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Modern trends in logistics of agricultural enterprises

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Abstract: The article is devoted to the analysis of the use of modern trends in the logistics of agricultural enterprises in Slovakia in order to achieve a competitive advantage and to ensure the improvement of the course of business activities. The research was carried out in 67 agricultural enterprises on the territory of Slovakia. The following methods of data collection were used: Computer-Assisted Web Interviewing, Computer-Assisted Telephone Interviewing and Computer-Assisted Personal Interviewing. When interpreting the results of research, descriptive statistics and hypothesis testing were used. Pearson's chi-squared test, Pearson's contingency coefficient and Tschuprow's coefficient were applied as statistical tests. The result of the analysis is the need for digitisation and transfer of Big Data that will lead to better decisions, resulting in higher operational efficiency, cost reduction, risk reduction, flexibility, efficiency, and clarity of logistic processes. Agricultural enterprises in Slovakia will have to accept Industry 4.0. The results of the research revealed that 71.6% of agricultural enterprises strongly agrees with the usage of logistic technology. Price has a strong influence, as an important factor, on the implementation of a new trend in logistics in case of 80.6% agricultural enterprises. 29.8% of respondents accept logistic trends but do not have the funds to implement them in their enterprise.

Keywords: Big Data; business logistics; Industry 4.0; Slovak agriculture; trends in logistics

Dynamic environment in which agricultural enterprises in the Slovak Republic have been operating after the accession into the European Union requires continuity in increasing efficiency of the production process for the preservation and growth of the domestic producers' competitiveness in the single agrarian market. Slovak agriculture has passed a transition period which has had negative consequences in terms of reduction of agricultural production including the drop of employment in agricultural basic industry (Bielik et al. 2010).

The ecologists all over the world warn against reckless exploitation of non-renewable resources and destruction of natural ecosystems on all levels: from the regional level to the planetary one. And the reason is not just that, often, the traditional agricultural cultivation of the countryside has to cede ground to big production halls and infrastructures. Global warming also represents a real danger (Jeníček 2012).

In the current turbulent times, the logistics of agricultural enterprises is affected by globalisation and dynamic growth of new technologies. Companies seek to reduce manufacturing lead-time in order to reduce the cost of production; short lead-times are a major source of potential competitive advantage and also can help achieve internal supply chain optimisation and better

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sustainability (Ivanov and Jaff 2017). The supply chain management is quite complex and comprises several aspects and viewpoints, all of which have nevertheless an ultimate goal: delivering the finished product to the client as soon as possible and at the lowest cost possible. Among the activities of the supply chain, it is important to highlight the maintenance, and more specifically the issue of spare parts and tools. In a nutshell, the challenges to meet are: a quick and reliable delivery of the spare parts inventory at minimum costs (Lozano et al. 2017).

A new alternative and complementary approach to Lean Manufacturing is called Quick Response Manufacturing (QRM). Such approach focuses its efforts on reducing the lead time in environments characterised by high variety of products and customisation (Godinho et al. 2017).

Quick Response Manufacturing is a company-wide organisational strategy that aims to shorten delivery time from the moment of order, through production, logistics, and delivery. It eliminates unproductive consumption of time as well as activities that do not contribute to the value of the product. This strategy is particularly useful for large-scale production and low repeatability. Using this strategy, enterprises managed to reduce delivery cycle significantly by up to 80–90% and simultaneously to reduce costs by 15–20% (Suri 2010).

Utilisation of Big Data accelerates logistic processes and also helps to improve the usage of information and working with them. The rapid increase in volume of available data is primarily the result of their automatic generation. One example may be the automatic recording of traffic information (Mayer-Schonberger and Cukier 2013).

The management and analysis of IoT data ("Big Data") can be used to automate processes, predict situations, and improve many activities, even in real-time. Moreover, the concept of interoperability among heterogeneous devices inspired the creation of appropriate tools with which new applications and services can be created and give added value to the data flows produced at the edge of the network. The agricultural sector was highly affected by Wireless Sensor Network (WSN) technologies and is expected to benefit equally from the IoT (Tzounis et al. 2017).

Warehouse Management System (WMS) is a good option for companies in all sectors improving the control of warehouse operations. In the last years some articles discussed the WMS infrastructure, operations, and the integration of WMS and other information technologies (Gomes et al. 2016).

Selecting the right combination of metrics to monitor and manage distribution is a challenge for even the most sophisticated marketers and it is not getting easier. The concept of omnichannel accepts the inevitability of need to employ multiple channels and is focused on integrating activities within and across channels in order to correspond to how consumers shop. Another aspect of the term omnichannel is that it often encompasses not just the channels of distribution through which a supplier's products reach the consumer but also the channels of communication – owned, paid, and earned – through which a marketer interacts with the consumer (Ailawadi and Farris 2017).

Omni-Channel Retailing – the retailer offers the customer all channels that are currently widespread, which at present means the physical store, catalogue, telephone, online shop, and mobile shop. Additionally, the customer can trigger full interaction and/or the retailer controls full integration of all channels (Beck and Rygl 2015).

Industry 4.0 is the Fourth Industrial Revolution by technical innovations, cybernetic-physical systems in production, and logistic processes (Bartodziej 2017).

Industry 4.0 is sometimes referred to as the 4th Industrial Revolution, and it is a vision of smart factories built with intelligent cyber-physical systems. It will enable manufacturing ecosystems driven by smart systems that have autonomous self-properties, for example self-configuration, self-monitoring, and self-healing. Industry 4.0 will allow us to achieve unprecedented levels of operational efficiency and accelerated growth in productivity. New types of advanced manufacturing and industrial processes revolving around machine-to-human collaboration and symbiotic product realisation will emerge (Thames and Schaefer 2016).

Industry 4.0 in global supply chain management moves traditional relations between supply chain links to a network of connections in which data are aggregated in disseminated servers. This is process organisation, from extraction through production to sales, in virtual space (Szozda 2017).

Research in the field of agriculture and logistics have so far been implemented in connection with marketing, education, and importance of logistics in agriculture. These studies were the primary sources structuring the research of new logistic trends in agriculture in Slovakia. The research in the field of logistics in agriculture, conducted by four American universities, has engaged marketing part of the supply chain and logistic business problems in practice. This resulted

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in findings that more and more enterprises have a logistics department to deal with coordination issues along the supply chain in conjunction with all other departments in the enterprise. For this reason, business logistics must apply a systemic approach aimed at meeting the needs of business entities (Biere 2001).

Rokicki (2013) from University of Warsaw, Poland, conducted research focused on determining the importance of logistics in the companies of the agribusiness sector. The author discusses the solutions applied in this sector as well as future plans related to logistics. As one of the outcomes of research it was found that the companies use a written form for stock accounting while electronic form is used much less frequently. Only a few companies use automatic recording. Future plans of the companies confirmed the importance of logistics. They mainly concerned investment in storage resources, transportation vehicles, and packaging equipment. Deployment of modern IT solutions, logistics cost balance, and training of staff in the field of logistics were mentioned as goals for the future less frequently.

The research conducted in Hungary by Munkácsi (2007) was focused on examining the effect of facility location on operation of an enterprise. The results make suggestions for modification of currently used logistic methods and suggest further methods for examination. The effect of agro-specific needs must be examined in carrying out innovations and making logistical planning methods reliable.

The main objective of the article is to identify, analyse, evaluate, and generalise the use of modern trends in logistics of agricultural enterprises in Slovakia on the basis of a knowledge base and of a research. On the basis of the above facts, enterprises in Slovakia might achieve competitive advantage on the market as well as secure or improve progress of their business activities.

MATERIAL AND METHODS

The research was carried out in 67 agricultural enterprises operating as Limited Liability Companies (s.r.o., 47.76%), Joint Stock Companies (a.s., 8.95%) and Agricultural Cooperatives (družstvo, 43.28%) in Slovakia which marked the sector of their activities in terms of the Statistical Classification of Economic Activities in the European Community (NACE) as 1A – Agriculture, forestry and fishing.

The questionnaire through which research was conducted in Slovak agricultural enterprises consisted of open-ended questions, closed-ended questions, semi-open questions, and rating scale questions. For rating-scale questions, ordinal scales were applied, more specifically the Likert scale. Scales were formed by numbers ranging from 0 to 6. They reflect the level of agreement/disagreement as follows: 0 (strongly disagree), 3 (neutral option), 6 (strongly agree).

Special scientific methods used to process the research results were the following: inquiry method, structured interview, elimination method, classification method, concretisation method, and mathematical-statistical methods. In order to conduct the research, data collection methods were used, including: CAWI method (Computer-Assisted Web Interviewing), CATI method (Computer-Assisted Telephone Interview) and CAPI method (Computer-Assisted Personal Interviewing).

In order to process the results of the questionnaire, one-dimensional descriptive statistics, two-dimensional descriptive statistics, and multidimensional descriptive statistics were used. Pearson's chi-squared test (χ^2), test of goodness of fit, was applied as the statistics test. In order to assess intensity of contingency, Pearson's contingency coefficient and Tschuprow's coefficient were used.

RESULTS AND DISCUSSION

The research revealed that 71.6% of agricultural enterprises studied strongly agree that the usage of logistic technology is a trend in logistics. 16.46% of agricultural enterprises have neutral opinion, while 11.94% of agricultural enterprises strongly disagree with that statement. The size of the agricultural enterprise is related to the usage of logistic technology. Due to the financial difficulty and complexity of the implementation of logistic technologies, small agricultural enterprises do not have the opportunity to develop their logistic technology trends. Active usage of logistic technologies is dominated by medium-sized and large enterprises, which also use this trend in maintaining competitiveness.

82.09% of respondents strongly agree with the statement that digitisation of logistic processes is a trend in logistics, 5.97% of enterprises has neutral opinion, 11.94% of respondents strongly disagree with the statement.

Table 1 shows descriptive statistics of the understanding of the trend in logistics. In the range from 0 to 6, when understanding trends in logistics, the most frequent value of respondents' responses is 6.

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Table 1. Descriptive statistics of understanding trends in logistics

Possibilities	$\bar{x}$	$\tilde{x}$	$\hat{x}$	σ^2	σ
Usage of logistics technology	4.17	5	6	2.32	1.52
Digitalisation of logistics processes	4.59	5	6	2.47	1.57

$\bar{x}$ – mean; $\tilde{x}$ – median; $\hat{x}$ – mode; σ^2 – variance; σ – standard deviation

Source: own processing

As a significant factor for implementation of a new trend in logistics, price has significant influence on 80.6% agricultural enterprises. Neutral opinion on this possibility was expressed by 11.94% of respondents. Price has no influence on implementation of a new trend in logistics in case of 7.46% of agricultural enterprises.

The research shows that 46.3% of agricultural enterprises said they accepted the trends in logistics and implemented them, 20.9% of agricultural enterprises accept trends in logistics but claim that these trends are not important for performance of logistics in the enterprise. 29.8% of respondents stated they accepted logistic trends but did not have the funds to implement them. 3% of agricultural enterprises do not accept logistic trends.

When deciding on whether to implement new trends in logistics, 31.3% of respondents are influenced by time savings. Neutral opinion was stated by 11.9% of respondents. Time savings have no influence on 7.4% of agricultural enterprises when deciding on implementation of a new trend in logistics. Wasting resources and consuming reserves have strong influence on 73.16% of respondents when deciding on implementation of a new trend in logistics. Neutral opinion was expressed by 10.44% of respondents. Wasting resources and consuming reserves have no influence on 16.4% of agricultural enterprises when deciding on implementation of a new trend in logistics.

Table 2. Descriptive statistics for decision to implement new trends in logistics

Possibilities	$\bar{x}$	$\tilde{x}$	$\hat{x}$	σ^2	σ
Price	4.74	5	6	2.42	1.55
Time reduction	4.29	5	5	3.28	1.81
Wasting and removing reserve	4.20	5	6	3.35	1.83

$\bar{x}$ – mean; $\tilde{x}$ – median; $\hat{x}$ – mode; σ^2 – variance; σ – standard deviation

Source: own processing

In Table 2, the mean, mode and median, variance, and standard deviation for decision to implement new trends in logistics are shown.

The main objective of the research was to identify the application of modern trends in logistics of agricultural enterprises in Slovakia. The choice of logistic trends consisted of four trends that the authors, based on literary research, consider to be current trends in business logistics.

Quick Response Manufacturing was used frequently by 20.89% of respondents, 7.46% of participants had neutral opinion of this trend. Quick Response Manufacturing was not used by 71.65% of agricultural enterprises.

11.96% of respondents expressed their opinion that Big Data in logistics is used frequently. Big Data in logistics was not used by 70.14% of agricultural enterprises and 17.9% of respondents had neutral opinion.

Warehouse Management System was used frequently by 52.25% of enterprises surveyed. Neutral opinion was expressed by 13.43% of respondents and 34.32% of agricultural enterprises did not follow this trend.

Industry 4.0 was used frequently as a trend by 5.98% of agricultural enterprises. Industry 4.0 was not used by 80.05% of respondents. Neutral opinion was expressed by 5.97% of agricultural enterprises.

Table 3 shows descriptive statistics of application of selected trends in logistics.

On the basis of the main objective of the article, a hypothesis related to modern logistic trends in agricultural enterprises was formulated and tested.

The formulated hypothesis is based on the PricewaterhouseCoopers survey. This enterprise conducted a

Table 3. Descriptive statistics in application of selected trends in logistics

Application of trends	$\bar{x}$	$\tilde{x}$	$\hat{x}$	σ^2	σ
Quick Response Manufacturing (QRM)	1.44	0	0	4.03	2.00
Big Data in logistics	1.34	0	0	3.03	1.74
Warehouse Management System	3.26	4	6	5.39	2.32
Industry 4.0	0.64	0	0	1.69	1.30

$\bar{x}$ – mean; $\tilde{x}$ – median; $\hat{x}$ – mode; σ^2 – variance; σ – standard deviation

Source: own processing

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survey of 2 000 enterprises in 26 countries in the world concerning the Industry 4.0 and digitisation. Currently, 33% of these 2000 enterprises, i.e. 660 enterprises, use Industry 4.0 and digitisation. In 2020, however, 72% of the 2000 surveyed enterprises will use Industry 4.0 and digitisation will be a regular part of their business processes (Geissbauer et al. 2016).

We believe that companies will probably adopt and utilise Industry 4.0 as a trend in corporate logistics, mainly due to the already ongoing Fourth Industrial Revolution and also in order to maintain competitiveness in the future.

The tested hypothesis was formulated as follows:

H_0: There is no statistically significant dependence between the use of Industry 4.0 and the implementation of a new trend in logistics at the significance level of $\alpha = 0.05$.

H_1: There is statistically significant dependence between the use of Industry 4.0 and the implementation of a new trend in logistics at the significance level of $\alpha = 0.05$.

The calculated testing characteristic (chi-squared = 10.098) was compared with 95-percentile χ^2 – division with: $(r - 1) \times (s - 1) = (3 - 1) \times (3 - 1) = 4$ degree of freedom $\chi^2_{0.95}(4) = 9.487729$; r – rows in the contingency table; s – columns in the contingency table.

Calculation showed that square contingency exceeds critical value, thus the null hypothesis is rejected.

Agricultural enterprises in Slovakia will have to accept Industry 4.0. This trend will be the most dynamically developed among selected trends in logistics. This is confirmed by the tested hypothesis: on the significance level of $\alpha = 0.05$, there is a statistically significant dependence between the use of Industry 4.0 and the implementation of a new trend in logistics.

Based on hypothesis verification, we measured intensity of this dependence. In order to determine intensity, the following were applied:

Pearson's contingency coefficient, which was calculated from the following relationship (Pacáková et al. 2009):

$$C = \sqrt{\frac{\phi^2}{1+\phi^2}} = \sqrt{\frac{\chi^2}{n+\chi^2}} \quad (1)$$

where: C – Pearson's contingency coefficient; ϕ^2 – mean square contingency; χ^2 – the chi-square statistic; n – the total number of observations.

Pearson's contingency coefficient indicates medium dependence (0.230976) between the use of Industry 4.0 and the implementation of new trends in logistics.

Tschuprow's contingency coefficient was calculated based on the following relationship (Pacáková et al. 2009):

$$\tau = \sqrt{\frac{\phi^2}{\sqrt{(r-1)\times(s-1)}}} \quad (2)$$

where: τ – Tschuprow's contingency coefficient; ϕ^2 – mean square contingency; r – rows in the contingency table; s – columns in the contingency table.

Tschuprow's contingency coefficient indicates weak dependence (0.016746) between the use of Industry 4.0 and the implementation of a new trend in logistics.

CONCLUSION

The need to innovate and implement modern logistic trends in agriculture is based on the fact that the population of the country continues to grow, so agricultural methods have to develop at the same pace. Examination of the need and intensity of the development of modern logistic trends in agriculture is a consequence of the above-mentioned fact.

Agricultural enterprises perceive trends in logistics and try to implement them. This stems from the fact that the future of agriculture depends on its digital transformation. The aim of farmers is to profit from newly implemented trends in the field of digital transformation in agriculture. Their activities in the field of implementation of new trends depend on funding. This is evidenced by the fact that agricultural enterprises in Slovakia are very influenced by price as a factor in introducing a new trend in logistics. From the selected trends, the one the most frequently used in agricultural enterprises is Warehouse Management System (WMS). The problem of surplus stocks is not unique, and many manufacturers today face the problem of stagnant components, raw materials, or their remains.

It is not possible to propose a single innovative model of the aforementioned contexts in business logistics according to which agricultural enterprises should operate. Based on these facts, we have designed three innovative models for using new trends in logistics.

The innovative procurement logistics model consists of the following trends: Big Data in logistics, and Industry 4.0. The role of trends in this model is to ensure all material items that are important for making a production or other business activity. The innovative model of procurement logistics is designed to simplify and expedite many logistics activities from flow

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of raw materials and auxiliary materials to entry into the warehouse or production.

The innovative production logistics model includes the following trends: Quick Response Manufacturing, Big Data in logistics, and Industry 4.0. The role of trends in the idealised model of production logistics is to provide the processes needed to prepare the production process. The innovative model of production logistics has all the logistics processes to manage efficiently and clearly, as the activities ranging from material flow of raw materials to storage of finished products are ensured in this model.

The innovative distribution logistics model consists of the following trends: Big Data in logistics, Warehouse Management System, and Industry 4.0. The role of trends in this model is to provide for all logistic processes in order to perform distribution. The innovative distribution logistics model is designed to simplify and streamline the flow of goods from the stock of finished products to the sales market.

Survey results show that only 5.98% of respondents used Industry 4.0 frequently and up to 88.05% of agricultural enterprises did not use this trend. Neutral opinion was expressed by 5.97% of respondents. This means that almost 6% of agricultural enterprises neither consider implementing the given trend, nor are interested in implementing it. However, 82.09% of enterprises identified digitalisation of logistics processes as a trend in enterprise logistics. With Industry 4.0, we can see synonyms such as Smart Manufacturing, Industrial Internet of Things, or Digital Enterprise.

The modern vision of agricultural development in the future can include Internet of Things. The development of IoT will facilitate crop tracking anywhere, as actual information over time is recorded. Agricultural machines are equipped with sensors, GPS navigation systems that allow mapping of the terrain, document the crops directly on collection, check the state of mechanisation, thus preventing delays and eliminating losses of time and finance. Another advantage of digitalisation and automation of agricultural technology is the precise dosage of crop pesticide sprays, which has a positive effect on reducing environmental impacts on soil quality and reduces excess preventive usage of chemicals, thus affecting the health of the population.

We believe that Industry 4.0 will be closely interconnected with Big Data in logistics in the coming period as the number of devices connected to the internet is growing. The digitalisation and transfer of Big Data will lead to better decisions, resulting in higher operational efficiency, cost reduction, and risk reduction. Millions of devices communicate with each other and send data via different communication channels to information systems.

Examined trends in agricultural logistics create space for efficient processes from crop production to the use of compound feed in livestock production. Agricultural enterprises have stockpiles needed for livestock breeding and also store seeds or components for agricultural machinery; after implementing these trends, costs can be minimised, time can be saved, and handling can be more effective. At present, the aim of agricultural enterprises is not only to achieve quantifiable results, but it also includes their responsibility for the environment, better crops, and the ability to grow their crops with new and more efficient methods.

The digitisation of enterprises will change the nature of work and bring about increased demands and requirements for skilled workers. The demand for workforce will grow steadily, as new professions will be created in enterprises with requirements to reflect on the digitisation of production and logistics. We see great potential in the use of Industry 4.0 not only in agricultural enterprises in Slovakia. The research studies from abroad say that Industry 4.0 is linked not only with industry but also with education. Foreign enterprises have already derived the concept of Logistics 4.0 from the concept of Industry 4.0. This approach creates a space for the modernisation of agricultural enterprises in the future.

Agricultural workers in enterprises and food producers have to take into account the trends of digital transformation in agriculture. By using technology in agricultural enterprises in Slovakia as a sustainable resource, we will be able to develop and move agriculture to higher levels of development in the future.

The challenge of modernisation of agricultural enterprises in the future in the field of agricultural technology is the development of digitisation – Industry 4.0, which prevents the production of more waste in higher food production. At present, it is a major problem for the population that requires the necessary steps and measures to eliminate food waste.

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