

Cloud computing adoption in small and medium-sized enterprises in Poland – benefit analysis

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Abstract

Small and medium-sized enterprises (SMEs) operating in a turbulent and fast-moving environment introduce innovative solutions, including new ICT, in order to survive or achieve a better market position. A number of studies show that the quality of ICT infrastructure and Information Systems supporting business processes has significantly improved in recent years in the case of manufacturing SMEs. The cloud computing model with a new subscription payment system creates new opportunities for collaboration and tends to increase productivity, which is one of the main factors behind its extensive proliferation. Our research continues studies in the area of cloud computing adoption seen from an organisational perspective. The aim of the paper is to analyse the benefits of using cloud computing solutions by small and medium-sized manufacturing enterprises in Poland. The implementation of this objective required, on the one hand, a review of the literature and previous studies on the application of the cloud computing model in SMEs, and, on the other hand, conducting our own research among this group of enterprises. Quantitative research was carried out using a survey questionnaire from December 2017 to February 2018, with the use of the CATI technique, among 277 small and medium-sized manufacturing enterprises in Poland. The analysis of the obtained research results shows that SMEs see the benefits of using cloud computing solutions and perceive these solutions in terms of processes supporting business management. These entities most often use less advanced cloud solutions, i.e., email services, data collection and storage and instant messaging systems, that facilitate communication with the environment, improve the flow of information and documents and support production processes.

Keywords: Cloud computing adoption, manufacturing companies. SMEs.

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1. Introduction

One of key elements of small and medium-sized enterprises' (SMEs) manufacturing ability to innovate and improve their business effectiveness is the implementation of new digital support of business processes. IT applications are now more widely available due to new cloud computing models offering new pricing systems. There is no doubt that business is moving to the cloud. The scalable computing pool of resources offered as a service transforms every aspect of modern manufacturing, reducing costs and increasing competitiveness.

Cloud computing has numerous definitions but, in general, it is understood as a computing architecture with a technology model enabling the delivery of IT resources and services on demand with greater flexibility and the ability to purchase IT services based on the payment scheme in which the customer pays according to the resources used. This definition follows the one proposed by the National Institute of Standard and Technology (NIST) [12]. Three main models of delivering such services can be distinguished into Software as a Service (SaaS), where the provider offers specific software, the client has no information about the platform and infrastructure and the configuration is usually a simplified one-step process; Platform as a Service (PaaS), where the provider offers a package of related applications available through the browser, which gives the possibility of using the software on many different platforms as well as provides access to the environment that helps to programme and create scalable solutions; and Infrastructure as a Service (IaaS), where the provider offers different variants of hardware infrastructure, system and user software along with maintenance services in various variants. Additionally, cloud computing is usually deployed in one of the following basic configurations: a public cloud, a hybrid cloud, a community cloud or a private cloud [12]. The SaaS model is perceived to be very attractive to small firms as it allows them to avoid the costs of infrastructure and application software. Some authors put emphasis on cloud computing as the convergence of IT efficiency and agility with cooperativeness of the business, as it eliminates traditional boundaries between businesses [13].

Cloud computing solutions and problems of its adaptation are currently the subject of a wide range of studies considering technical as well as business and social issues. A major effort is being made to determine how enterprises operate and integrate into supply chains, how they manage the product life cycle and change the way products are planned, designed, distributed and used by customers. Three main concepts of cloud manufacturing are described in the literature: intelligent manufacturing, Internet of Things (IoT)-enabled manufacturing and cloud manufacturing. Some similarities, such as the aims of smart decision-making and resource optimisation or technologies, such as IoT and Big Data analytics, can be found among these categories [18].

Cloud manufacturing represents a model that supports technologies, such as 3D printing IoT or virtualisation the application, which create a major business opportunity for smaller manufacturers, helping them to effectively manage their business activities. The next generation industry, called according to the German strategy Industry 4.0, focuses on a smart object able to communicate and behave in the smart environment [18].

Most global enterprises apply cloud computing in some part of their businesses. The main advantages of shifting an ERP system to clouds were analysed and defined as much lower costs, faster time to the market and great opportunities for creating new sources of value [1], [9].

This has been confirmed by several analytical studies such as the IDC report showing 2/3 of 600 respondents using a public cloud for two or more applications and almost the same percentage using a private cloud [2]. The report from 2018 predicts that firms remaining outside the cloud risk isolation from innovation. Another study conducted by the Economist Intelligence Unit indicates that over half of the surveyed respondents perceived cloud computing as an important issue for better supply chain management, enabling design and prototyping, and almost half saw its great significance for inventory, orders and distribution [4]. A list of the most important issues related to the adoption of computing cloud solutions, grouped into 10 categories, along with recommendations for decision-

makers in this process was presented by El-Gazzar et al. [3]. Different techniques and approaches including neural networks are applied to better understand the issue [14]. It has been proven by many studies that the adoption of information systems by organisations generally follows the Diffusion of Innovation (DOI) model or occurs within the technology–organisation–environment framework (TOE). Some differences have been identified in the adoption of cloud computing solutions in the manufacturing and services sectors. The study conducted by Oliveira et al. [13], which applied combined DOI and TOE approaches, has confirmed that the manufacturing and services sectors have different drivers of cloud computing adoption. Their research model explained 36.1% of cloud computing adoption among firms in the manufacturing sector. Although a great deal of work has been carried out, there is still not enough research on the topic and a pressing need for more knowledge about cloud computing proliferation in SME manufacturing firms can be observed. The influence of company size on the perception of opportunities and threats associated with the cloud ERP adoption was described by Johansson [10], and the conclusion suggest a need for further research on the differences between SMEs as these entities relate differently to several considered issues.

This paper focuses mainly on presenting the drivers of adoption of the cloud computing model in SMEs and analysing benefits resulting from the use of cloud computing solutions by small and medium-sized manufacturing enterprises in Poland.

2. SMEs' adoption of ICT and cloud solutions

SMEs have to adapt to the changing business and technological environment in order to compete in the market. The ICT adoption in the case of SMEs depends on the company's size, type of business and regulatory frameworks. The internal and external factors affecting SMEs' decisions and choices regarding ICT were described and categorised by Nguyen [16] and Ghobakhloo et al. [5]. Giotopoulos et al. [6] examined different aspects of ICT adoption in 3,500 SMEs in Greece considering the role of technological competencies, human capital and internal organisation in ICT adoption. Their results show that involvement in R&D and innovation activities, as well as participation in research projects or collaboration, increase the likelihood of adopting ICTs in SMEs. They also stress the role of technological capabilities, organisational skills and human capital as very important factors helping to implement new technologies. Most research results confirm lower costs as the primary determining factor for ICT adoption. SMEs in general show a positive attitude towards ICT, but they do not recognise its strategic potential, so the plans and ways in which SMEs implement Information Systems and engage in e-commerce are not very fast, they follow an evolutionary rather than revolutionary model, depending on strategic importance for their business activities [7]. The research on SMEs' decisions concerning e-commerce adoption in developing countries has been also conducted. It indicates that perceived benefits, technology readiness, owners' innovativeness, IT ability and experience are the determinant factors that influence the evaluation of e-commerce benefits and its proliferation [15].

Nowadays, progressive digitisation of products and the servitisation trend are changing manufacturing (Issa et al., 2017). This research area with its new challenges also lies within the field of scientific interests. A number of drivers of and barriers to cloud computing adoption have been analysed and listed by different authors. Vidhyalakshmi and Kumar [17] developed the list of factors that SMEs should evaluate to determine cloud suitability for their business. Cloud-based applications, mainly ERP solutions, are at the centre of interest as a source of innovation implementation [11], in particular, many SMEs shift to cloud-based ERP solutions (Castelina, 2011). A great deal of effort has been made to prepare SMEs to this change. Numerous research results can be found on barriers to and drivers of adoption of these solutions, along with roadmaps and case studies, e.g., German Platform Industrie 4.0 [8] and similar platforms in Europe, Asia and America. The literature study shows different groups of barriers to and drivers of cloud computing adoption. Duan et al. [1] analysed the factors that influence adopting ERP as SaaS, confirming lower upfront costs and lower operating costs as factors being at the top of the list of benefits.

Polish companies are also trying to find best ICT solutions that can support their business activities and make them grow. In this study, we attempt to identify business motivators that stimulate firms to make decisions about acquiring cloud computing solutions. The list of motivators was prepared based on an in-depth literature review and covered, among others, financial, communication and developmental aspects.

The following research hypothesis was adopted on the basis of the conducted literature review: *there is a relationship between benefits of using computing cloud solutions by SMEs and their size measured by the number of employees.*

3. Analysis of benefits resulting from the use of cloud computing solutions by small and medium-sized manufacturing enterprises in Poland – results of empirical research

3.1. Research methods and characteristics of the enterprises surveyed

The adopted research hypothesis was verified on the basis of the primary research conducted from December 2017 to January 2018 with the CATI methodology among 400 Polish manufacturing enterprises using cloud computing services. The sampling frame was the database of the Market Research and Analysis Centre and the sampling unit (and the statistical unit in the study) was the so-called legal unit (which is an approximate equivalent to an enterprise with all its branches) with the registered office and/or production plant based in the territory of the Republic of Poland.

In the first stage of the study, approx. 50,000 enterprises belonging to Section C – Industrial processing – were randomly selected according to the Polish Classification of Activities based on the size of the enterprise measured by the number of employees (four groups: microenterprises – employing 0–9 persons, small enterprises – with 10–49 employees, medium-sized enterprises – with 50–249 employees, and large enterprises – with more than 249 employees).

The realised sample size, i.e., the number of received, completed questionnaires was 400. The conducted quantitative research, on the one hand, made it possible to reach more business entities and ensure the degree of anonymity of the respondents (it was often a prerequisite for conducting the survey). On the other hand, there was a high degree of difficulty associated with completing the survey, e.g., partially filled questionnaires, and problems with the interpretation of some questions.

In order to assess the representativeness of the realised sample, a comparison of its structure with the structure of the population was carried out based on the following characteristics: company size (micro-SMEs) and location (the province according to its office address). The comparison results allowed us to regard the analysed sample as representative of the general population.

The analysis of benefits resulting from the use of cloud computing services presented in the next part of the paper will concern 277 micro-SMEs using these services. The sample surveyed was dominated by medium-sized enterprises with a 52.7% share, while small enterprises accounted for 29.2% and microenterprises for 18.1%. The spatial market structure of the surveyed SMEs was dominated by the international market (58.9% of the responses), followed by the domestic market (31.8% of the responses), the local market (the poviát in which the firm operates) (6.1% of the responses), and the regional market (the province in which the enterprise operates) with the smallest share of 4.0% (see Table 1). These results are surprising in the context of the specificity of SMEs, whose main markets are local and regional ones. In the sample, however, medium-sized manufacturing enterprises, whose market is usually the international market followed by the domestic one, have the largest share.

Table 1. The spatial range of market activity of the surveyed enterprises (%)

Range of activity	Company size			
	Micro	Small	Medium	Total
Local (poviat area)	22.0%	2.5%	2.7%	6.1%
Regional (province area)	6.0%	4.9%	2.7%	4.0%
Domestic	36.0%	39.5%	24.7%	31.0%
International	36.0%	53.1%	69.9%	58.9%
Total	100%	100%	100%	100%

Data for 277 enterprises.

Source: The authors' own compilation.

The capital structure of the surveyed small and medium-sized manufacturing enterprises was dominated by domestic capital (88.4% of the responses) (see Table 2). The analysis by company size shows that this type of capital dominated about 95.9% of microenterprises, 90.7% of small enterprises and 84.2% of medium-sized enterprises.

Table 2. The capital structure of the surveyed enterprises (%)

Capital structure	Company size			
	Micro	Small	Medium	Total
100% Polish capital	95.9%	88.0%	79.4%	85.2%
Dominance of Polish capital	0.0%	2.7%	4.8%	3.2%
Dominance of foreign capital	4.1%	2.7%	4.8%	4.0%
100% foreign capital	0.0%	6.6%	11.1%	7.6%
Total	100%	100%	100%	100%

Data for 277 enterprises.

Source: The authors' compilation.

3.2. Research results and conclusion

The aim of the conducted research was to identify and analyse benefits of using cloud computing solutions by small and medium-sized manufacturing enterprises in Poland. In the first stage of the analysis of the obtained research results, it was checked whether the assumption of the chi-square test was met, i.e., all the expected counts were greater than or equal to 5. Next, the test was applied to verify if there was a statistically significant relationship between the analysed variables, i.e., benefits resulting from the use of computing cloud solutions by an SME and its size measured by the number of employees. When examining the relationship between the variables, the following hypothesis was verified:

H_0 : the variables tested are independent

against the following alternative hypothesis:

H_1 : the variables are dependent.

The calculations carried out on this basis showed (see Table 3) that only in the case of four benefits analysed (8, 12, 14 and 16) H_0 should be rejected for H_1 , as the probability in the chi-square test was lower than the assumed level of $\alpha=0.05$; thus, the relationships were statistically significant. To check the strength of the dependence, the contingency coefficient (C) was calculated indicating the existence of a weak dependence between the analysed variables. On the other hand, in the case of the other analysed benefits, H_0 should be adopted, which indicates a lack of dependence between these benefits and the size of the enterprise measured by the number of employees.

Table 3. Values of statistics

Benefits resulting from computing cloud solutions	Chi-square statistic	Chi-square p-value	Contingency coefficient (C)
1. Lower operating costs (production-related)	1.288	0.525	-
2. Better adaptation to the expectations of customers and business partners	0.921	0.631	-
3. Better use of data for knowledge management	0.438	0.803	-
4. Development of new products and creation of innovations	1.359	0.507	-
5. Development of new business models	1.172	0.556	-
6. Better communication with the environment	0.694	0.707	-
7. Increased work efficiency	3.452	0.178	-
8. Reducing product time to market	6.323	0.042	0.151
9. Greater flexibility of products and services offered	1.010	0.603	-
10. Access to applications previously not available due to high costs	3.647	0.161	-
11. More efficient allocation of resources	2.749	0.253	-
12. Improving production preparation	9.976	0.007	0.190
13. Improving production processes	1.315	0.518	-
14. Improving quality management processes	7.955	0.019	0.169
15. Quick access to knowledge	2.798	0.247	-
16. Access to detailed data related to production processes	7.433	0.024	0.164

Data for 277 enterprises.

Source: The authors' compilation.

A detailed analysis of the benefits resulting from the use of cloud computing solutions by small and medium-sized manufacturing enterprises shows (see Table 4) that the most frequently indicated benefits include: better communication with the environment (63.5% of the responses), increased work efficiency (57% of the responses) and quick access to knowledge (56% of the responses). The least indicated benefits are: reducing product time to market (21.3% of the responses), development of new business models (22.7% of the responses) and greater flexibility of products and services offered (24.9% of the responses). The most frequently indicated benefits resulting from the use of computing cloud solutions by micro and small enterprises include: better communication with the environment (10.7% and 18.1% of the responses, respectively) and increased work efficiency (10.1% and 19.1% of the responses, respectively). Medium-sized enterprises also pointed to better communication with the environment (34.7% of the responses) and quick access to knowledge (31.4% of the responses). The results of the research provide only partially positive verification of the adopted research hypothesis about the existence of a relationship between benefits resulting from the use of computing cloud solutions by SMEs and their size measured by the number of employees, as only for 4 of the 16 benefits analysed (i.e., reducing product time to market, improving production preparation, improving quality management processes and access to detailed data related to production processes) there exists a statistically significant dependence between these variables, but it is very weak.

Table 4. Benefits resulting from the adoption of computing cloud solutions by the surveyed enterprises (%)

Benefits from the implementation of computing cloud solutions by the surveyed enterprises	Company size			
	Micro	Small	Medium	Total
Better communication with the environment	10.7%	18.1%	34.7%	63.5%
Increased work efficiency	10.1%	19.1%	27.8%	57.0%
Quick access to knowledge	8.3%	16.3%	31.4%	56.0%
Better use of data for knowledge management	9.7%	14.5%	25.6%	49.8%

Better adaptation to the expectations of customers and business partners	8.3%	11.6%	20.2%	40.1%
Lower operating costs (production-related)	6.5%	13.0%	19.9%	39.4%
More efficient allocation of resources	5.8%	10.1%	27.7%	38.6%
Access to applications previously not available due to high costs	6.9%	8.7%	22.3%	37.9%
Access to detailed data related to production processes	3.2%	10.5%	20.6%	34.3%
Improving quality management processes	3.2%	11.6%	13.7%	28.5%
Development of new products and creation of innovations	6.2%	7.2%	14.4%	27.8%
Improving production preparation	4.7%	11.9%	11.2%	27.8%
Improving production processes	5.1%	9.0%	12.6%	26.7%
Greater flexibility of products and services offered	5.4%	6.5%	13.0%	24.9%
Development of new business models	4.3%	5.4%	13.0%	22.7%
Reducing product time to market	6.1%	4.7%	10.5%	21.3%

Data for 277 enterprises.

Source: The authors' compilation.

4. Conclusion

Management of an SME operating in a changing environment often requires increasingly the implementation of appropriate solutions in the area of information technologies that allow, among others, to optimise and automate processes, support the decision-making process, facilitate cooperation with suppliers and provide value to the customer. Using cloud computing services by enterprises is undoubtedly one of such solutions. Based on the analysis of the literature and the current research, it can be concluded that SMEs are increasingly often using more or less advanced cloud solutions.

This was also confirmed by the authors' own research indicating that SMEs recognise benefits resulting from cloud computing solutions perceiving these solutions in terms of processes supporting business management. These entities usually use less advanced cloud solutions, such as email services, data collection and storage or instant messaging systems, facilitating communication with the environment, improving the flow of information and documents and supporting production processes. The use of cloud computing in SMEs also allows us to gain benefits in the area of human resources management, providing employees with flexibility of the place and time of work, contributing to the optimal planning and organisation of tasks, thereby increasing employee satisfaction and motivation.

In addition, the use of cloud computing services allows SMEs to save on investments in IT infrastructure, i.e., to avoid the purchase of expensive equipment and software, employment of specialists, ensuring security of collected data and provision of professional technical support and services, as these are supplied by the computing cloud provider.

A wide range of possibilities of using cloud computing, its scalability and availability via the Internet prove that it is a solution introducing new quality and new possibilities of managing SMEs.

In the opinion of the authors, further research should focus on the analysis of changes in business models of SMEs using cloud computing services.

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