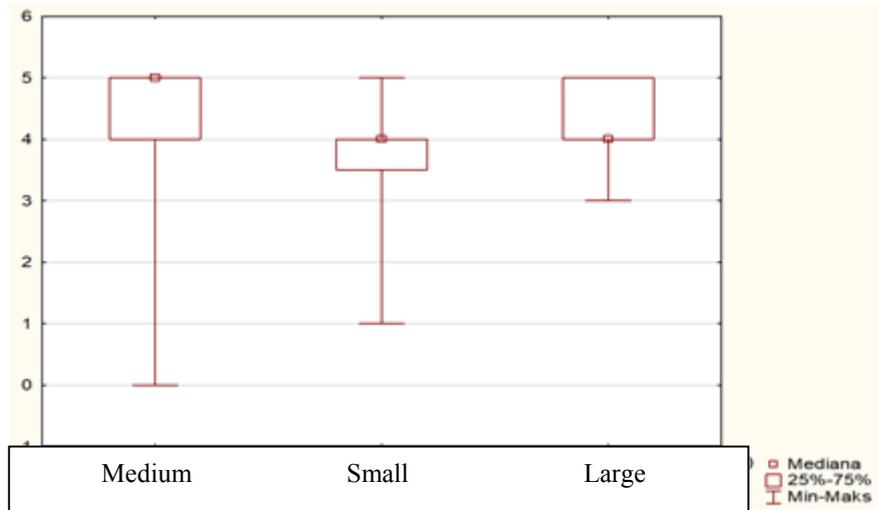


Figure 1. The spread of results in ICT solution: Warehouse Management Systems (WMS). Adapted from: author's own research.

Yet, respondents who represent enterprises of various legal status find the following two ICT solutions significantly different. Firstly, advanced analytical and reporting systems (Business Intelligent BI) are considered as of importance for joint stock companies, limited liability companies and natural persons conducting business activities (median 4), contrary to the general or limited partnerships (Figure 2). The second solution i.e. Internet of Things (IoT) is recognised as valid for natural persons conducting business activity (median 5) whereas representatives of limited partnerships did not find it a significant solution (median 1). Interestingly, such solution is assessed in joint stock companies as medium (median 3) (Figure 3).

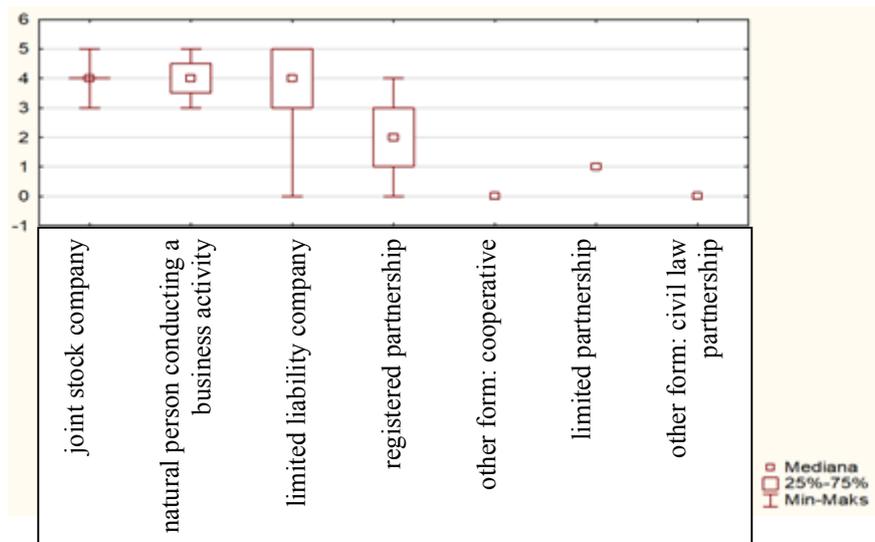


Figure 2. The spread of results in ICT solution: Advanced analytical and reporting systems (Business Intelligent BI). Adapted from: author's own research.

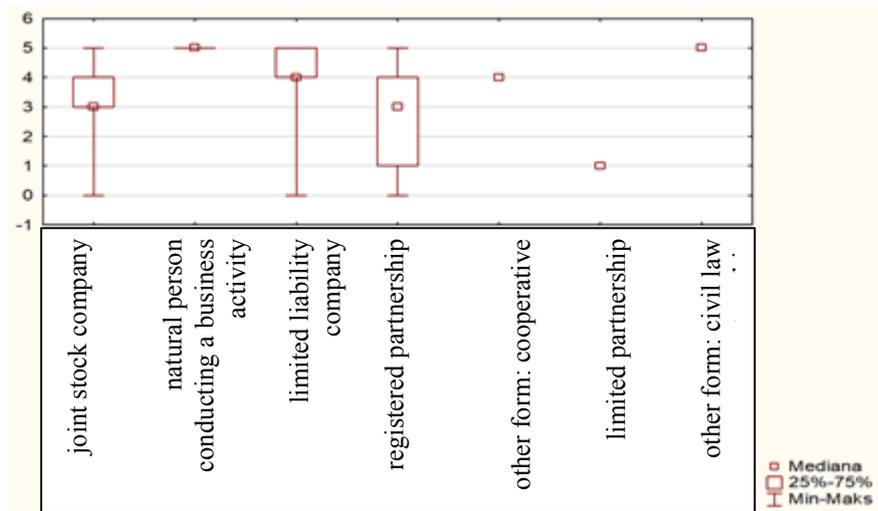


Figure 3. The spread of results in ICT solution: Internet of Things (IoT). Adapted from: author's own research.

The spread of results in the Internet of Things solution, which aims at supporting the Intelligent Enterprise, varies in evaluation depending on the existence on the market factor. The representatives of the companies which have performed on the market for more than 25 years rank it less important (median 3,5) in comparison to relatively recent companies – up to 5 years (median 5) (Figure 4).

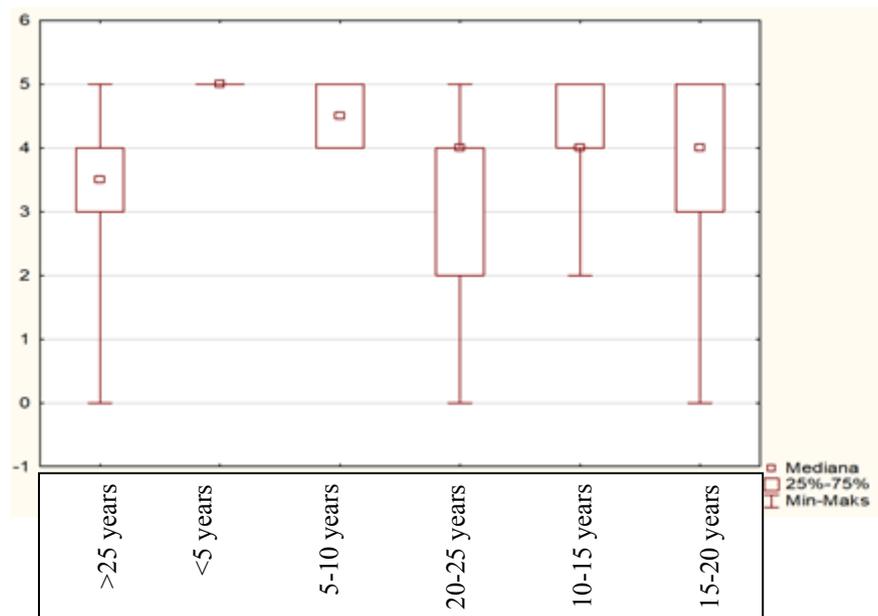


Figure 4. The spread of results in ICT solution: Internet of Things (IoT). Adapted from: author's own research.

The ICT solution: Supplier Relationships Management systems (SRM) which generally has been recognised as a valid and common solution (median 4, frequency 49%), appears to be more significant for representatives of manufacturing and trading companies (median 5) than to manufacturing companies (median 4) (Figure 5).

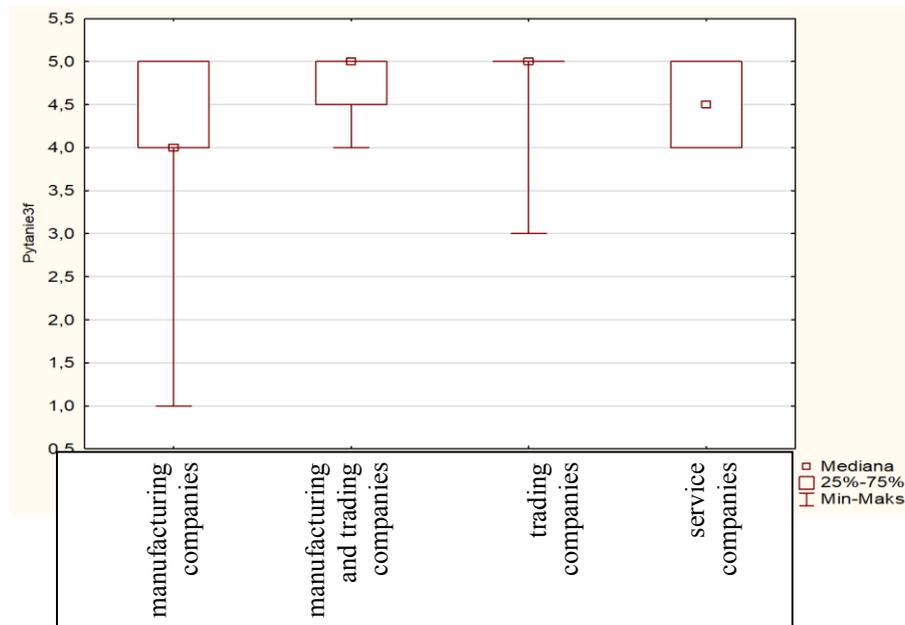


Figure 5. The spread of result in ICT solution: Supplier Relationship Management systems (SRM). Adapted from: author's own research.

The spread of research results visualise differences in perception of ICT information and communication solutions in terms of nominal variables such as the size of enterprise, its legal status, nature of business activity or period of market existence. However, the representatives of the large companies with long market existence tend to be more cautious in willingness to implement new ICT solutions, in comparison to the small and recent.

4. Conclusion

Logistics megatrends (in particular: transformations in logistics models, globalisation, growing influence of modern, innovative and intelligent technologies, use of ICT technology, global competition and changes inside corporations) are nowadays shaping logistics activity itself and its various areas of operational activity. The convergence of megatrends has led to the significant changes in the functioning of contemporary enterprises and has resulted in creation of the entirely new concept of the Intelligent Enterprise. The idea of the Intelligent Enterprise is based on systematic processes within an organisation, wherein such organisation is being defined as a complex organism with many structures and ongoing processes and devotion to knowledge acquirement. Through application of learning processes, an enterprise is able to stay ahead of the other companies on the market, especially those that learn slower or do not acquire any knowledge at all.

The results of the research also indicated the most important attributes of the Intelligent Enterprises, these are: fast and flexible performance, ability to use acquired knowledge and finally, ability to gain economical benefits on the basis of this knowledge. At the same time,

the most important areas of the Intelligent Enterprises that distinguish them on the market, are financial, technological and organisational intelligence. The Intelligent Enterprise is also characterised by an effective cash management system and it is able to provide products of high quality by application of modern technologies. In an Intelligent Enterprise, all employees easily adapt to new tasks and challenges. All in all, these factors create an intelligent organism that is able to cooperate and deal with a competitive environment. Facilitating ICT solutions is another characteristic feature of the Intelligent Enterprise. Finally, the most important information and communication technologies that support the enterprise's functioning are customer and supplier relationship systems, as well as automatic identification systems.

In the author's opinion, further research should be carried out in the various areas of the Intelligent Enterprises activity. The current issue should merit a balanced approach taking into account the following factors: Intelligent Supplier and concept of Intelligent Supply Chain.

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