FINDING SPECIFIC GROUPS OF AGRICULTURAL SMES THAT USE DIGITAL TECHNOLOGIES TO MANAGE SELECTED PROCESSES

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Abstract

The paper presents the relevant results of research that was conducted on a current and symbolic topic that offers new perspectives and opportunities for small and medium-sized enterprises (SMEs) in the context of the 4th industrial revolution – the digital industrial revolution. This paper deals with the issue of the identification of specific groups of agricultural SMEs using digital technologies to manage selected processes. The paper's main aim is to determine if it is possible to divide the agricultural SMEs, which have implemented their processes using information technology into several characteristic groups that significantly differ by the types of processes. The fulfilment of the content of the paper is based on the research of primary data and their analysis in relation to the defined topic of the research. To achieve this goal, the cluster analysis method has been used.

Key words

Agriculture 4.0, digital technologies, industrial revolution, Industry 4.0, small and medium-sized enterprises

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Introduction

For several years, a number of developed countries have been dealing with the onset of the so-called "4th industrial revolution", which is fundamentally changing the nature of industry, energy, trade, logistics and other parts of the economy and the entire society. The "Industry 4.0" trend is seen as a transforming force that will deeply impact agriculture. Agriculture is changing in recent years too and, in the same way as an industry, is forced to modernize its work methodologies and take advantage of opportunities offered by digital technologies (Monteleone, S. et al., 2020). The trend is building on an array of digital technologies: the Internet of Things, Big Data, Artificial Intelligence, and of digital practices: cooperation, mobility, and open innovation. They imply a transformation of the production infrastructures. They will enable both increased productivity and quality and environmental protection. But they also generate modifications in the value chain and business models with more emphasis on knowledge gathering, analysis and exchange (European Commission, 2017). The digital revolution presents not only a huge opportunity for SMEs but also a great challenge. However, to reap these benefits, businesses will need to invest in equipment, information and communication technology (ICT) and data analytics, as well as the integration of data flow across the global value chain (European Parliament, 2015).

This paper focuses on finding specific groups of agricultural SMEs using digital technologies to manage selected processes. The article is based on the main aspects of the "Agriculture 4.0" initiative; whose basic directions of implementation are the active use of various digital technologies, which are to be established for the introduction of qualitatively new approaches to the organization of the activities of agricultural enterprises. In addition, the creation of digital platforms is considered one of the approaches to improve economic, organizational, and managerial relations that take place in the process of economic activity of agricultural enterprises.

The structure of the paper is as follows. In the theoretical part, the opinions of other researchers are presented in the field. The next part defines the research goal and methodology including a description of empirical data. Then we deal with the results and short discussion on them. The final part of the paper summarizes the results of

the research in an integrated form, the limits of research and the focus of further research.

The literature on this topic suggests that the application of the principles of the 4th industrial revolution is of great importance, especially for small and medium-sized enterprises, and therefore should be widely represented in research, theory and business practice.

Literature overview

Hermann et al. (2015) point out that although Industry 4.0 is currently the top priority of many companies, research centres and universities, there is no generally accepted definition of the term. The term "Industry 4.0" became public knowledge in 2011 when an initiative with that name - an association of representatives from business, politics, and academia - promoted the idea as an approach to strengthening the competitiveness of the German manufacturing industry.

According to Perales et al. (2018), Industry 4.0 is a wide term that implies a drastic change in the way companies operate - upcoming innovations and transformations of production processes. The Internet and digitization enable the complete connection and automation of all production processes as well as the services associated with them. However, current research about Industry 4.0 is diverse, limited and clearly insufficient regarding its implementation in operational levels of the production processes (Hermann et al., 2015).

Many authors observed various aspects of enterprise processes in which Industry 4.0 finds its application. The implementation of digital technologies into the management of SMEs' processes is affected by various factors such as the organizational capabilities of SMEs (Annosi et al., 2019), the nature of the business, the size of the company, the management decision, the view of internal and external pressure (Rijswijk et al., 2019, Müller et al., 2018), and technological advancement, government policy and other.

Revolution 4.0 is at the centre of interest of small and medium-sized enterprises both in industry and agriculture. Agriculture within the agricultural supply chain faces specific challenges to enable the operational application of Industry 4.0 guidelines. The integration of Industry 4.0 and Agriculture 4.0 provides the opportunity to transform industrial agriculture into the next generation, namely "Agriculture 4.0" (Liu et al., 2020). The industry is developing much faster than agriculture (today there is talk of the so-called Industry 5.0). While Agriculture 4.0 is still limited to a few advanced companies. Regardless of the recommended industry or agriculture 4.0 for large companies, small and medium enterprises often face difficulties in such advanced development due to the continuous progress in innovation and technology (Tubis and Grzybowska, 2022). According to Rauch et al. (2020) This is primarily due to the lack of knowledge about solutions supporting Industry 4.0 and the high costs related to investments in new technologies. Mittal et al. (2018) emphasize that SMEs often do not adopt new solutions, mainly because they fear investing in bad technologies or adopting inappropriate practices.

Several studies highlight the potential of Agriculture 4.0, such as improvements in planning and management, and intelligent use of data collected through advanced technologies for sustainable growth (Braun, Colangelo and Steckel, 2018). Weersink et al. (2018) summarize the results of several studies based on the idea of Agriculture 4.0 and confirmed that the interaction of farming operations using digital information in all farm sectors and processes has brought positive changes. The fusion of precision agriculture and the Internet of farming leads to Agriculture 4.0 (or digital agriculture), which interconnects different technologies aimed at improving the yield and sustainability of crops, increasing working conditions, and the quality of production and processing (Zambon et al., 2019).

Braun et al. (2018) stress that for the agricultural sector, efficient value creation across all levels along the whole supply chain is also of great importance. The support of a digitalized and comprehensive understanding of reality enables new potential benefits for all involved partners. To achieve this, a holistic approach to digitalization is necessary.

In today's innovative environment, despite the benefits of Industry 4.0 or Agriculture 4.0 for

large enterprises, small and medium-sized enterprises often face complications in such innovative processes due to the constant development of innovation and technology (Zambon et al., 2019a). A well-organized political, legal and infrastructural overview is essential for building a business with an Industry 4.0 approach. While larger firms can get ahead through innovation processes and anticipate the potential risks of digitization to their business models, SMEs may struggle. These editorial aims to offer relevant results of research that has been carried out on this current and symbolic topic, offering new perspectives and opportunities, especially for SMEs (Zambon et al., 2019b). Policymakers should design strategies and calls for proposals to encourage SMEs to invest in these technologies and make them more competitive in the market.

Goal and Methodology

In our research, we tried to find answers to research question-related about processes, which are managed by using information technology within Slovak agricultural SMEs (RQ: Which processes do you manage by using of the information technology?). Respondents could mark the following possibilities:

PA) Accounting and finance

PB) Procurement and stock management

PC) Planning and scheduling of production

PD) Sales and customer relationship management

PE) Quality assurance and quality control

PF) Network control of production machinery and equipment

PG) Post-warranty service

PH) Managing/minimizing energy consumption.

The main goal of the paper is to find out, if is it possible to divide the SMEs, which have implemented their processes by using the information technology into several characteristic groups that significantly differ by the stated types of processes.

To achieve the stated goal a survey of 171 SMEs' opinions has been chosen and the questionnaire survey was used as a principal method. The questionnaire was created by the research team within the Vega project No. 1/0718/22 and subsequently distributed to the respondents personally, or by email.

We developed a questionnaire and distributed it to managers or owners of agricultural SMEs in eight self-governing Slovak regions (table 1).

The structure of the research sample according to their main characteristics is provided in the following tables and figures. Table 1 presents the division of respondents according to the self-governing region in which the SMEs carry out their entrepreneurial activities. A large number of SMEs belonged to the category of micro-enterprises (54.39%) and the Trenčín region (39.18%).

Table 1 Research sample according to self-governing region

Region		BA	TT	TN	NR	ZA	BB	KE	PO	Total
micro (0-9)	N	12	14	40	4	20	2	0	1	93
	%	7.02	8.19	23.39	2.34	11.70	1.17	0.00	0.58	**54.39**
small (10-49)	N	5	2	24	6	21	3	2	0	63
	%	2.92	1.17	14.04	3.51	12.28	1.75	1.17	0.00	**36.84**
medium (50-249)	N	3	4	3	1	3	0	1	0	15
	%	1.75	2.34	1.75	0.58	1.75	0.00	0.58	0.00	**8.77**
Total	**N**	**20**	**20**	**67**	**11**	**44**	**5**	**3**	**1**	**171**
	%	**11.70**	**11.70**	**39.18**	**6.43**	**25.73**	**2.92**	**1.75**	**0.58**	**100.00**

Source: own research, Notice: BA-Bratislava region, TT-Trnava region, TN-Trenčín region, NR-Nitra region, ZA-Žilina region, BB-Banská Bystrica region, KE-Košice region, PO-Prešov region

To evaluate the research question, the cluster analysis was used. Using cluster analysis, we divided the respondents into several characteristic groups that differ in the types of processes managed using information technology. Based on the calculation in STATISTICA application a graphical output (dendrogram) of the cluster analysis was constructed.

Findings and Discussion

The respondents' answers, indicating the options, are shown in Table 2. Most SMEs used information technology for PA) accounting and finance (149 SMEs) and PB) procurement and stock management (118 SMEs). The least SMEs used information technology for PG) Post-warranty service (27 SMEs). Accounting information as quantitative information about economic entities is useful for economic decision making and it can be used for strategic planning, management oversight, and operation oversight (Putra, 2019). For the accounting department, which records the financial movements of the business and reports the results of them, it is effective to use intelligent systems for helps to reduce human-made mistakes and the system acts faster.

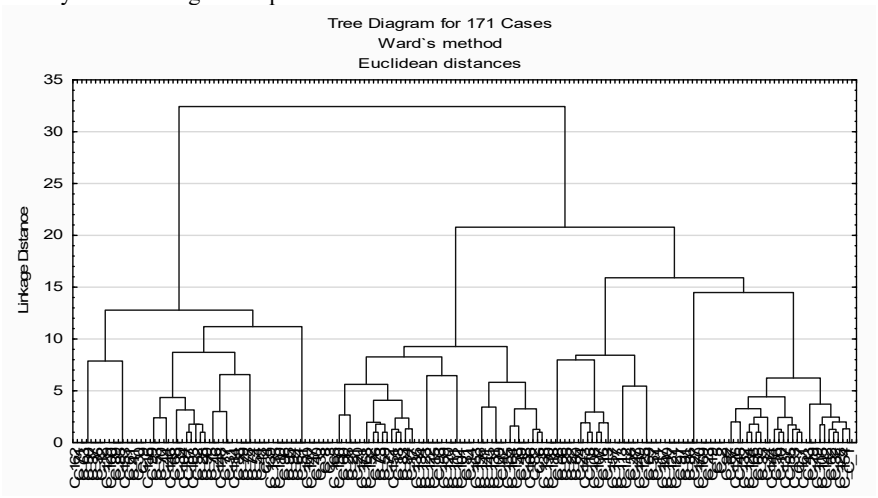
Table 2 Processes managed by using of the information technology

Process	Answer	No	Yes	Process	Answer	No	Yes
PA	**N**	22	149	**PE**	N	106	65
	%	12.87	87.13		%	61.98	38.02
PB	**N**	53	118	**PF**	N	127	44
	%	30.99	69.01		%	74.27	25.73
PC	**N**	86	85	**PG**	N	144	27
	%	50.29	49.71		%	84.21	15.79
PD	**N**	73	98	**PH**	N	133	38
	%	42.69	57.31		%	77.78	22.22

Source: own research

Many factors will affect the implementation of Industry 4.0 elements such as the size of the enterprise, the number of employees, the sector in which the enterprises do business, financial indicators such as e.g., amount of equity and liabilities, fixed assets, ways of financing (Vrchota et al., 2020). In our research, we evaluated if the size of the enterprise affects the processes managed by using informational technologies.

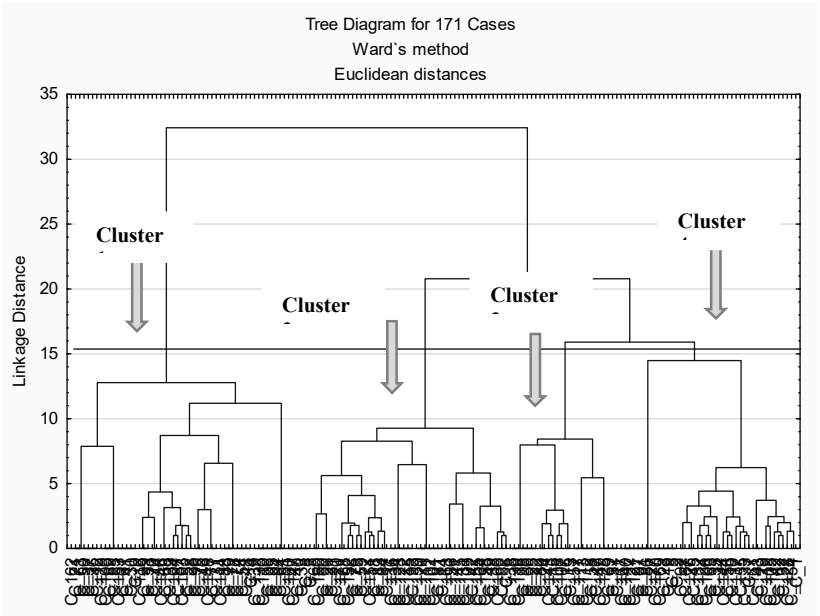
Figure1 Cluster analysis – dendrogram of processes



Source: own research

From this dendrogram, we can identify that the surveyed entrepreneurs tend to cluster into two different clusters. Subsequently, these clusters break down into 4 smaller clusters (Figure 2).

Figure 2 Cluster analysis (processes) – identification of 4 clusters



Source: own research

For the interpretation of the cluster analysis, below the graph of means (Figure 3) and the result of the analysis of variance of the 4 identified cluster s are provided (Table 3). They were generated by the K-means method, which better expresses the characteristics of the individual clusters as well as what are the averages of the individual characteristics of the studied clusters.

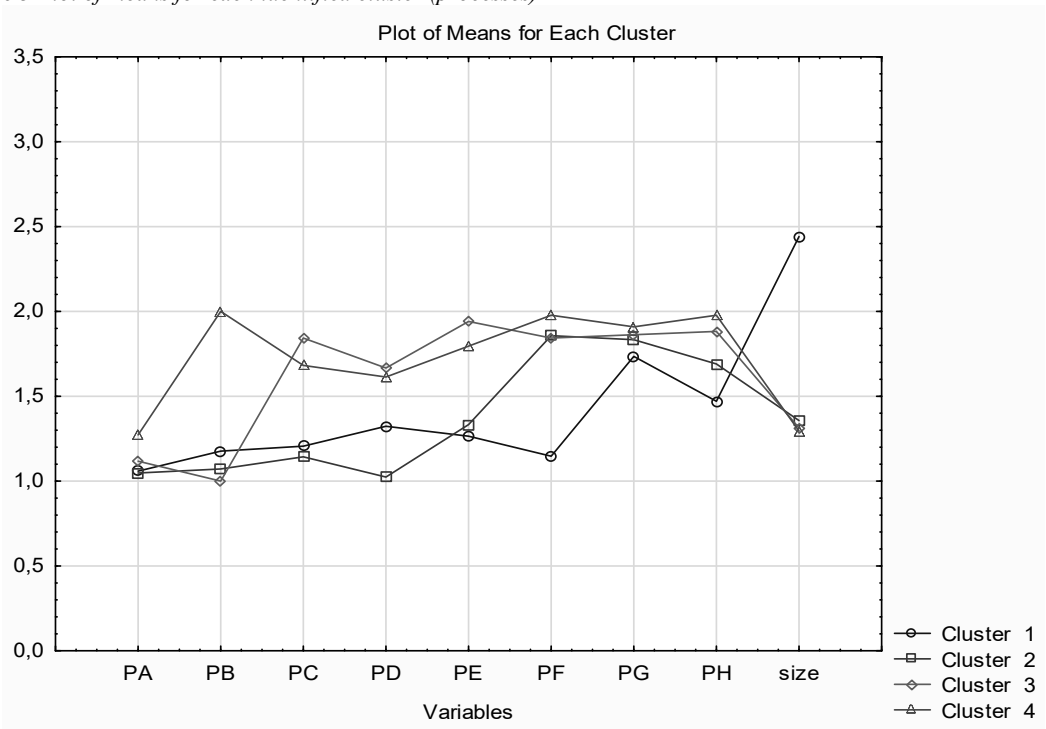
Table 3 Results of analysis of variance from the performed cluster analysis

Variable	cluster 1	cluster 2	cluster 3	cluster 4	signif. p
PA	1,11	1,00	1,25	1,11	**0,00**
PB	1,34	1,09	1,45	1,32	**0,00**
PC	1,64	1,07	1,85	1,29	**0,00**
PD	1,55	1,09	1,64	1,36	**0,00**
PE	1,82	1,30	1,78	1,50	**0,00**
PF	1,89	1,50	1,91	1,57	**0,00**
PG	1,91	1,77	1,85	1,82	0,36
PH	1,91	1,52	1,95	1,64	**0,00**
size	1,07	1,84	1,36	2,18	**0,00**

Source: own research

Figure 3 confirms the significant difference of means between the clusters for the characteristics related to the size of the enterprise. The characteristics of the clusters confirm the statement above.

Figure 3 Plot of means for each identified cluster (processes)



Source: own research

The first cluster consists of 44 enterprises (Table 4), which belong to micro-enterprises (41 enterprises) and small enterprises (3 SMEs). This cluster does not include medium enterprises. SMEs in this cluster use digital technologies mainly for managing PH processes Managing/minimizing energy consumption (1.91±0.29).

The second cluster also consists of 44 enterprises (Table 4), while the largest share is made up of enterprises from the category of small enterprises (21 SMEs). These companies, as was the case with the companies involved in the first cluster, use digital technologies especially for PH (1.52±0.51).

The third cluster consists of 55 SMEs (Table 4). The largest share is made up of enterprises belonging to the category of micro-enterprises (36), followed by small enterprises (18). There is only one enterprise from the category of medium-sized enterprises in this cluster.

The fourth cluster consists of 28 enterprises (Table 4). In terms of size category, there are 21 small enterprises, 1 micro-enterprise and 6 medium-sized enterprises in this cluster. Digitization is mainly used for PH (1.64±0.49)

Table 4 Classification of enterprises in clusters and the analysis of clusters' members - processes (output from STATISTICA)

Case No.	Cluster 1 44 cases Distance	Case No.	Cluster 2 44 cases Distance	Case No.	Cluster 3 55 cases Distance	Case No.	Cluster 4 28 cases Distance
C_6	0,55	C_2	0,43	C_1	0,51	C_20	0,43
C_13	0,50	C_5	0,38	C_3	0,32	C_34	0,46
C_14	0,32	C_7	0,44	C_4	0,35	C_38	0,37
C_30	0,28	C_11	0,54	C_8	0,32	C_49	0,37
C_31	0,50	C_15	0,46	C_9	0,36	C_58	0,53
C_36	0,37	C_18	0,55	C_10	0,50	C_67	0,46
C_54	0,35	C_19	0,46	C_12	0,38	C_73	0,46
C_63	0,37	C_21	0,43	C_16	0,52	C_80	0,42
C_65	0,47	C_22	0,28	C_17	0,49	C_83	0,54
C_79	0,35	C_23	0,41	C_28	0,41	C_84	0,38
C_87	0,39	C_24	0,54	C_29	0,44	C_86	0,32
C_88	0,35	C_25	0,38	C_32	0,48	C_97	0,40
C_89	0,43	C_26	0,35	C_33	0,36	C_105	0,56
C_90	0,45	C_27	0,38	C_37	0,56	C_106	0,59
C_91	0,43	C_35	0,49	C_39	0,42	C_107	0,59
C_92	0,49	C_45	0,40	C_40	0,36	C_108	0,57
C_94	0,27	C_47	0,48	C_41	0,39	C_111	0,32
C_95	0,31	C_55	0,45	C_42	0,41	C_115	0,36
C_96	0,35	C_57	0,53	C_43	0,57	C_119	0,48
C_99	0,44	C_60	0,47	C_44	0,43	C_126	0,47
C_102	0,36	C_66	0,45	C_46	0,46	C_129	0,38
C_103	0,53	C_69	0,40	C_48	0,33	C_130	0,42
C_109	0,35	C_72	0,49	C_50	0,40	C_138	0,37
C_116	0,41	C_81	0,38	C_51	0,34	C_149	0,47
C_121	0,44	C_82	0,44	C_52	0,45	C_152	0,50
C_122	0,31	C_98	0,45	C_53	0,38	C_164	0,39
C_123	0,35	C_101	0,42	C_56	0,46	C_168	0,39
C_127	0,40	C_112	0,46	C_59	0,51	C_171	0,39
C_128	0,44	C_113	0,39	C_61	0,36		
C_131	0,39	C_117	0,39	C_62	0,65		
C_134	0,35	C_118	0,28	C_64	0,34		
C_135	0,27	C_120	0,34	C_68	0,41		
C_136	0,35	C_124	0,39	C_70	0,45		
C_139	0,39	C_125	0,44	C_71	0,36		
C_140	0,44	C_133	0,38	C_74	0,34		
C_145	0,35	C_143	0,60	C_75	0,44		
C_146	0,41	C_144	0,48	C_76	0,55		
C_147	0,32	C_151	0,44	C_77	0,43		
C_150	0,43	C_157	0,29	C_78	0,33		
C_155	0,45	C_158	0,44	C_85	0,36		
C_160	0,32	C_159	0,34	C_93	0,41		
C_162	0,36	C_166	0,52	C_100	0,36		
C_165	0,39	C_167	0,32	C_104	0,53		
C_169	0,44	C_170	0,32	C_110	0,32		
				C_114	0,33		
				C_132	0,38		
				C_137	0,55		
				C_141	0,49		
				C_142	0,48		
				C_148	0,42		
				C_153	0,39		
				C_154	0,48		
				C_156	0,47		
				C_161	0,41		
				C_163	0,47		

Type of enterprise	Cluster 1	Type of enterprise	Cluster 2	Type of enterprise	cluster 3	Type of enterprise	cluster 4
micro	41	**micro**	15	**micro**	36	**micro**	1
small	3	**small**	21	**small**	18	**small**	21
medium	0	**medium**	8	**medium**	1	**medium**	6
Total	**44**	**Total**	**44**	**Total**	**55**	**Total**	**28**

Source: own research

Conclusion

Industry and the entire economy are undergoing fundamental changes caused by the introduction of information technology, cyber-physical systems and artificial intelligence systems into production, services, and all sectors of the economy. The impact of these changes is so fundamental that they are referred to as the 4th industrial revolution. It is necessary to respond to these trends, as they offer huge opportunities from the point of view of sustainability and increasing the productivity of production and services, and thus the demand for skilled workers. Otherwise, there is a risk of loss of competitiveness not only for companies but also for the economy as a whole, with significant impacts not only on employment and productivity but on the entire development of society.

The development of connectivity in agricultural tools is leading to significant advances in agricultural practices. They enable the development of precision agriculture and increase the transparency of the sector. However, they also face significant challenges in the key need to enable data exchange in the business ecosystem and the need to invest in new infrastructure and tools (European Commission, 2017).

The performed analysis enabled the practical implementation of the ideas developed in the "Agriculture 4.0" concept. It is capable of significantly increasing the efficiency of agricultural production and reducing the dependence of the functioning of agroecosystems on natural factors, as well as contributing to the greening of agricultural production processes.

Within this research, certain limits can be defined, which can be seen to a limited extent, although representative, the sample of respondents, or in the timing of research for a favourable phase of the economic cycle. At the same time, the research results show that the issue of may be an interesting area for further research.

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