

Barriers to the development of cloud computing adoption and usage in SMEs in Poland

Dorota Jelonek, Elżbieta Wysocka

Abstract— Entrepreneurs who consider changing the traditional IT management model to cloud computing have concerns about the security and confidentiality of data, the integration of internal IT infrastructure with new solutions, insufficient availability of services through the Internet or the quality and efficiency of services. The article confirmed the hypothesis that Polish SMEs managers perceive barriers to implementation and development of cloud computing in a similar manner to managers from other EU countries. In addition, it has been shown that mental barriers, including lack of knowledge and lack of trust are the most serious barriers to the dissemination of the cloud computing model. The biggest legal barriers are related to concern about data security, in particular the protection of personal data, whereas among technical barriers "slow Internet connection" is not a significant obstacle in the development of cloud computing in the opinion of Polish managers. This confirms a steadily increasing broad access to high-speed Internet. The study also proved that the vast majority of Polish SMEs managers evaluate the decision of implementing cloud computing as highly risky, especially in the context of losing full control over information resources and the fear of disclosing them without the owner consent.

Keywords—cloud computing, SMEs, barriers: mental, legal, technical.

I. INTRODUCTION

CLOUD computing is nowadays one of the most important trends in the development of new business models, co-defining the organizational structure and the enterprise management methods. In the opinion of many managers as well as in numerous scientific publications, cloud computing improve business competitiveness by reducing costs and increasing flexibility.

Any concerns that accompany the transition to cloud computing will gradually disappear with the growing popularity of this solution and the increase of managers knowledge about it. The rising number of managers who believe that cloud computing usage is safe and may bring many tangible benefits may additionally help in the eliminations of these concerns. As every new model of IT service, cloud computing faces various barriers that hinder its implementation in enterprises. The current model of IT resources management is changed and it is followed by migration of data from own servers, therefore many managers associate it with losing control over their IT resources. What is

more, in the traditional model a user can select and configure software more freely than in the cloud computing model, which imposes certain requirements and restrictions on applications and their functions.

Partial IT outsourcing is a common practice among SMEs in Poland, however a complete technology outsourcing of business processes is possible only due to development and increased accessibility to the cloud computing model.

The purpose of this article is to identify the barriers which prevent managers of SMEs sector in Poland from implementing cloud computing solutions. Results were compared with the outcomes of research carried out on the sample companies based in European Union. The authors aim to confirm the following hypothesis:

H1: Polish SMEs managers perceive barriers to implementation and development of cloud computing in a similar manner to managers from other EU countries.

H2: Mental barriers, including lack of knowledge and trust are the most serious barriers to the dissemination of the cloud computing model.

H3: The biggest legal barriers are related to the concern about data security, in particular the protection of personal data.

H4: Among the technical barriers "slow Internet connection" is not a significant obstacle in the development of cloud computing in the opinion of Polish managers. This confirms a steadily increasing broad access to high-speed Internet.

H5: The vast majority of Polish SMEs managers evaluate the decision of implementing cloud computing as highly risky, especially in the context of losing full control over information resources and the fear of disclosing them without the owner consent.

This article is organized as follows. Section 2 presents the issue of cloud computing model. Then, in Section 3, types of cloud computing services were described. Section 4 presents cloud computing from the perspective of SMEs, taking into account potential benefits and concerns of this decision. In the next section the research method was discussed, additionally the research sample and the basic questions included in the survey for the identification of mental, technical and legal barriers were presented. The results of the study were compared with the results of the research conducted on a sample companies from EU region, and the insightful analysis

of the results confirmed the positive verification of all research hypotheses.

II. THE ISSUE OF CLOUD COMPUTING MODEL

The concept of cloud computing was first introduced by S.E. Gilletta i M. Kapora in 1996 [1] and formulated by them definition of this term is still valid.

Cloud computing is a relatively new business model in the computing world. It is adopted by enterprises [2] [3], public sector [4], regional business community [5] and many other organizations. According to the official NIST definition, "cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction"[6].

Armbrust et al. [7], define that, "cloud computing refers to both applications delivered as services over the Internet and the hardware and systems software in the datacenters that provide those services".

Enterprises can use this solution to outsource the administration of databases, management of applications and information systems, hence they do not need to have storage for servers and other infrastructure anymore.

The cloud computing model comprises five essential characteristics. The characteristics are described as on-demand self-service, broad network access, resource pooling, rapid elasticity and measured service [8]. On-demand self-service denotes the unilateral provisioning of resources without human interaction with the provider while broad network access means that services are delivered over a network [9]. Resource pooling is the set of resources such as storage, processing, memory, bandwidth, which can be offered to many clients. Rapid elasticity indicates that resources are dynamically scaled up and down with demand and, finally, measured service refers to the automatic control and optimization of resources through pay-per-use metering capabilities [9].

III. TYPES OF CLOUD COMPUTING SERVICES

The majority of literature reviews define a Cloud Computing Framework as a Service Oriented Architecture (SOA) [10].

Depending on how advanced cloud computing is, three basic types or levels of this service are currently distinguished:

- Infrastructure as a Service (IaaS),
- Platform as a Service (PaaS),
- Software as a Service (SaaS).

Each of the service types serve different purposes and target different customers however they share a common business model that is that they 'rent' the use of their computing resources including services, applications, infrastructures, and platform to customers[11].

Infrastructure as a Service (IaaS) means using computer hardware via the Internet. IaaS is divided into Compute Clouds

and Resource Clouds [10]. Compute Clouds provide access to computational resources such as CPUs, hypervisors and utilities. Resource Clouds contain managed and scalable resources as services to users.

Infrastructure as a Service model refers to the tangible physical devices (raw computing) like virtual computers, servers, storage devices, network transfer, which are physically located in one central place (data center) but they can be accessed and used over the internet using the login authentication systems and passwords from any dumb terminal or device [12]. Examples: Amazon S3 (Simple Storage Service), Amazon EC2 (Elastic Compute Cloud) and Rackspace Cloud Servers.

Platform as a Service (PaaS) is a more advanced level of cloud computing service than IaaS. PaaS provides a full or partial application development environment that enables developers to access resources for application development and to collaborate with others online.

This solution offers specific services allowing treatment of the infrastructure elements as one entity and using a single virtual supercomputer on which – thanks to special software components – scalable applications can be developed. PaaS offers an agile development environment that makes it easier for IT professionals to develop applications quickly and to adopt them instantly because it eliminates the wait for deployment of suitable hardware and software for the applications [13]. Examples: Microsoft Azure Service Platform, Salesforce - Force.com, Google App Engine and Amazon Relational Database Services.

Software as a Service (SaaS) model is the most elaborate level of cloud computing. User gets access not only to the hardware infrastructure, but also to defined IT applications. Software as a Service model can be understood as the variation to the application service provider model (ASP), where customers pay, rent, or subscribe to applications or services from the cloud providers to access applications or services such as online storage and database capabilities via the Internet [14]. A client does not bear the costs of purchasing software licenses and only pays for each usage of specific functions of programs running on a provider's server. An access to selected functions "on demand" is an advantage. SaaS solutions can provide services such as Customer Relationship Management (CRM), Enterprise Resource Planning (ERP), Human Resource Management (HRM), finance and accounting systems, analytical systems. Some office applications and email and web pages management systems are also available. Examples: Salesforce, Netsuite and Google Apps.

Enterprises can choose how to implement the services in the cloud computing model from several types of "clouds": private clouds, public clouds, community clouds and hybrid clouds.

Private clouds is a solution designed for a specific organization and used exclusively by it. Private clouds give organizations more control over security, transparency and compliance but require substantial capital, operational

expenditures and a highly proficient IT team.

In public clouds, the infrastructure is owned by a single provider however it is addressed to the general public or a specific industry. Google Apps is a good example of this kind of cloud.

Community clouds provide cloud infrastructure for several organizations and it supports specific communities with common goals (e.g. policy, mission, security requirements). That solutions have the advantage of cost efficiency compared to private clouds.

Hybrid clouds are combinations of two or more "clouds" (private, public, or community) which are unique entities however linked by a single technology.

IV. CLOUD COMPUTING FROM THE SMEs PERSPECTIVE

Cloud computing is definitely making waves with SMEs and is slowly creeping into their business strategy formulation and implementation now and in the near future. Basing on the research results of Gupta, Seetharaman and Raj SMEs are not hesitant to incorporate cloud into their business strategy despite the few concerns being cited by industry pundits [12]. Decisions to implement cloud computing model are frequently preceded by identifying benefits and possible risks. The list of factors that influence decisions about the usage of cloud computing can be very long and contain factors specific to the region, industry, business model and management style. The attempt to assess the impact of five selected factors on the implementation of cloud computing in SMEs have been undertaken by P. Gupta, A. Seetharaman and J. R. Raj [12]. Firstly, ease of use and convenience is the biggest favorable factor followed by security and privacy and then comes the cost reduction. The fourth factor reliability is ignored as SMEs do not consider cloud as reliable. Lastly but not the least, SMEs do not want to use cloud for sharing and collaboration and prefer their old conventional methods for sharing and collaborating with their stakeholders [12].

Among the most frequently mentioned changes associated with introducing cloud computing model many scientist list cost savings and operational flexibility [15]. Cloud computing model reduces fixed costs associated with the purchase of infrastructure and eliminates the need of certain infrastructure (and its future software update) purchase. Hence the energy costs of infrastructure usage are decreasing and the savings in lowering staffing costs are visible, due to the fact that there is no need to hire employees to operate their own systems.

This situation affects the enterprise flexibility both in terms of the resources volume and access to the latest technology solutions. What is more the ability of accessing data through the internet allows managers to read or edit information resources of the company from any place, at any time and by using various devices.

The main perceived benefits of the cloud computing model in SMEs were also the subject of The European Network and Information Security Agency research [16]. Fig. 1 shows the results of the study.

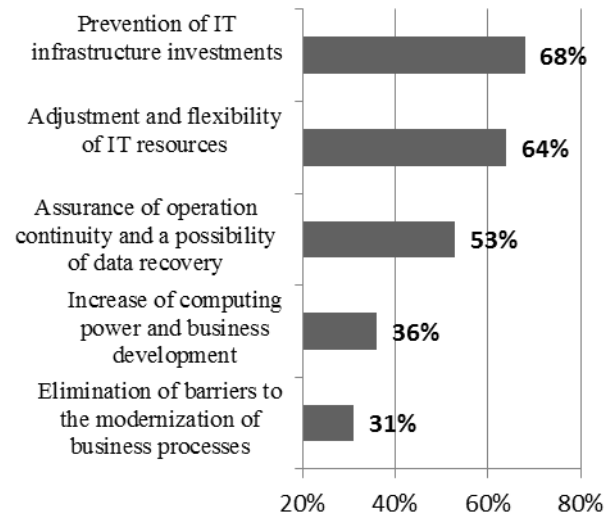


Fig. 1 Benefits of cloud computing model in SMEs [12]

Costs savings are seen as key benefits of cloud computing and 68% of SMEs indicated that this solution would help in avoidance of investments in IT infrastructure. Adjustment and flexibility of IT resources is also of a great importance for companies (64%), especially when the company do not need to worry about software updates or a new product versions or any other kind of necessary actions that has to be carried out in order to adapt systems to the changes in regulations (e.g. changes in tax rates). In the opinion of 53 % of respondents cloud computing provides business operation continuity and it allows data recovery, however the rest of the respondents (47%) are worried about the efficiency of Internet connection , the security of data transfer and its storage. From the point of view of SMEs the increase of computing power and business development (36%) and the elimination of barriers to modernization of business processes (31%) are not very important.

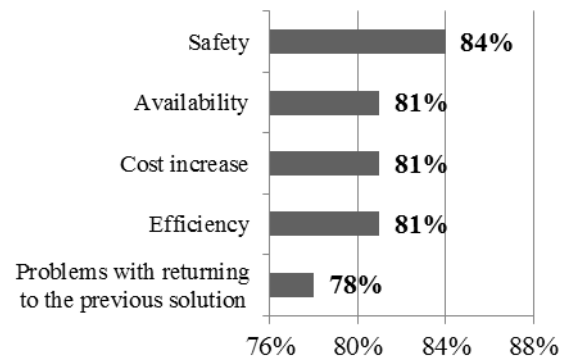


Fig. 2 Drawbacks of cloud computing model in SMEs [16]

The data presented in Fig. 2 confirm that companies have some serious concerns hindering full adoption of cloud computing model. The percentage of respondents who believe that all factors are important is very high. The biggest concerns about cloud computing relate to data security (84%). However

there are relatively small differences in answers ranging from 78% to 84% of respondents. This indicate that SMEs believe that each of the five indicated factors is a drawback or concern of cloud computing. Presented results justify the need of conducting further research on the topic of barriers to the development of cloud computing identification, in order to mitigate these barriers in the future hence dispel the fears and concerns of managers.

V. BARRIERS TO ADOPTION AND USAGE OF CLOUD COMPUTING. RESEARCH RESULTS.

The SMEs sector is dynamic and open to innovations and new solutions, however in the case of cloud computing decisions are thought through carefully, without a rush. Even the awareness of cloud computing benefits do not convince managers to its usage. The effect of “scale leveling” is the undoubted benefit of using cloud computing and Internet in business. It means that small enterprises can benefit from more advanced systems and application by incurring only the costs of actual resources used without having to bear the investment costs.

The attempt of seeking an answer to the question “What prevents SMEs based in various EU countries from implementation and further development of cloud computing?” has been undertaken in the IDC report [17]. The report was an inspiration for the authors of this study to verify the perception of barriers by the Polish SMEs.

Polish companies participated in IDC study in 2012, however the specificity of the economy of each country is different, the determinants of doing business are various, the internet infrastructure level differs, other regulations are not the same either, therefore in these contexts the perception of barriers to cloud computing implementation may be unlike those in EU.

There are 1.8 million enterprises in Poland, from which 99.8% are small and medium-sized enterprises [18]. In the light of the above, presented study results carried out on a sample of 134 companies are not representative to the entire Polish SME sector. Nevertheless in the authors' opinion, the results are an interesting attempt of building the image of Polish SMEs, which face the challenge of cloud computing implementation.

The study involved: 80 micro-enterprises, 42 small-enterprises and 10 medium-enterprises from the following sectors: manufacturing - 39, trade - 65 and services – 30.

The study was conducted in January - February 2014 with the use of electronic questionnaire. Link to the survey was given via email sent to the companies. Questionnaire return rate was 27%. The results of few chosen survey questions are presented below. In order to examine the relevance of each barrier to the cloud computing implementation decision, twelve questions from IDC report [17] research carried out on sample european enterprises were used.

– Security & data protection: "We are worried about the security and data protection guaranteed by cloud services"

- Trust: "It is difficult to judge which cloud services are trustworthy"
- Data location: "We do not know and/or cannot control the location of our corporate data"
- Local support: "There is no local support for the services"
- Change control: "We cannot control software changes and upgrades made by the vendor"
- Ownership of customisation: "We do not know who owns the customisations/changes we make to the cloud services"
- Evaluation of usefulness: "We do not know how to evaluate the usefulness of cloud service for our organization"
- Slow Internet connection: "Our Internet connection(s) is/are not reliable or fast enough"
- Local language: "There is no local language version of the services"
- Tax incentives: "Tax and other incentives make buying with capital more attractive than paying for what we use on subscription"
- Legal Jurisdiction: "If we have a dispute with the cloud service provider, I may have to go to court in another country inside the EU"
- Data Access and Portability "Concern about our ability to move data from one vendor to another or onto our own IT"

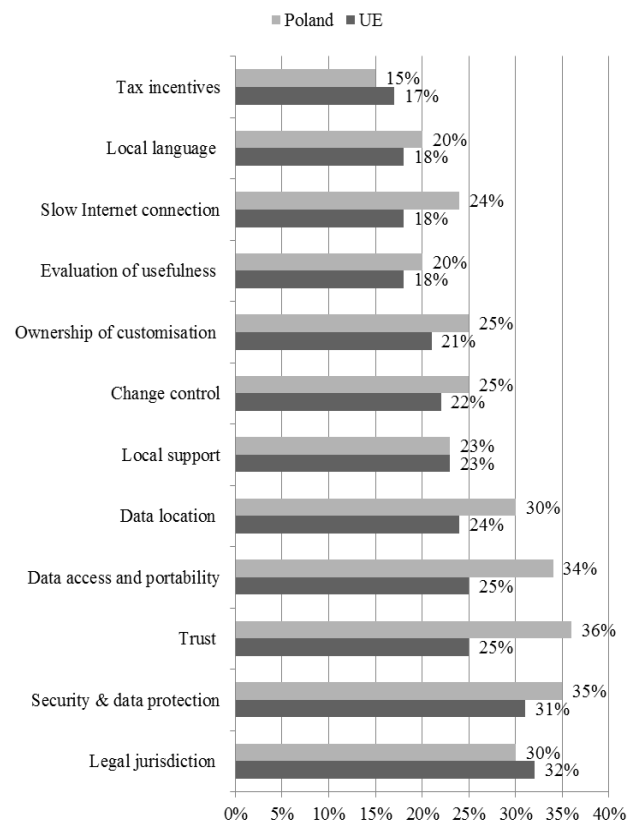


Fig. 3 The relevance of the barriers to the cloud computing implementation

Respondents rated each response on a scale: low barrier, average barrier, high barrier. The research results including only the “high barrier” response are shown in Fig. 3. For

comparison, results of research carried out for EU companies in different countries have been added.

Most serious barriers in the assessment of Polish SMEs are: “trust” (36%), "security and data protection" (35%) and "data access and portability" (34%). The lowest-rated barriers are as follows: "tax incentives" (15%) and the "local language" (20%). According to the respondents of the EU enterprises the most serious barrier are "legal jurisdiction" (32%), "security and data protection" (31%), "trust" (25%) and "data access and portability" (25%).

Had to create a ranking of the five most serious barriers, the same barriers would have been indicated by both Polish SMEs and enterprises based in EU countries (only in a different order).

Table 1. Relevance of mental, legal technical barriers to cloud computing adoption

Barriers	The relevance of barrier to cloud computing adoption			
	Low barrier	Average barrier	High barrier	
Mental barriers				38% of all responses was a „high barrier”
Trust	10%	54%	36%	
Data access and portability	14%	52%	34%	
Data location	22%	48%	30%	
Evaluation of usefulness	30%	50%	20%	
Legal barriers				29% of all responses was a „high barrier”
Local support	41%	36%	23%	
Legal jurisdiction	14%	56%	30%	
Ownership of customisation	18%	57%	25%	
Tax incentives	62%	33%	15%	
Technical barriers				33% of all responses was a „high barrier”
Security & data protection	24%	41%	35%	
Change control	22%	53%	25%	
Slow Internet connection	10%	66%	24%	
Local language	34%	46%	20%	

The analysis of the survey results showed that in the opinion of respondents mental barriers are more frequently than technological or legal barriers perceived as a strong obstacle in the decision on whether or not to implement cloud computing solutions. Among all responses "high barrier" as much as 38% of responses related to the mental barriers, 33% to the technical barriers and 29% to the legal barriers. Taking into account all responses, concerning twelve barriers the respondents rated the relevance of vast majority of barriers as “average”. “tax incentive” was the only to be rated by most of respondents (62%) as a “low barrier”.

When asked to assess the risk of cloud computing, 68% of respondents have given the answer “high risk”, 23% “medium risk” and 11% “low risk”.

VI. CONCLUSION

The results of the survey conducted among Polish SMEs confirmed the hypothesis that Polish SMEs managers perceive barriers to implementation and development of cloud computing in a similar manner to managers from other EU countries. A higher percentage of “high barrier” indications by Polish SMEs in comparison to the EU companies in the case of as many as nine barriers is a significant difference in the perception of barriers to cloud computing. Most of these differences vary from 2% (local language) to 11% (trust). In the case of "tax incentives" and "legal jurisdiction" there was 2% less indications "high barrier" in Polish SMEs than in those based in EU.

The second hypothesis i.e mental barriers, including lack of knowledge and trust are the most serious barriers to the dissemination of the cloud computing model was also positively verified. 38% of all “high barrier” indications were related to mental barriers, 33% to technical barriers and 29% to legal barriers. The biggest concerns are associated with respondents 'trust'.

Also, the third hypothesis was confirmed, as the most important legal barriers are related to concern about data security, and in particular the protection of personal data. The hypothesis that among the technical barriers "slow Internet connection" is not a significant obstacle in the development of cloud computing in the opinion of Polish managers and that this confirms a steadily increasing broad access to high-speed Internet was also verified as positive. "Slow internet connection" as "high barrier" was indicated by 24% of respondents, whereas "security & data protection" as "high barrier" was indicated by 35% of respondents. The vast majority of Polish SMEs managers evaluate the decision of implementing cloud computing as highly risky, especially in the context of losing full control over information resources and the fear of disclosing them without the owner consent.

In conclusion, the most important point is that cloud computing is still a challenge for SMEs and decisions about its usage are taken with large concerns. Managers need more knowledge about this model and about advanced tools that can facilitate their daily business activities. The vision of the benefits that cloud computing offers, and presentations of good practice are the key factors that in the near future will further increase the popularity of cloud computing in SMEs.

REFERENCES

[1] S.E. Gilletta i M. Kapora *The Self-governing Internet: Coordination by Design*, MIT Press, 1996.
 [2] A. Nowicki, L. Ziora, *Application of Cloud Computing Solutions in Enterprises. Review of Selected Foreign Practical Applications*, Business Informatics, No. 205, Wrocław 2011, pp. 203-213.
 [3] Q. Li, C. Wang, J. Wu, J. Li, Z.-Y. Wang, *Towards the business-information technology alignment in cloud computing environment: An approach based on collaboration points and agents*. International Journal of Computer Integrated Manufacturing, vol. 24, no. 11, pp. 1038–1057, November 2011.
 [4] C. Russell, F. Jeff, J. Norm, M. Seanan, P. Carolyn, S. Patrick, J. Stanley, *Cloud Computing in the Public Sector: Public Manager* 5

- Guide to Evaluating and Adopting Cloud Computing*, Cisco Internet Business Solutions Group 2009.
- [5] D. Jelonek, C. Stepniak, T. Turek, *The Concept of Building Regional Business Spatial Community*. In: ICETE 2013. 10th International Joint Conference on e-Business and Telecommunications. Proceedings. 29-31 July 2013, Reykjavik, Iceland 2013
- [6] The National Institute of Standards and Technology's (NIST), <http://www.nist.gov/itl/csd/cloud-102511.cfm> (20.02.2014).
- [7] M. Armbrust, A. Fox, R. Griffith, A. Joseph, R. Katz, *Above the Clouds: A Berkeley View of Cloud Computing*, Technical report No. UCB/EECS-2009-28 University of California at Berkeley, 2009, USA.
- [8] P. Mell, T. Grance, 2011, The NIST definition of cloud computing: Recommendations of the National Institute of Standards and Technology. Retrieved from <http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf>
- [9] N. Brender, I. Markov, *Risk perception and risk management in cloud computing: Results from a case study of Swiss companies*, International Journal of Information Management 33 (2013) p. 727.
- [10] V. Chang, R. J. Walters, G. Wills, *The development that leads to the Cloud Computing Business Framework*, International Journal of Information Management 33 (2013) pp. 524-538.
- [11] A. Lin, N. Chen, *Cloud computing as an innovation: Perception, attitude, and adoption*, International Journal of Information Management 32 (2012), p. 534.
- [12] P. Gupta, A. Seetharaman, J. R. Raj, *The usage and adoption of cloud computing by small and medium businesses*, International Journal of Information Management 33 (2013) pp. 861– 874.
- [13] M. Greer, *Software as a service inflection point: Using cloud computing to achieve business agility*. New York: Global Authors Publishers, 2009.
- [14] N. Leavitt, *Is cloud computing really ready for prime time?*, Computer, 42(1), 2009, pp. 15–20.
- [15] <http://www.praktycznateoria.pl/cloud-computing/>
- [16] *An SME perspective on cloud computing*, The European Network and Information Security Agency, 2009.
- [17] *Quantitative Estimates of the Demand for Cloud Computing in Europe and the Likely Barriers to Up-take*, IDC 2012.
- [18] *The activities of non-financial enterprises in 2011*, GUS, 2013.