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## THE BARRIERS AND BENEFITS OF IMPLEMENTING CLOUD COMPUTING IN ECONOMIC ORGANIZATIONS

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## BARIERY I KORZYŚCI ZWIĄZANE Z IMPLEMENTACJĄ CHMURY OBLICZENIOWEJ W ORGANIZACJACH GOSPODARCZYCH

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**Summary:** Information management in all types of organizations is nowadays directly connected with IT technologies implementation. Enterprises presently operating in global economy conditions are forced to take actions that increase their competitiveness and decrease the cost related to financing secondary activities, among others the functioning of IT departments. The dynamic development of cloud computing and services available in this model now constitutes an alternative for processing, storing and distributing information. The article presents selected aspects of the current stage of cloud computing development, possibilities of applying its services in economic organizations, with a particular consideration of the barriers and benefits that influence its implementation. Research concerning these features has been presented with the use of a new model of information management in enterprises in Poland and throughout the world.

**Keywords:** cloud computing, economic organization, IT technologies, data, information.

**Streszczenie:** Zarządzanie informacją w każdego typu organizacji jest obecnie nierozdzielnie związane z używaniem technologii informatycznych. Przedsiębiorstwa, działające obecnie w warunkach gospodarki globalnej zmuszone są do podejmowania działań zwiększających ich konkurencyjność oraz obniżających koszty związane z finansowaniem działalności pobocznych, między innymi funkcjonowania działów IT. Dynamiczny rozwój chmury obliczeniowej i dostępne w tym modelu usługi stanowią obecnie alternatywę obsługującą procesy przetwarzania, magazynowania i dystrybuowania informacji. W artykule przedstawiono wybrane aspekty obecnego stanu rozwoju chmury obliczeniowej, możliwości implementacji jej usług w organizacjach gospodarczych, ze szczególnym uwzględnieniem barier i korzyści decydujących o jej wdrożeniu. Zaprezentowano badania dotyczące tych cech z wykorzystaniem nowego modelu zarządzania informacją w przedsiębiorstwach w Polsce i na świecie.

**Słowa kluczowe:** chmura obliczeniowa, organizacja gospodarcza, technologie informatyczne, dane, informacja.

## 1. Introduction

The development of IT technologies creates the behaviour of today's enterprises on the economic market. The evolution of informatic tools is changing the way of processing, storing and distributing information. D. Jelonek and T. Turek stress the fact that knowledge and information and communication technologies contribute most to competitiveness increase. Managers who can make use of the available information, select and thus identify the most significant threats, are able to make a proper decision and save the organization from the influence of unfavourable risk [Jelonek, Turek (eds.) 2013, p. 5; Bogucka 2015, p. 167]. Appropriately selected and up-to-date information is currently a key factor that conditions the competitiveness of enterprises [Kisielnicki 2015, p. 16]. Therefore enterprises, regardless of their trade and size, strive at the creation of the most effective infrastructure for information management. The process of improving the IT infrastructure is a continuous one. This results from the dynamics of new technologies development and leads to discussions concerning the financial profitability of investments into the IT area, as a continuous implementation of the latest solutions in this respect constitutes a serious burden to the budgets of functioning organizations.

An alternative to the necessity of the constant improvement of the possessed IT infrastructure that has been undergoing a very dynamic development in recent years is cloud computing. This solution changes completely the approach to IT resources utilization as this model promotes "hiring" the computing power and application solutions with the use of the Internet. The issue of IT infrastructure improvement is the responsibility of the service provider and the customer, an entrepreneur who needs to implement specific solutions, can access them through the global network paying a subscription just as in the case of the telephone or other media.

The dynamic development of cloud computing services and the attractive financial terms of the payment model encourage more and more enterprises to migrate their IT resources into this model of information processing. The most important factors that influence the decisions of entrepreneurs to utilize this model include: the will to increase the company's competitiveness, reducing the IT costs, the possibility to administer servers in the cloud, simplicity in introducing new products and the possibility to change flexibly the work parameters of particular elements of the IT environment<sup>1</sup>. This paper aims at presenting the current state of cloud computing development, describing the barriers and benefits of implementing

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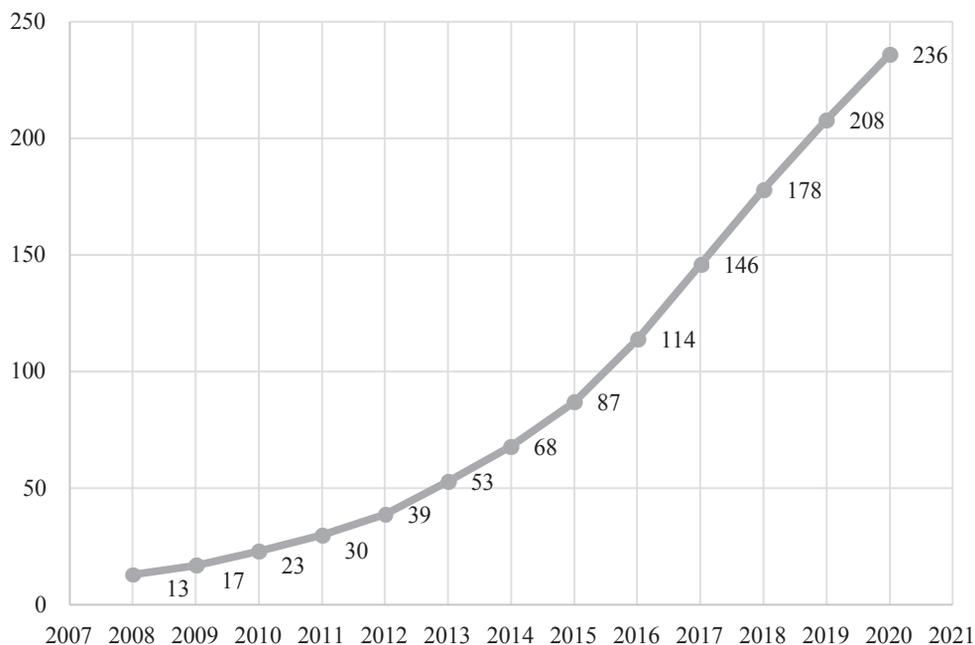
<sup>1</sup> Results of the research conducted in 2016 by e24cloud. The whole research was published in the report [Raport e24cloud].

its services in enterprises. The authors also include in it the results of the latest research concerning various aspects of the functioning of cloud computing. The presented research is a continuation, the first part of it was conducted by the research agency PMR Consulting & Research (Figure 2) in 2016 and the second part was conducted by “Computerworld” in cooperation with Google and ITMAGINATION (Figures 3 and 4).

## 2. General characteristics of cloud computing

The origins of cloud computing date back to the 1960s. It was then that the American scientist John McCarthy stated that soon all the processes carried out with the use of computers and connected with their computing power utilization would be made available to the public. The mainframe computers functioning at that time constituted the nucleus of making computing power available by means of computer networks. However, cloud computing nowadays has evolved to its present state practically since the 1990s. Its beginning accompanied the popularization of the HTTP protocol (Hypertext Transfer Protocol) used to send hypertext documents in the WWW (World Wide Web) network. The term “Cloud Computing” was used for the first time in 1997 by Ramnath Chellapp during the lecture “Intermediaries in Cloud-Computing: A New Computing Paradigm” given at the “INFORMS meeting” in Dallas [Parys 2015, p. 799]. At the end of the 1990s a rapid and uncontrolled development of electronic business occurred, which was based mainly on the Internet [Chmielarz 2007, p. 35].

Particular elements of the developed later infrastructure of the cloud, were made available to the users in the form of: electronic mail, chats on Internet portals, virtual servers and hostings, constituted the first commercial services functioning on the virtual market. The development of hardware and software network technologies allowed for the creation and implementation of more and more advanced solutions. After the Amazon Web Service (AWS) was launched in 2006, followed by the introduction of the user-open API (Application Programming Interface), the further development of the cloud occurred. Amazon, through modernizing its data centres and improving the architecture, significantly changed for the better the quality of its customer service and the efficiency of the conducted activities. Next, open-source platforms for private clouds creation appeared. The first one of them was Eucalyptus, fully compatible with the API platform of the AWS. Thanks to the support of the European Commission, OpenNebula was created [Szmit 2012, p. 4]. In the following years their products in cloud computing were made available by Google and Microsoft, and the biggest software producers followed in their footsteps. Figure 1 presents the total revenues generated by the cloud computing services market in the world [Robinson 2017]. The data was presented by the research and consultancy company Forrester Research, Inc. The report was published in 2016. The values since that year are projected ones.



**Fig. 1.** Total revenues from cloud computing (US\$ billions)

Source: [Robinson 2017].

At present the following models of cloud computing model can be distinguished [Mell, Grance 2011, p. 2; Kiełtyka, Kobis 2013, p.14]:

- IaaS (Infrastructure as a Service) – the model in which the service provider makes available computer hardware to entrepreneurs in the form of scalable server resources, or allows for using the computing power of processors. The service recipients install all the indispensable software necessary to start the applications on their own.
- PaaS (Platform as a Service) – is the IaaS model extended with the system environment fitted with a software development platform that allows software development. Users can install their own applications and software solutions and also create their own applications based on the provided software development environment.
- SaaS (Software as a Service) – is currently the most advanced cloud computing environment. Users only manage their data; hardware, operating systems and application are controlled and managed by the service provider. The model provides ready-to-use applications, being the equivalent of desktop ones. A great majority of services that are currently offered on the market make use of the SaaS model [Subashini, Kavitha 2011, p. 3].

Apart from the three abovementioned models there are currently functioning models that constitute environments adjusted to specific economic activity. These models are based on the three mentioned ones, being their variations. They include, for example BPaaS (Business Process as a Service) – the environment for companies that seek for resources to increase their flexibility and decrease financial processes costs; CCaaS (Contact Center as a Service) – the environment that provides a complete infrastructure for call centres services without the need to incur multi-million investments as it takes place in the case of “on site” implementations, and others.

Except for the models that differentiate services with respect to the number of offered products, a division can also be distinguished with reference to the place where data is stored by the service provider. Four basic models can be distinguished here, which include [Mell, Grance 2011, p. 3; Kiełtyka, Kobis 2013, p. 14]:

- Public cloud model – where the service recipients store their data in some unknown location. Servers responsible for storing and processing data can be located within the territory of a given country, continent or wherever in the world (depending on the economic entity rendering services).
- Private cloud model – where servers and software are physically present in the territory controlled by the service recipient. In this model, service recipients have direct access to the informatic infrastructure of the cloud.
- Hybrid cloud model – is the model that combines the previously mentioned ones. A part of data (e.g. less valuable) is stored in the public cloud, and a part (e.g. personal data) is stored in the private cloud.
- Dedicated cloud model – is a certain variation of the public cloud. It consists in a part of the cloud distinguished by the service provider (distinguished servers), which can be accessed only by the given customer (e.g. a state administration office).

### **3. Factors influencing the change of information management model**

The decision on the manner of modernising the existing IT infrastructure in an economic entity and the selection of a suitable model of the cloud is conditioned by several factors:

- present technical condition of the possessed IT and communication infrastructure,
- complexity level of utilized software,
- sensitivity level of processed personal data,
- enterprise size.

Those economic entities that have existed on the market for several years or several decades usually possess a precisely developed information processing policy that is supported by the IT infrastructure developed over many years. The

financial and design investments into the information management infrastructure conducted over the years do not always correlate with the need of a sudden rejection of the possessed resources for the sake of the total reorganization of the manner in which informatic tools are utilized. Enterprises that possess an efficient and modern infrastructure will aim to amortise the incurred expenditures. The situation is different in the case of enterprises that face the necessity to modernise the technological infrastructure. These entities demonstrate a greater will to make use of cloud computing, particularly in cases where the investment profitability analysis confirms incurring the lower costs of IT resources modernisation.

Another equally important factor is the analysis of the possessed software. Despite the constantly growing portfolio of available applications, many enterprises make use of solutions whose functionality outgrows the abilities of their cloud equivalents or simply is not available in the cloud. This concerns in particular large enterprises and corporations that use dedicated solutions, which were configured in the past especially to meet the needs of the activity conducted by them. Migration of the resources into the cloud is only possible if a similarly functional software solution occurs, which is based on a compatible database engine that allows for the smooth transfer of physical data. The multitude of applications being used by economic entities also creates the condition for the hybrid cloud computing model application, where only a part of the resources is virtualized, and a part remains in the previous stationary form. However, the existence of such a model is conditioned by the possibility of a flexible exchange of data between the cloud applications and the ones operating locally in the client-server model.

A very important factor is also the type of processed data. According to the legislative measures in force, personal data, and sensitive data in particular, has to have ensured defined security levels against unauthorised access [Catteddu 2010, p. 17]. The selection of a given model of the cloud should in such a case be precisely defined, so the guarantees provided by the service provider meet at least the minimal requirements in this respect imposed by the appropriate laws.

The last factor that significantly influences the choice of the solution is the size of the enterprise. This concerns two aspects:

1. Amount of processed data.
2. Flexibility in the scope of changing the information management manner.

Large enterprises and corporations when deciding to change the model of IT departments functioning have to consider all the possible reasons of failure that can occur. An emergency plan has to be developed in case the cloud does not function properly. The amount of transferred data causes that operations of this type generate long transitional periods, in which enterprises have to function in a “normal” way. Limited access to any information resources in this period may result in serious losses. The SME sector enterprises have a relative freedom of operations in this respect. A relatively lower number of utilized applications and information resources

allows for the quick migration of data and possibly a quick reaction in cases of a failure. These enterprises are characterized by a high flexibility of operation.

#### **4. Possibilities of cloud computing application in enterprises**

In 2016, the researched group of 74 917 enterprises employing 10 and more persons was dominated by small entities, i.e. with the number of employees fewer than 50 persons (75.1%). The group of medium entities with the number of employees between 50 and 249 comprised 20.2% of entities. The smallest group constituted large enterprises with the number of employees more than 249 persons (4.7% of the total number of enterprises) [Główny Urząd Statystyczny].

Medium, small and micro entities most easily adjust themselves at many levels of actions to the economic environment. This is primarily connected with the low level of complexity with reference to the processed information model. These enterprises, while processing relatively small amounts of data (compared with large entities) use for these purposes solutions of a relatively low level of complexity. The most numerous group of the SME sector enterprises is constituted by micro-enterprises. They are a core element of all economies and it is generally considered that they are most flexible and adaptive among those available to organizations. The influence of micro-enterprises in the whole economy is growing. Small enterprises and micro-enterprises in particular frequently act as incubators for future economic giants [Werber, Žnidaršič 2013, p. 97].

The main needs that determine the scope of IT technology application in the SME sector enterprises include:

- generating office documents,
- invoicing, issuing VAT invoices and other sales documents,
- contact with customers,
- employee mobility,
- marketing actions.

The basic software that functions in practically every economic organization is the so-called office software. This is also one of the first solutions that function within the SaaS (Software as a Service) model, available in versions both for individual users as well as enterprises. The most popular solutions in this area include: Office 365, Google Apps, Zoho. At the time when the BYOD (Bring On You Own Devices) trend is gaining popularity, these applications are adjusted to work on any hardware platform [*Chmura – aplikacje internetowe...*]. Thanks to the function of accessing software via an Internet browser, these applications are practically adjusted to work in any operating system, which in practice allows, for example, to edit a spreadsheet on a smartphone with Android or any other system. Additionally, mechanisms implemented in contemporary SaaS solutions enable group work with documents. All the documents generated by an enterprise are placed on virtual disks that can be accessed only by persons granted a defined level of encrypted access. Editing

documents can take place at a simultaneous participation of a practically unlimited number of users connected to the “cloud” system, regardless of their location, on any device connected to the global network – the Internet. A similar scenario is impossible to implement in a traditional, stationary version of an office package.

In the case of SME entrepreneurs, particularly small companies and self-employed persons, having a constant unlimited access to the IT infrastructure has also its advantages in cases where specialist applications are used. Such software is for example software supporting accounting processes, including the issuance of sales documents. At present there are numerous solutions of this type functioning within the SaaS cloud model. On the Polish market the following applications can be distinguished: wFirma, iFirma, Comarch Cloud and others. By applying the abovementioned solutions, the owners and the employees of companies are able to generate documents for their customers and contractors anywhere in the world if only access to the Internet is possible. Similarly to office applications the database is available online.

A vital factor from the enterprise’s perspective is the possibility of unlimited contact with the customer. Mobility in this scope is nowadays a natural phenomenon. Mobile telephones offer practically unlimited possibilities of communication. Applications available in cloud computing supplement this offer. Mobile clients of electronic mail, website live chat systems enable the freedom of enterprise’s customers servicing without the necessity to be physically present at the company’s location.

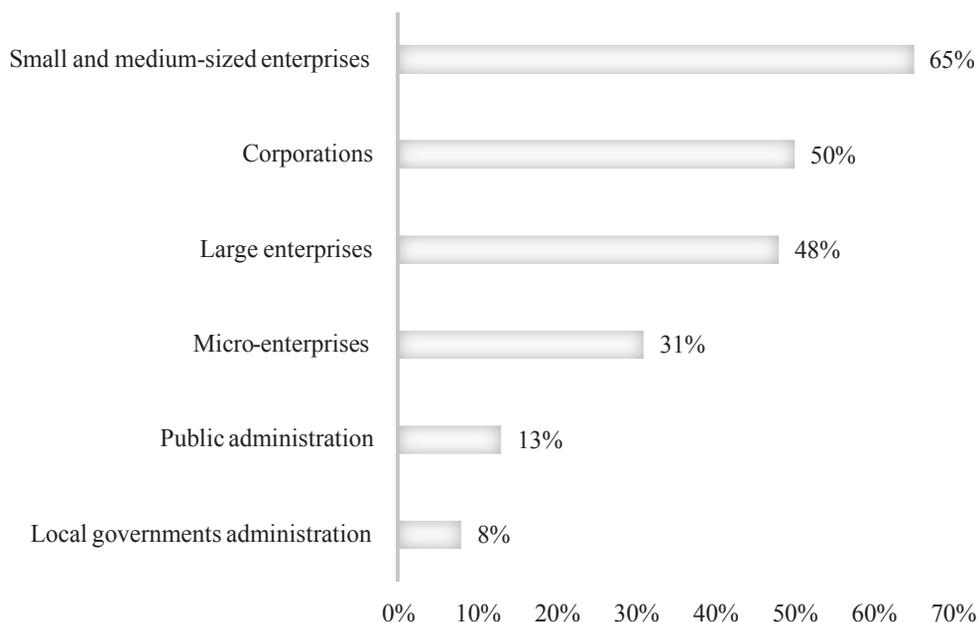
Any enterprise presently functioning on the economic market is forced to conduct marketing activities in order to acquire clients and business partners. In the case of large entities or corporations these activities are performed by dedicated marketing departments or hired advertising agencies, which comprehensively carry out the entrusted tasks. In the case of small and micro enterprises, these actions are performed by the owners or the employees. The presently available tools that function in the cloud allow for the effective promotion of the activity without possessing specialist knowledge in this respect. Virtual instruments such as: Google AdWords, Google Analytics, Facebook Ads, Content Marketing include advanced tools which enable to reach a precisely determined group of customers. Thus, cloud computing offers unlimited possibilities of brand promotion at a relatively low cost of service without the necessity to employ outsourcing companies.

## **5. Research on barriers and benefits of cloud computing application in enterprises in Poland and in the world**

The utilization of the tools offered by cloud computing is still relatively low in Poland and as results from the data by the Central Statistics Office (October 2017): only 10% of the total number of Polish enterprises make use of such solutions nowa-

days. The largest number of implementations concerns large economic entities (37.1% of the total number). In the case of medium-sized enterprises it is 17.2% of the total number. The lowest number of cloud solutions implementations was recorded among small enterprises (7.6%) [Ofiakowski 2017].

However, the development of the cloud computing market services in Poland grew in Poland by over 25% compared to 2015. The value of the cloud computing market in Poland in 2016 amounted to USD 160 million [Jadczak 2017], and the projected value at the end of 2017 amounts to USD 200 million. According to the report by PMR [Raport PMR, 2016], one of the most important trends in IT outsourcing in Poland in the coming years will be the implementation of cloud computing solutions. The research shows that the SME sector represents the group that is most interested in implementing cloud computing solutions (Figure 2). The research was conducted on the basis of interviews among 111 IT suppliers in Poland who offer cloud computing services. The least interested group are local governments and public administration (respectively 8% and 13% of those indicated). Thus, it can be concluded that implementing new solutions is the goal of those organizations that want to increase their competitiveness on the economic market and optimize the costs they incur to maintain the IT infrastructure.

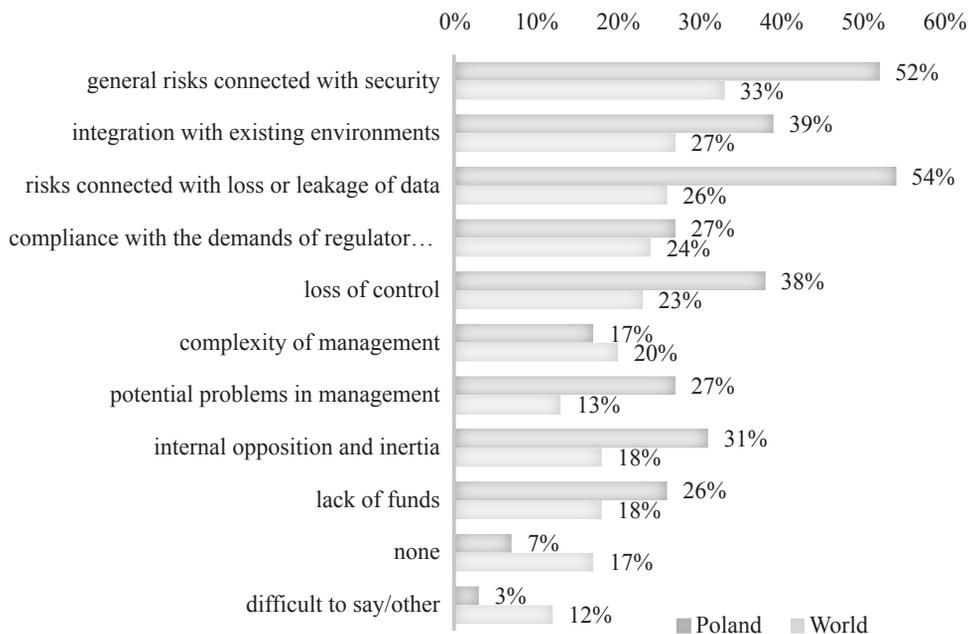


**Fig. 2.** Entities interested in Cloud Computing services in 2016-2017 in Poland (forecasts of the respondents), 2016 (based on interviews with 111 IT providers in Poland offering cloud computing services)

Source: [Raport PMR 2016].

An interesting research was conducted in 2017 by “Computerworld” in cooperation with Google and ITMAGINATION. One of the assumptions of this research was to compare the specificity of the Polish cloud market with its foreign equivalents. With this in mind a part of the questions that Polish respondents were asked referred to the questions and findings of the “Cloud Security Spotlight Report 2017”, a publication prepared by CrowdResearch Partners on the basis of the answers of over 1900 respondents from the whole spectre of industries and organization sizes in numerous countries [Pietruszyński 2017]<sup>2</sup>.

In Poland the cloud computing market research comprised 180 IT specialists coming from organizations of various sizes operating in all the significant branches of the Polish economy: 31% of the respondents were representatives of large enterprises and corporations, 45% representatives of medium-sized and small enterprises, and 24% came from micro-enterprises that employ fewer than 10 persons. The largest share of the respondents came from IT companies (28%), academic and educational sector organizations (16%), industrial and manufacturing enterprises (10%) and public administration bodies and uniformed services (9%).



**Fig. 3.** The most important barriers that hinder cloud computing adaptation in Poland and in the world

Source: [Pietruszyński 2017].

<sup>2</sup> <http://crowdresearchpartners.com/portfolio/cloud-security-report/>.

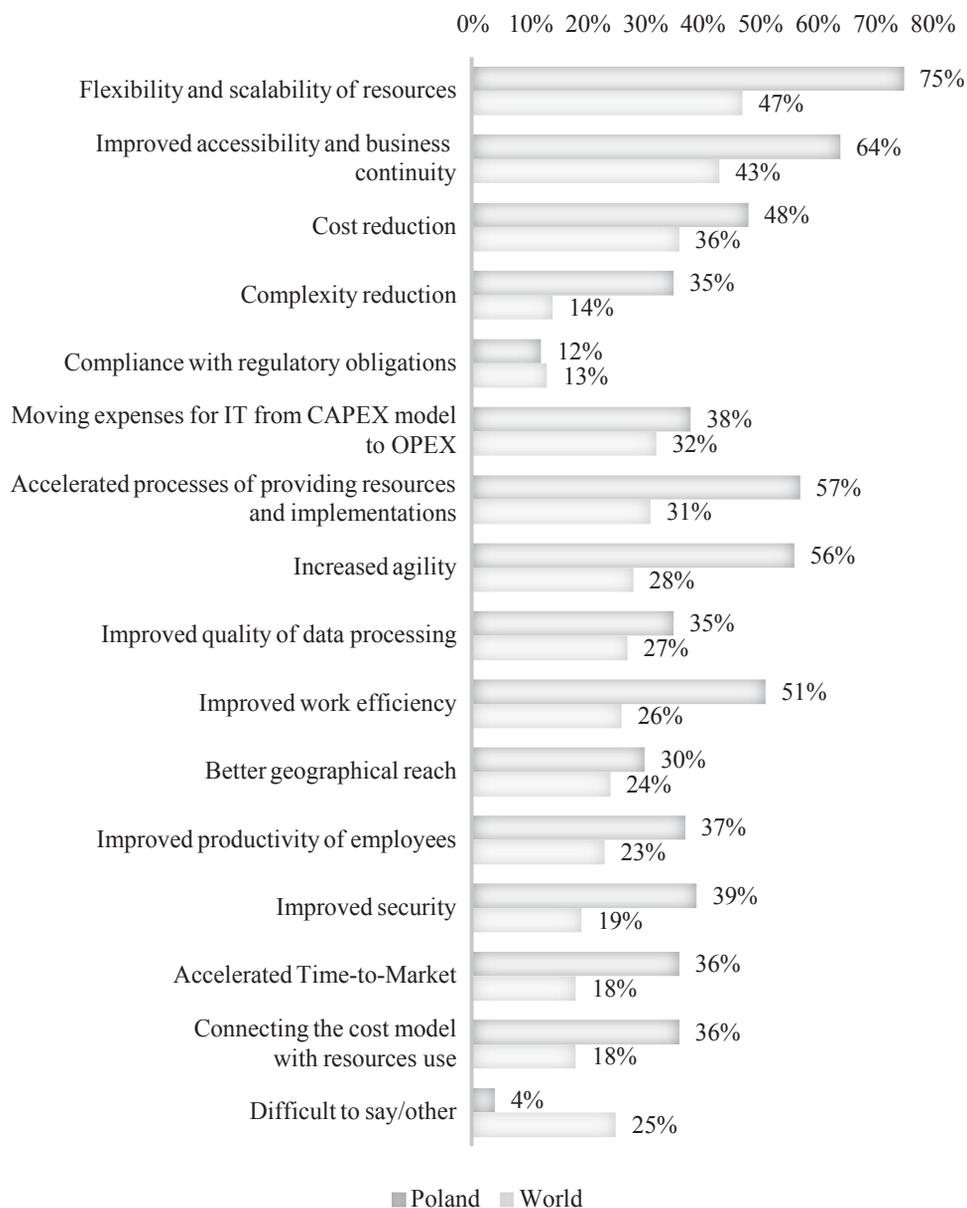
In this paper the authors present the results of two issues covered by the research. They concern the barriers that hinder the implementation of cloud computing solutions (Figure 3) and the benefits of this IT management model utilization (Figure 4).

It turns out that the biggest barrier, both according to the Polish respondents as well as those world-wide, are fears connected with the security of data stored in the cloud. They probably result from the fears of migrating their information resources to fairly unknown locations (the geographical location of servers). The specificity of cloud computing operation assumes storing data on servers that are located in geographically dispersed locations. Moreover, the data stored is copied for security reasons among various centres frequently located in different countries. The lack of personal control over the physical servers raises concerns about the possibility of unauthorized access or accidentally making data available to unauthorized persons. Another reason for concerns is also the requirement to comply with all the statutory obligations connected with personal data security. However, it should be stressed that nowadays datacentres of the largest cloud computing providers comply with strict security standards, and considering the approaching regulations of RODO, i.e. the EU's regulation on personal data protection, companies that want to provide services in the cloud will have to comply with the legal standards imposed by these regulations.

An important barrier, according to the respondents, is also the fear of the possibility of integrating cloud computing with the IT environments already existing in organizations. The specificity of operation of some enterprises does not allow them to migrate the whole IT infrastructure to the cloud. Therefore, it is of vital importance that the possibility of data exchange between service and desktop applications is ensured. Particularly important in this respect is to maintain the compatibility of the databases that store data.

In the case of Polish enterprises, a considerable importance is also attached to: loss of control (38% of indications) internal opposition and inertia (31% of the indications). Similarly to the issues connected with security, it is important to provide proper education in the scope of cloud computing utilization.

In contrast to the barriers of cloud solutions implementation, significant benefits can be distinguished in this scope. The most important ones according to the respondents include: flexibility and scalability of resources (75% Poland and 47% world), improved accessibility and business continuity (64% Poland and 43% world). Cloud computing ensures access to information resources of the enterprise practically from any place in the world with the use of the Internet and on practically any device. These benefits result in a significant increase in the mobility of the employees and additionally allow to implement group work in organizations. Moving the resources to the cloud is the best solution to make them available to employees via the Internet, regardless of the place they perform their professional duties.



**Fig. 4.** The most important benefits achieved as a result of cloud computing implementation

Source: [Pietruszyński 2017].

Other vital factors include: cost reduction (48% Poland and 36% world) and moving the IT expenses from the CAPEX model to OPEX (38% Poland and 32%

world). Changing the model of expenses for maintaining the IT infrastructure of organizations allows newly created ones to decrease the financial barrier of IT infrastructure development, and the existing ones can flexibly spread over time financial expenditures while simultaneously maximizing the utilization of the computing power of servers.

## 6. Conclusion

Despite its very dynamic development, cloud computing still encounters a varied approach to its application. The specificity of operations of particular organizations and the varying level of knowledge on the principles of cloud functioning generate barriers in its implementation. These barriers are frequently caused by the uncertainty linked to the migrating the whole information capital of organizations to be managed by external companies (cloud providers) who frequently impose the form in which the application resources of the SaaS model are to be used. However, the benefits presented in the paper concerning the implementation of cloud computing should be an incentive for managers of all enterprises regardless of their size to analyse the benefits and costs accompanying the migration to the new model of IT management. This will allow them to develop the best possible scenario of information management and therefore increase the enterprise's competitiveness, both in the marketing aspect as well as with reference to limiting the costs incurred to maintain technological departments. The presented research was conducted among enterprises of various sizes. An interesting attempt would be conducting similar research but for each type of enterprises separately. This would allow to perceive the differences in recognizing the benefits and barriers among micro, small, medium-sized and large enterprises.

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