Cloud Computing and Its Role in Enterprise Management and Innovation: Insights from Poland

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Abstract

Cloud computing (CC) plays a key role in the digital transformation of SMEs by providing flexible IT resources that support management and innovation. This study aimed to assess the impact of CC on innovation and management in over 400 Polish SMEs. The results show that CC particularly supports resource management in medium-sized and commercial enterprises and facilitates innovation in companies with higher profits, greater investments, and larger customer bases. Research limitations, such as the overrepresentation of certain industries, suggest caution in generalizing the findings. Nevertheless, CC emerges as a crucial factor for SME growth and competitiveness, indicating the need for further in-depth research.

Keywords: cloud computing, management, innovation, enterprise

1. Introduction

Modern information and communication technologies (ICT), particularly cloud computing (CC), are increasingly crucial for enterprise transformation, innovation, and efficient management. CC enables access to scalable IT resources such as applications, platforms, databases, and infrastructure services, supporting process automation, decision-making, and collaboration. In today's dynamic and uncertain market environment, CC by providing various IT solutions, can play a key role in enterprise management processes, enabling effective use of resources, flexible response to changes, developing new business models and maintaining competitiveness in the market [1-2]. Moreover, cloud computing creates an environment for the operation and integration of technologies such as ERP/BI systems, IoT, AI, Blockchain, Media Streaming, Data Science or E-commerce, can also become a stimulator of enterprise innovation, making it easier for them to enter new markets, generating new sources of revenue and improving return on investment. As a result, CC can provide new opportunities for implementing innovations (e.g., product, process, and organizational), especially in the SME sector, where access to technological and capital resources is often limited [3-4]. However, the scientific literature still lacks consistent and comprehensive insight into how CC influences enterprise innovation and management in practice.

To explore the role of cloud computing in supporting innovation and management, the authors conducted a study among over 400 small and medium-sized enterprises (SMEs) in Poland. The research focused on identifying how CC influences different types of innovation (product, process, organizational, marketing) and management aspects such as resource optimization, process improvement, and structural changes. The results offer insight into the conditions under which CC brings the most value to SMEs and highlight the importance of enterprise characteristics, such as size, industry, or investment level. These findings contribute to a better understanding of digital transformation processes in

SMEs and support further research and practical strategies for enhancing competitiveness through cloud adoption.

2. Literature review

The increased popularity and dynamic development of cloud computing have made it a key element of digital transformation, enabling enterprises to quickly adapt to changing market and technological conditions. Properly selected cloud computing solutions increase the efficiency and effectiveness of business processes and enterprises. Cloud computing (CC) is a collection of technological solutions (hardware, IT platforms, software, and related services) that enables flexible, scalable, and relatively low-cost access to IT resources on demand and via a network, regardless of the device or location [5]. Cloud computing generates many benefits for enterprises that can improve flexibility in adapting to the changing market situation, reduce operating costs, and enable faster and cheaper generation of innovations (e.g., e-services) [6] and through CC, enterprises gain quick and easy access to advanced, pay-for-time, flexible, and constantly developed IT solutions, which can constitute the basis for introducing innovative products/services or new operating methods [7]. Cloud computing can provide enterprises with IT solutions that enable them to quickly start and test new ideas, methods, and principles of operation, which creates the right climate for introducing innovations. Nowadays, the cloud is becoming a "launch platform" for most technological innovations, ultimately creating a competitive advantage for enterprises that use cloud computing. However, it should be emphasized that any IT solutions available in the cloud do not provide innovation on their own but can support it. In empirical studies, various relationships between cloud computing (CC) and innovativeness are analyzed [8-10], however, there is a lack of publications and research comprehensively addressing the impact of cloud computing on SME innovativeness.

Enterprises can use cloud technologies to create new needs, conquer a new market, attract a new customer segment, or create new revenue streams [11]. For enterprise managers, cloud computing provides solutions supporting the automation of processes (including decision-making processes), facilitating proactive management, and effective cooperation with partners and customers. In the topic of the impact of cloud computing on enterprise management, various studies have been conducted [12-14], yet broad analyses on how cloud computing influences SME management are still missing.

3. The Methodology

The article aims to examine the impact of cloud computing solutions on supporting business management and to determine its role in creating the innovative potential of enterprises. For this purpose, it is necessary to ask research questions:

RQ1- How do individual types of enterprises assess the impact of cloud computing on innovation?

RQ2 - In which aspects of innovative enterprise activity is the most significant impact on cloud computing?

RQ3 - How do individual types of enterprises assess the impact of cloud computing on management?

RQ4 - In which aspects of enterprise management is the most significant impact of cloud computing?

To assess the impact of cloud computing (CC) on innovation potential and management support, a study was conducted in October 2023 among Polish SMEs using cloud solutions. A random sampling method ensured representativeness, with data collected mainly via CAWI (Computer Assisted Web Interview). Respondents included department managers, IT staff, top management, and specialists. The minimum sample size was calculated using a standard formula for estimating population structure with a required accuracy, yielding a threshold of 384 completed questionnaires. With 409 valid responses obtained, the sample meets representativeness criteria. The survey [15] covered 409 firms: 231 small (56%) and

178 medium-sized (44%). Given that transport, warehousing, and trade sectors represent over half the sample, subsequent non-parametric analyses focus on these two industries.

The collected primary data were analyzed using statistical methods. First, responses regarding the company's situation were examined. Ordered logistic regression was applied to identify the impact of cloud computing on innovation and company management.

Table 1 presents the description, symbols, types, and main values of descriptive statistics of all variables used in the logistic regression model. Both types of variables, dependent and independent, were measured using a 5-point Likert scale ("5" means "significant increase", "1" means "not at all").

Table 1. Descriptive statistics

Description	Label	Type		Mean	S.E.*	M*	D*	S.D.*	SD^2	Skewness	Kurtosis
Independent variables											
Enterprise profit	x_1	Likert scale (1–5)		4,007	0,415	3,0	3,0	8,440	71,243	11,478	131,59
Number of clients	x_2	Likert scale (1–5)		3,602	0,241	3,0	3,0	4,890	23,912	19,409	387,45
Capital expenditure	x_3	Likert scale (1–5)		3,314	0,245	3,0	3,0	4,973	24,734	18,611	366,267
Expenditures on innovative activities	x_4	Likert scale (1–5)		3,590	0,243	3,0	3,0	4,933	24,335	18,910	374,194
Number of innovations implemented	x_5	Likert scale (1–5)		3,736	0,243	3,0	3,0	4,925	24,262	18,906	374,174
Competitiveness	x_6	Likert scale (1–5)		3,592	0,242	3,0	3,0	4,906	24,075	19,212	382,333
Market share	x_7	Likert scale (1–5)		3,519	0,242	3,0	3,0	4,907	24,083	19,247	383,228
Dependent variables											
Management											
Managing your resources	y_1	Likert scale (1–5)		3,148	0,423	2,0	1,0	8,590	73,800	11,172	126,883
Business process management	y_2	Likert scale (1–5)		3,287	0,249	3,0	1,0	5,047	25,481	17,805	345,315
Remodeling of management processes	y_3	Likert scale (1–5)		3,734	0,243	4,0	4,0	4,928	24,288	18,873	373,417
Changing the operating model on the market	y_4	Likert scale (1–5)		3,012	0,248	3,0	3,0	5,040	25,410	18,037	351,235
Innovation											
Product innovation	z_1	Likert scale (1–5)		3,929	0,419	4,0	4,0	0,419	72,605	11,176	127,000
Process/technology innovation	z_2	Likert scale (1–5)		3,458	0,244	3,0	3,0	0,244	24,503	18,783	371,064
Organizational innovation	z_3	Likert scale (1–5)		3,512	0,247	3,0	3,0	0,247	25,199	17,981	349,912
Marketing innovation	z_4	Likert scale (1–5)		3,021	0,250	3,0	1,0	0,250	25,708	17,715	342,936

*S.E. – Standard Error, M – Median, D – Dominant, SD – Standard Deviation

To provide a clearer understanding of the research objectives and to guide the analysis of cloud computing's impact on business innovation and management, the research model was developed (fig.1).

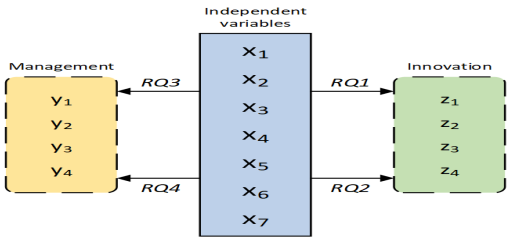

Fig. 1. Research model

Quantitative statistical methods were used to analyze the acquired primary data: Cronbach's alpha coefficient (to check the internal consistency of the scales used); Kaiser-Meyer-Olkin (KMO) and Bartlett tests of sphericity (to assess the adequacy of the sample for all variables); Kendall's tau-b rank coefficient (to identify existing correlations); non-parametric U'Mann-Whitney test (to compare two groups) and ordered logistic regression

model (to analyze the influence of independent variables on dependent variables). Each of these methods enables reliable and accurate data analysis and guarantees reliable conclusions on the impact of cloud computing on the management and innovation of enterprises.

4. The Results

4.1. The Reliability Analysis

The results presented in table 2 indicate that the Alpha Cronbach coefficient is acceptable, which means high internal consistency of the scale. The KMO test results were 0.495 and 0.498, and Bartlett's test of sphericity confirmed the reliability of the research tool used (1409.652 and 546.757).

Table 2. The Reliability Analysis results

Variables	Cronbach's Alpha	KMO Test	Bartlett's Test
Independent	0,994	0,495	1409,652*
Dependent	0,991	0,498	564,757*

*p-value < 0,001

All obtained values for the tests performed confirmed the high internal consistency of the scale and the reliability of the research tool used.

4.2. Correlation Analysis

Table 3. The correlation analysis results

Variables	x_1	x_2	x_3	x_4	x_5	x_6	x_7
x_1	**1**	-0,004	-0,042	-0,078	0,055	-0,017	-0,045
x_2	-0,004	**1**	0,2	0,145	-0,052	-0,055	-0,045
x_3	-0,042	0,2	**1**	0,564	-0,024	-0,007	-0,005
x_4	-0,078	0,145	0,564	**1**	-0,1	0,015	0,038
x_5	0,055	-0,052	-0,024	-0,1	**1**	0,045	0,074
x_6	-0,017	-0,055	-0,007	0,015	0,045	**1**	0,905
x_7	-0,045	-0,045	-0,005	0,038	0,074	0,905	**1**
z_1	0,019	-0,028	0,02	0,045	-0,008	0,003	0,025
z_2	-0,005	0,013	-0,033	0,003	0,021	-0,008	0,02
z_3	-0,006	0,004	0,057	0,06	0	0,058	0,027
z_4	0,029	0,011	0,096	0,108	-0,033	0,02	-0,018
y_1	0,157	-0,023	0,003	0,013	0,088	-0,092	-0,087
y_2	0,057	-0,027	0,05	0,05	0,004	0,075	0,09
y_3	-0,017	0,06	0,123	0,072	-0,039	-0,016	0,006
y_4	0,2	0,002	-0,035	0,034	-0,064	-0,052	-0,032

Variables	z_1	z_2	z_3	z_4	y_1	y_2	y_3	y_4
x_1	0,019	-0,005	-0,006	0,029	0,157	0,057	-0,017	0,2
x_2	-0,028	0,013	0,004	0,011	-0,023	-0,027	0,06	0,002
x_3	0,02	-0,033	0,057	0,096	0,003	0,05	0,123	-0,035
x_4	0,045	0,003	0,06	0,108	0,013	0,05	0,072	0,034
x_5	-0,008	0,021	0	-0,033	0,088	0,004	-0,039	-0,064
x_6	0,003	-0,008	0,058	0,02	-0,092	0,075	-0,016	-0,052
x_7	0,025	0,02	0,027	-0,018	-0,087	0,09	0,006	-0,032
z_1	**1**	0,489	0,003	-0,018	0,018	0,031	-0,025	0,058
z_2	0,489	**1**	0,03	-0,006	-0,026	0,039	-0,06	0,032
z_3	0,003	0,03	**1**	0,589	-0,013	0,028	0,039	0,029
z_4	-0,018	-0,006	0,589	**1**	0,016	0,007	0,063	0,016
y_1	0,018	-0,026	-0,013	0,016	**1**	-0,005	-0,008	0,197
y_2	0,031	0,039	0,028	0,007	-0,005	**1**	0,365	0,021
y_3	-0,025	-0,06	0,039	0,063	-0,008	0,365	**1**	-0,07
y_4	0,058	0,032	0,029	0,016	0,197	0,021	-0,07	**1**

Kendall's tau-b coefficient was used to examine the correlation between all variables. As table 3 shows, there are statistically significant correlations between the dependent and independent variables. There are weak correlations between:

- company's profit and expenditure on innovative activities (-0.078), management of available resources (0.157), and change of the operating model on the market (0.200);
- number of customers and investment outlays (0.200), and operating outlays (0.145);
- investment outlays and remodeling of management processes (0.123) and marketing innovation (0.096);
- expenditure on innovative activities and the number of implemented innovations (-0.100), remodeling of management processes (0.072), and marketing innovation (0.108);
- the number of implemented innovations and market share (0.074) and management of available resources (0.088);
- competitiveness and resource management (-0.092) and business process management (0.075);
- market share and resource management (-0.087) and business process management (0.090);
- remodeling of management processes and changing the operating model on the market (-0.070).

Slightly stronger correlations occur between:

- management of resources and changing the operating model on the market (0.197);
- business process management and remodeling of management processes (0.365).

However, strong correlations occur between:

- investment outlays and outlays on innovative activities (0.564);
- competitiveness and market share (0.905);
- product innovation and process/technology innovation (0.489);
- organizational innovation and marketing innovation (0.598);

4.3. U'Mann-Whitney test results

The U'Mann-Whitney test was used to check whether there were significant differences in the dependent variables for two independent groups. In the first step, it was checked whether there were significant differences in the perception of the impact of CC on the company's innovation. In the second step, it was checked whether there were significant differences in the perception of the influence of CC on enterprise management. The companies were analyzed in terms of their business profile and size. The first group compared companies operating in the transport, storage, and trade industries. The second group included a comparison between small and medium-sized enterprises. The obtained results are presented in table 4.

Table 4. The U'Mann-Whitney test results

Transport&Warehouse / Trade							
Variables	**U**	**Z**	**p**	**Variables**	**U**	**Z**	**p**
z_1	7469,500	-1,10511	0,269	y_1	6495,000	-2,71849	0,006
z_2	7560,500	-0,95445	0,339	y_2	7957,500	0,29718	0,766
z_3	7899,500	-0,39320	0,694	y_3	7851,500	0,47267	0,636
z_4	8004,000	-0,22019	0,825	y_4	8039,500	-0,16142	0,871
Small / Medium							
z_1	18929,50	-1,37437	0,169	y_1	16672,00	-3,27900	0,001
z_2	19349,00	-1,02044	0,307	y_2	20255,50	0,25564	0,798
z_3	20416,00	0,12023	0,904	y_3	19337,50	1,03015	0,302
z_4	20269,50	0,24383	0,807	y_4	19642,50	-0,77282	0,439

Based on the results obtained, it can only be concluded that in only two cases, there were significant differences - commercial enterprises (Z=-2,71849, p=0,006) and medium-sized enterprises (Z=-3,27900, p=0,001) significantly more often indicated the impact of CC on enterprise management, especially in the aspect of managing their resources. In the remaining cases, no significant statistical differences were identified, so it can be assumed

that enterprises operating in the transport and storage industry, as well as commercial enterprises, as well as small and medium-sized enterprises do not show significant differences in the perception of the impact of CC on innovation and enterprise management.

4.4. Ordered logistic regression results

In the last stage of the research, analyses were carried out to determine the impact of independent variables on selected dependent variables. For this purpose, ordered logistics regression was used. Table 5 presents the results of the analyses carried out, enabling the determination of the influence of dependent variables on enterprise management.

Table 5. The results of logistics regression for the first group of dependent variables

Variables	Symbols	y_1		y_2		y_3		y_4	
		Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Enterprise profit	x_1	0,473	0,623	-1,427	0,635	-1,299	0,644	-0,040	0,521
Number of clients	x_2	0,663	0,620	0,158	0,663	-0,331	0,711	-0,367	0,559
Capital expenditure	x_3	-0,599	0,430	0,273	0,408	-1,276	0,474	0,056	0,353
Expenditures on innovative activities	x_4	-1,223	0,541	0,479	0,485	-1,041	0,569	0,006	0,402
Number of innovations implemented	x_5	-0,222	0,486	0,391	0,492	-1,307	0,609	1,127	0,462
Competitiveness	x_6	0,393	0,577	-0,008	0,398	-0,658	0,598	0,651	0,494
Market share	x_7	0,299	0,573	-0,019	0,598	-0,456	0,588	0,605	0,491

Analyzing the above results, it is visible that:

- Enterprises with higher profits, a more significant number of customers, and an increase in the number of implemented innovations more often indicated that CC influenced company management in improving business process management (-1,427, 0,635), among others. By optimizing, automating, and accelerating existing main and supporting processes;
- Enterprises with higher profits indicated significantly more often that CC influenced the management of the enterprise in terms of significant structural changes and remodeling of existing management processes (-1,299, 0,644), e.g., including not only significant changes in the organizational structure and business processes but also modification of the principles of cooperation with business partners;
- Enterprises with higher capital expenditure indicated significantly more often that CC influenced the management of the enterprise in terms of significant structural changes and remodeling of existing management processes (-1,276, 0,474), e.g., including not only significant changes in the organizational structure and business processes but also modification of the principles of cooperation with business partners;
- Enterprises incurring increased expenditure on innovative activities significantly more often indicated that CC influenced the management of the enterprise in terms of better management of resources (-1,223, 0,541), including through better use of human, material, and intangible resources, which increased the effectiveness of undertaken activities and investments;
- Enterprises recording an increase in the number of implemented innovations significantly more often indicated that CC influenced the management of the enterprise in terms of changing the model of operation on the market (-1,307, 0.609), e.g., changing the industry of activity, focusing on activities in the Internet space, entering this market or transforming the enterprise into an organization network or virtual. They also indicated significantly more often that CC influenced the change of the operating model in the market (1,127, 0,462).

In the remaining cases, no significant relationships were identified, indicating the influence of independent variables on dependent variables.

Table 6 presents the results of the analyses and it is visible that:

- Enterprises with higher profits indicated significantly more often that CC influenced innovation in terms of product (development of a new product/service, improvement, differentiation of products/services) (5,260, 0,859), process/technology (change in existing

production processes, introduction of new production methods, provision of services or distribution methods) (1,497, 0,667) and organizational (implementation of new organizational methods) (1,405, 0,690);

Table 6. The results of logistics regression for the second group of dependent variables

Variables	Symbols	z_1		z_2		z_3		z_4	
		Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Enterprise profit	x_1	5,260	0,859	1,497	0,667	1,405	0,690	0,890	0,117
Number of clients	x_2	1,216	0,665	1,919	0,694	-0,085	0,671	-0,360	0,583
Capital expenditure	x_3	0,712	0,456	0,946	0,429	-0,562	0,464	-0,372	0,382
Expenditures on innovative activities	x_4	0,494	0,545	0,962	0,526	-0,027	0,557	-0,812	0,451
Number of innovations implemented	x_5	0,347	0,534	1,861	0,558	1,270	0,593	0,112	0,488
Competitiveness	x_6	1,238	0,697	0,835	0,584	1,039	0,674	-0,187	0,546
Market share	x_7	0,858	0,670	0,563	0,578	0,835	0,662	-0,190	0,542

- Enterprises with a more significant number of customers, increased investment outlays, and an increase in the number of implemented innovations significantly more often indicated that CC influenced process/technological innovation (change in existing production processes, introduction of new production methods, provision of services or distribution methods) (1,919, 0,694);
- Enterprises with a higher capital expenditure more often indicated that CC influenced process/technological innovation (change in existing production processes, introduction of new production methods, provision of services or distribution methods) (0,946, 0,429)
- Enterprises recording an increase in the number of implemented innovations significantly more often indicated that CC influenced innovation in terms of process/technology (change in existing production processes, introduction of new production methods, provision of services or distribution methods) (1,861, 0,558) and organizational (implementation of new organizational methods) (1,270, 0,593).

In the remaining cases, no significant relationships were identified, suggesting that the independent variables do not have a substantial influence on the dependent variables.

5. Conclusions and Discussion

This study affirms that cloud computing (CC) plays a pivotal role in enhancing innovation and management capabilities, particularly within small and medium-sized enterprises (SMEs). Globally, research consistently identifies CC as a driver of resource flexibility, operational scalability, and innovation potential. Studies conducted by [16] and [17] highlight its contributions to digital transformation, improved process efficiency, and support for innovation across organizational functions. Furthermore, studies realized by [18] and [19] highlight the crucial role of cloud platforms in facilitating inter-organizational collaboration and driving innovation, particularly when combined with AI and IoT. Yet, as caution, the effectiveness of CC relies heavily on a firm's digital maturity and adaptive capabilities [20].

Findings from Polish SMEs support these global observations. Cloud computing notably enhances resource management in medium-sized and large firms, driving innovation—especially in product, process, and organizational forms—in businesses with higher profits, more customers, and greater investment levels. However, the influence of CC was less pronounced in firms lacking these attributes.

Nonetheless, this study has limitations. The overrepresentation of transport, warehousing, and trade sectors could limit the generalizability of results, and some sampling bias may persist despite the use of random selection. Statistical analyses suggest that CC's perceived benefits are closely linked to firm-specific characteristics such as profitability and investment capacity. To fully understand CC's strategic value for SMEs, future research should employ broader and more diverse industry samples, as well as more refined analytical methods. Ultimately, the success of CC adoption hinges not only on the availability of cloud solutions but also on an enterprise's ability to adapt, innovate, and strategically apply these tools to meet evolving market demands.

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