The assessment of the significance of differences between cloud computing factors and their impact on management in SME's enterprises

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Abstract

The information systems in today's world play an essential role because of their ability to influence sectors of economic activity, and in many cases, are the basis of enterprises' activity in many different areas. Moreover, cloud computing is one of the most critical elements of an information system. Currently, available cloud computing solutions are implemented in many enterprises, regardless of their sizes and field of activity. These solutions generate a range of benefits for the enterprise itself and affect the management throughout the whole organization. Thus, the purpose of the article is to identify significant differences in the perception of the impact of cloud computing factors on enterprise management depending on the number of employees. Research conducted among SME sector enterprises showed that medium-sized enterprises record the main differences in the perception of the impact of selected cloud computing factors on management.

Keywords: cloud computing, enterprise, management, factors.

1. Introduction

Competitive struggle and constantly changing conditions of functioning in the business environment cause that enterprises use solutions offered by information systems in the form of Internet of Things (IoT), virtualization technologies, Social Networks (SN), Social Media (SM), Data Science, E-commerce and Cloud Computing (CC) more often [9][20]. Furthermore, cloud computing is currently a significant trend in developing information systems, which is on the top priority list in many enterprises [11]. Moreover, today, in a highly competitive world and global economy, enterprises must fulfill market needs and expectations and compete with other enterprises to win more customers. To achieve this, enterprises need to have efficiency on cost and the right technology to improve their management, and cloud computing is the proper solution that supports its needs [23].

While cloud computing initially offered services related to the transmission, collection, or processing of information, now this is the solution which offers an *innovative business model for the pervasive, convenient, and on-demand access to the virtualized and distributed resources such as network, servers, storage, applications, and services* [2]. CC is also described as the *aggregation of computing as a utility and software as a service where the applications are delivered as services over the Internet, and the hardware and systems software in data centers provide those services* [10]. The cloud is *a nebulous assemblage of computers and servers accessed via the Internet* [19]. It is perceived as a solution which affects the enterprise's management through the inter-organizational relationship promotion [7][13], encourage collaboration with customer [26], better agility in responding to environmental changes [16] and value creation for enterprises [18].

During the fourth industrial revolution, referred to as Industry 4.0, which significantly contributed to the digitization and automation of production, the enterprise's use causes the

transformation of the entire enterprise system, delivering enterprises with more flexibility, agility, and productivity [21]. Many enterprises perceive the use of cloud computing as a solution that stimulates the development of an organization and accelerates the time to introduce new services or products on the market while reducing IT resources, which entails a reduction in costs [22]. As a result, cloud computing has been quickly adopted by enterprises of all sizes and from different sectors. In addition, cloud computing contributes to a change in the management model in an enterprise, making it more effective in cooperation, ensuring the efficiency of management processes and IT capabilities [1]. Thus, cloud computing is one of the most impactful information technology that significantly impacts enterprise management.

The conducted literature studies made it possible to formulate the following research question:

RQ: *are there significant differences in the perception of the impact of certain cloud computing factors on business management?*

Thus, the main hypothesis assumes that *there are significant differences in the perception of the impact of CC solutions on business management*.

In order to verify the formulated research hypothesis, frequency analyzes, and U Mann-Whitney tests were performed.

The conducted considerations indicated that the solutions offered by cloud computing significantly affect enterprise's functioning and management processes realization. However, depending on the size of the enterprise, there may be significant differences between the perception of the impact of specific factors on the management of the enterprise and its size.

The conducted empirical research was concentrated on identifying the differences, and the main research problem focused on understanding and explaining the specificity of these differences. Thus, the article's main purpose is to identify significant differences in the perception of the impact of cloud computing factors on enterprise management depending on the number of employees.

The presented paper is organized as follows: section 2 - Cloud computing influences enterprise management; section 3 - Research Methodology; section 4 - Data Analysis Results; section 5 – Conclusions and section 6 – References.

2. Cloud computing influence on enterprise management

At present, cloud computing is a modern technology available to ensure better continuity of business and development. However, according to statistical data, the total number of cloud computing users reached 3,4 bln, which is about half of the world's total population in 2018. These statistics clearly show that cloud computing technology is growing exponentially and will soon dominate the information technology market [5].

First of all, the implementation of cloud computing in the enterprise changes the way of collecting, sending, and processing information, which is crucial from enterprise management. Information is the most valuable source of an enterprise, and its quantity and quality determine the effective conduct of management processes. Thanks to cloud computing, information is not only quickly sent within the enterprise information system, which increases management flexibility but is also analyzed faster, which causes, for example, faster changes implementation in the products or services offered, and can also contribute to the changes in the way they are designed. Cloud computing can also be treated as a repository for gathering and analyzing information and a place where more and more operations affecting the management processes are carried out [6].

Cloud computing also affects the development of cooperation between individual departments of the enterprise, positively affecting cooperation between employees or enabling the home-office mode [12]. The use of cloud computing in the enterprise also reduces the costs incurred, e.g., due to the possession of proprietary data centers, related to the costs of the energy needed to power or the costs of services related to their operation [15]. In particular, the development of cloud computing has dramatically facilitated the scaling of new ideas at significantly lower costs than before [3]. Costs, saved in this way, can be used, for example, for activities related to the development of new products or

services, thereby increasing the level of innovation of the enterprise itself [17].

The impact of cloud computing on organization management is recognized not only by enterprises but also by start-ups that are increasingly offering their products and services as software-centric entities, from which data and information are continually derived. In this case, organizational functions blur as management processes become increasingly iterative [14]. Cloud computing also improves customer service processes. Many professional services have achieved global success thanks to the cloud, without which it would not be possible to launch them quickly and their provision [4]. Thanks to the cloud, employees have access to information that helps them serve customers anytime of the day and from anywhere. In addition, the cloud connects employees with potential buyers through many devices - mobile, laptops, or desktop computers [25].

Of course, the above considerations do not fully cover the topic of the impact of cloud computing on the enterprise management processes, but thanks to them, it became possible to emphasize the occurrence of this impact. Furthermore, it seems to be only a matter of time before the cloud will significantly impact management as traditional computers or client-server servers.

Enterprises using cloud computing differ from each other in many aspects; thus, the impact of cloud computing on management will be different, and the perception of this impact will be different by the enterprises themselves.

3. Research Methodology

3.1. Data collection

The research procedure assumed surveying randomly selected enterprises of the SME sector. For the purpose of this article, we accepted the SME definition, provided by EU Recommendation: *The category of micro, small and medium-sized enterprises (SMEs) is made up of enterprises that employ fewer than 250 persons and which have an annual turnover not exceeding 43 million EUR, and/or an annual balance sheet total not exceeding 43 million EUR* [8]. This definition considers the following three criteria: staff headcount, annual turnover, and annual balance sheet total.

The course of the study included the following stages (fig. 1):

1. The research questionnaire development - the final form of the questionnaire took the form of a survey consisting of 29 questions, covering the following areas of research:
   - reasons for CC implementation,
   - benefits and disadvantages of CC
   - CC impact on selected enterprise activity aspects
   - CC impact on enterprise management
   - CC impact on enterprise objectives' realization
   - the questions related to the size of the company, the length of CC use, the operation range of the company, and the costs of CC.
2. Preparation of the base of enterprises to which questionnaires were sent - the main base of enterprises were mainly the SME enterprises, to which surveys were sent. The minimum sample size for estimating the probability of p success in a general population was calculated based on the following formula:

$$n = \frac{u_{\alpha}^2 p(1-p)N}{u_{\alpha}^2 p(1-p)+(N-1)d^2} \approx 236 \quad (1)$$

where:
α = level of significance (0,1-0,01),
u^2_{α} = the value acquired from the table of normal distribution for the adopted level of significance,
p – the structure index,

d – accepted level of the highest error

As is evident from the calculations, the minimum sample size, with the adopted confidence level 1-2 = 0.90, and the accepted level of highest error d = 6%, should be 236 questionnaires. Because the study involved 250 questionnaires, it can be assumed that this condition has been met.

3. Survey realization and collection of completed questionnaires - the primary survey was conducted from July to September 2019, while questionnaires were sent to 250 SMEs. After the initial analysis, it turned out that nine enterprises did not meet the criteria for medium-sized enterprises and were classified as large enterprises. The respondents were representatives of the company in managerial positions, owners, and IT specialists, who have an excellent knowledge of information systems used in the enterprise (table. 1).

Table 1. The sample structure due to the size of the enterprise and the type of respondent.

Size of the enterprise	**The type of the respondent**			
Microenterprise		frequency	%	Cumulative %
	Owner	98	76%	76%
	Manager	9	7%	83%
	IT specialist	22	17%	100%
	TOTAL	**129**	**54%**	**54%**
Small enterprise	Owner	25	35%	35%
	Manager	18	25%	61%
	IT specialist	28	39%	100%
	TOTAL	**71**	**29%**	**83%**
Medium-sized enterprise	Owner	9	22%	22%
	Manager	9	22%	44%
	IT specialist	23	56%	100%
	TOTAL	**41**	**17%**	**100%**
TOTAL:		**241**		

4. Development of an integrated response database and data coding for statistical analysis – in total, 250 survey questionnaires have been returned, 9 of them were excluded from the research. Thus 241 questionnaires were qualified for further analysis. After qualifying the received questionnaires, an integrated response database was developed containing all the answers to the issues contained in the surveys, and the process of raw coding data was carried out so that further analyzes could be carried out. For database development and raw data coding, the Excel 2019 spreadsheet was used.

5. Conducting reliability, frequency, and nonparametric tests using the Mann-Whitney U test - Statistica 13 software was used to perform the analyzes and tests.

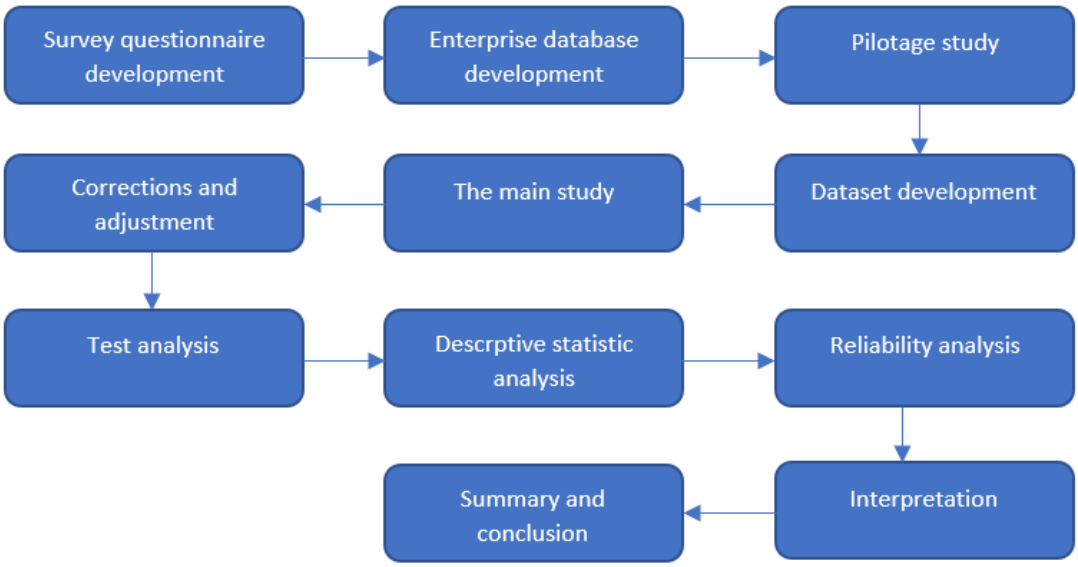

Fig. 1. The research process stages

3.2. The Reliability analysis

The reliability analysis is most often associated with constructing complex scales, in particular summary scales, i.e., consisting of many individual items (questions). Reliability of the scale - understood as its internal coherence, gives us information about how a given scale measures what it measures; that is, to what extent individual items of the scale measure the full scale. The Cronbach's Alpha coefficient is most commonly used in the reliability analysis, which measures the ratio of individual items' variance to the full-scale variance (the sum of these items). Its value is between 0 and 1. The closer it is to 1 – the higher is the reliability. Due to the fact, that many authors use a wide range of different qualitative descriptors, alpha values were described as follows: (0.93–0.94), strong (0.91–0.93), reliable (0.84–0.90), robust (0.81), fairly high (0.76–0.95), high (0.73–0.95), good (0.71–0.91), relatively high (0.70–0.77), slightly low (0.68), reasonable (0.67–0.87), adequate (0.64–0.85), moderate (0.61–0.65), satisfactory (0.58–0.97), acceptable (0.45–0.98), sufficient (0.45–0.96), not satisfactory (0.4–0.55) and low (0.11). in general was assumed it is acceptable when alpha is higher than 0,45 [29].

The results of the reliability analysis of the 241 questionnaires are presented in table 2.

Table 2. The reliability test results of the total 241 questionnaire

Variable	Item number	Average	Variance	Standard Deviation	Cronbach's Alpha
CC implementation reasons	16	3,26	1,21	1,1	0,81
CC benefits	26	3,31	1,21	1,1	0,92
CC disadvantages	17	2,77	1,08	1,03	0,85
CC impact on selected enterprise activity aspects	16	3,01	1,38	1,17	0,91
CC impact on enterprise management	4	1,61	0,39	0,63	0,81
CC impact on enterprise objectives' realization	6	1,63	0,45	0,67	0,82

For all the variables, the Cronbach's Alpha values are higher than 0,80, which means that the scale's reliability is acceptable.

3.3. The U Mann-Whitney Test

The U Mann-Whitney test concerns the study of the convergence of two characteristics (or one for two communities) presented on the ordinal scale [28]. It is used when the data do not meet the assumptions for the use of the t-Student test, and the goal is to compare two groups independent of each other. The measure of central tendency for this test is not

average but median. The limitation in numbers only indicates that the most prominent sample should have at least ten records. The following hypotheses are assumed in this test [27]:
H0: two samples have identical distributions, so they are similar,
H1: the two samples are significantly different in the distribution of the examined characteristic.
It is also possible to perform a one-sided test, for which an alternative hypothesis was stipulated that the level of the feature in the second sample is stochastically (randomly) higher than in the first sample.
The U - Mann-Whitney test is carried out using the following formula:

$$Z = \frac{U-EU}{\sigma} = \frac{\left(R_{\min(k)} - \frac{n_k(n_k+1)}{2}\right) - \frac{n_1 n_2}{2}}{\sqrt{\frac{n_1 n_2 (n_1+n_2+1)}{12} - \frac{n_1 n_2 \sum_{i=1}(t_i^S - t_i)}{12(n_1+n_2)(n_1+n_2-1)}}} \quad (2)$$

where:
$R_{min(k)}$ - the sum of the ranks for the group in which the sum is the lowest,
n_k - number of observations in a group with a smaller sum of ranks,
n_1 - the size of the first group,
n_2 - the size of the second group,
t - number of observations having the same rank.

Critical values for smaller samples are read from the Whitney U-Mann table, for larger ones - from the normal distribution tables for the α/2 significance level [27].

The probability of making a first type error (i.e., rejecting the tested hypothesis) is p (p-value), which is the lowest level of significance leading to the rejection of the tested hypothesis. However, if p (p-value) is lower than the adopted significance level, then the tested hypothesis is rejected by an alternative hypothesis [24].

4. Data Analysis Results

4.1. The descriptive statistics analysis

In order to statistically present the data obtained, a frequency analysis was performed. Frequency analysis is a valuable tool used during raw data mining. The following values were inspected during the frequency analysis - numbers, percentages, cumulative percentages, averages, medians, variances, and standard deviations. The obtained results are presented in Table 3.

Table 3. Descriptive Statistical Results

	Classification	Frequency	%	Cumulative %
The size of the company	Micro	129	54%	54%
	Small	71	29%	83%
	Medium	41	17%	100%
The length of CC use	Up to 3 years	79	33%	33%
	3-6 years	87	36%	69%
	6-10 years	42	17%	86%
	more than ten years	33	14%	100%
	Local	34	14%	14%

The operation range of the company	Regional	55	23%	37%
	National	43	18%	55%
	European	92	38%	93%
	Worldwide	17	7%	100%
Costs of the CC	up to 1250 Euro	37	15%	15%
	1250-2500 Euro	44	18%	34%
	more than 2500 Euro	65	27%	61%
	I do not know	95	39%	100%

According to the presented table, it is visible that microenterprises are dominant in the group of surveyed entities – 54%, in the second place, are small enterprises, with 29% share and, medium enterprises are the smallest group – 29%. CC is a pretty new solution for most companies, 36% of them have been using CC for more than three years, but less than 6, 33% of them have been using CC no longer than three years. Another 31% of the companies have been using this solution for longer than six years and, only 14% of which – have been using CC for longer than ten years. According to the surveyed enterprises, most of them operate on a European scale – 38%, 23% of them on the regional scale, and only 7% - operate on the worldwide scale. Regarding the costs of CC use, the vast majority of the respondents indicated "I do not know" – 39% of them. 27% admitted that the costs of CC use were higher than 2500 Euro, 18% admitted that the costs of CC use were between 1250 and 2500 Euro, and 15% of them indicated the costs no higher than 1250 Euro per year.

4.2. The U Mann-Whitney test results

As mentioned in the section 3.3, the U Mann-Whitney test makes it possible to compare two independent groups with each other. The U Mann-Whitney test was used to determine if there are significant statistical differences in assessment:

- Reasons that played the most crucial role in CC implementation;
- CC benefits and disadvantages;
- CC impact on business management;
- CC impact on enterprise objectives' realization;
- Including cc solutions on the company's business strategy;
- CC impact on selected enterprise activity aspects

Due to the selected groups of enterprises in the SME sector, the following tests were compared:

- Micro enterprises with small;
- Micro enterprises with medium;
- Small and medium enterprises;
- And enterprises that have indicated the need to consider the use of cloud computing in the process of creating a business strategy with those that have indicated the lack of such a need.

Table 4 presents test values for variables related to assessing the significance of differences in assessing the most important causes that played the most crucial role in the CC implementation and the perception of CC disadvantages and benefits.

Table 4. U Mann-Whitney test results.

Factor	Micro/medium		Small/medium		Mean		
	Z	*p*	*Z*	*p*	micro	small	medium
Flexibility of solutions	-2,05137	0,040232			3,68	3,62	4,07
Better support for home office			-2,00239	0,045243	3,36	3,24	3,77
Independence from hardware and software used by users			-1,98929	0,046670	3,60	3,42	3,87
Accelerated implementation of innovation, including the introduction of new	-2,05989	0,039410			3,06	3,36	3,12

services/products							
Better cooperation between employees and partners	-2,35936	0,018307			3,35	3,34	3,80
Better business continuity	-2,32323	0,020167			3,24	3,44	3,70
Problems with the data security and its processing	-2,19395	0,028239	-1,98929	0,046670	2,96	2,98	3,52
Lack or limited control over the supplier's activities	-1,96961	0,048883			2,97	3,05	3,35

Z – the value of the test statistic, *p* - significance

The results presented in table 4 showed that:

- Reasons for implementing CC in the enterprise in the form of the flexibility of solutions were significantly more often indicated by medium-sized enterprises (Z = -2,05137; p = 0,040232) than micro ones. Medium-sized enterprises (Z = -2,00239; p = 0,045243) also significantly more often indicated the reason for better support for a home office than small enterprises. For other CC implementation reasons in the form of financial benefits, reduced demand for IT specialists, high availability, ease of use, increased efficiency, high level of security offered by an IT provider, improved cooperation between employees and partners, better meeting customer needs, better accountability and control, unlimited storage space, acceleration in the implementation of innovations, including the introduction of new services or products, and the development of new ventures and business projects, no significant differences were found.
- The benefits of using CC in the enterprise in the form of independence from hardware and software used by users were significantly more often indicated by medium-sized enterprises (Z = -1,98292; p = 0,046670) than small ones. Medium-sized enterprises also significantly more often indicated benefits in the form of accelerated enterprise development (Z = 2,05989; p = 0,039410), better cooperation between employees (Z = -2,35936; p = 0,018307) and better business continuity (Z = -2,32323; p = 0,020167) than micro ones. In the case of other benefits resulting from the implementation of CC in an enterprise in the form of better economic efficiency, higher security level, higher flexibility and scalability, higher accessibility, easy use of IT resources, better cooperation with clients and partners, reduced demand for IT specialists, better IT infrastructure management, faster running of innovations, better environmental protection, knowledge development, and employees activation in the area of wider use of IT technology no significant differences were found.
- On the other hand, in the case of CC disadvantages, only in two cases significant differences were noted: medium-sized enterprises significantly more often indicated the problem related to the security of collected and processed data than micro-enterprises (Z = -2,19395; p = 0,028239) and small ones (Z = -1,98929; p = 0,046670). Also, in the absence or limited control over the supplier's activities, this defect was significantly indicated by medium-sized enterprises rather than micro-enterprises (Z = -1,96961; p = 0,048883). For the other disadvantages in the form of different legal problems, dependency on the quality of the Internet connection, partial or total dependence on the supplier, difficulties in adapting IT resources to customer's needs, problems related to data migration, high costs of broadband Internet connections, limited possibilities to integrate local and external IT resources, solutions' technological immaturity, market immaturity that generates the risk of cooperation with a non-professional supplier, lack of local technical support; appropriate language version; qualified employees and tax incentives or EU funds, risk of losing knowledge in the IT area and possibility to incur additional/unpaid costs, no significant differences were found.

Table 5. U Mann-Whitney test results on CC impact on enterprise management and objectives' realization.

Factor	Micro/medium		Small/medium		Mean		
	Z	*p*	Z	*p*	micro	small	Medium
Impact of CC on enterprise management							
Better management of available resources	-2,81341	0,004902			1,30	1,42	1,72
Significant structural changes	-2,19968	0,027830			1,69	1,75	1,97
Impact of CC on objectives' implementation							
Better recognition and use of emerging market opportunities	-2,45061	0,014262			1,49	1,66	1,87
Business diversification	-2,65023	0,008044	-1,97289	0,048509	1,64	1,73	2,02
Better implementation of management processes (planning, organizing, motivating, and controlling)	-2,23958	0,025119			1,40	1,52	1,77

Z – the value of the test statistic, *p* - significance

The results presented in table 5 showed that:

- Medium-sized enterprises significantly more often indicated that CC solutions affect company management through better management of their resources, and tangible and intangible resources had an impact on the increase of investment efficiency (Z = -2,81341; p = 0,004902) and introducing structural changes and remodeling of existing management processes in the enterprise, including not only changes in the organizational structure of the enterprise and business processes but also changes in the principles of cooperation with business partners (Z = -2,19968; p = 0,027830) than micro ones.
- In addition, medium-sized enterprises significantly more often indicated that the use of CC solutions in the enterprise enabled: better recognition and use of emerging market opportunities (Z = -2,45061; p = 0,04262), better implementation of management function (Z = -2,23958; p = 0,025119) and diversification of the enterprise's operations (Z = -2,65023; p = 0,008044) than micro and small enterprises (Z = -1,97289; p = 0,048509).

Table 6 presents the results of tests when the effects of using CC in an enterprise were adopted as variables. In this case, groups of enterprises were compared, not because of the size, but because of the attitude to whether contemporary enterprises creating their strategy business should include the use of information technology in the form of CC.

Table 6. U Mann-Whitney test results on CC impact on enterprise strategy.

Factor	Yes/No		Mean	
	Z	*p*	Yes	No
Better cooperation	2,634639	0,008423	3,46	2,41
Better understanding of the nearest social environment	2,113453	0,034563	2,74	2,00
Improvements in education	2,206207	0,027370	3,05	2,25
Influence on economy sectors' development	2,647890	0,008100	3,32	2,25
Supporting entrepreneurship	2,480050	0,013137	3,35	2,41
Competitiveness support and development	3,557757	0,000374	3,51	2,25
Supporting start-ups	2,513176	0,011965	3,47	2,50
Supporting quick run of e-services	3,546715	0,000390	3,64	2,33
Supporting innovations	2,563970	0,010349	3,63	2,58

Z – the value of the test statistic, *p* - significance

The results presented in the table 6 indicate that the companies that agreed with the statement that modern enterprises while creating their business strategy should take into account the use of modern information technologies such as Cloud Computing, significantly more often indicated that CC solutions contribute to the improvement of people's cooperation (Z = 2,634639; p = 0,008423), better understanding of the nearest social environment (2,113453, p = 0,034563), influence on the improvements in education (2,206207; p = 0,027370), influence on economy sectors' development (Z = 2,647890; p = 0,008100), support entrepreneurship (Z = 2,480050; p = 0,013137), competitiveness (Z

= 3,557757; p = 0,000374), start-up's (2,513176; p = 0,011965), support quick run of e-services (3,546715; p = 0,000390) and innovativeness (Z = 2,563970; p = 0,010349).

6. Conclusions

The main purpose of the conducted research and analysis was to verify the adopted research hypothesis assuming significant differences in the perception of the impact of cloud computing solutions on business management. The obtained results enabled positive verification of the adopted research hypothesis because they indicate that depending on the size of the enterprise, there are significant differences in the perception of the impact of cloud computing factors on management in the enterprise.

First of all, these differences occurred in the case of medium-sized enterprises. As was presented above, medium-sized enterprises significantly more often indicated flexibility of solutions, better support for home office, independence from hardware and software used by users, accelerated implementation of innovation, including the introduction of new services/products, better cooperation between employees and partners, better business continuity, problems with the data security and its processing and lack or limited control over the supplier's activities as factors which significantly affect enterprise management.

In addition, medium-sized enterprises significantly more often indicated factors' influence in the form of better management of available resources, significant structural changes, better recognition and use of emerging market opportunities, and better implementation of management processes (planning, organizing, motivating, and controlling) on management than micro and small enterprises. However, all categories of surveyed enterprises that indicated the need to consider the use of cloud computing solutions in the process of creating business strategy significantly more often indicated that cloud computing solutions result in better cooperation and a better understanding of the nearest social environment. Also, improve the education, influence economy sector's development; support entrepreneurship, competitiveness and development, start-ups, a quick run of e-services and innovations.

However, this study has several limitations, which determine the further directions of research. First of all, the conducted research was limited only to Polish enterprises. Thus it limits its generalizability. Moreover, a further direction of consideration may be conducting similar research on a sample of enterprises from other countries, which will allow conducting a comparative analysis on a larger scale. In addition, in this study, an attempt to determine the impact of cloud computing on enterprise management was carried out from owners, managers, and IT specialists' perspectives. However, further studies can concentrate on the perspective of cloud computing users to better examine the impact of its solutions on enterprise management processes.

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