WARSAW SCHOOL OF ECONOMICS

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Doctoral Thesis Summary

The Use of Cloud Computing in Order to Create Public Value by Local Government Units

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1. Motivation

Technological progress that can be observed in recent years, causes the rapid computerisation development, which promotes a transformation of behaviour and attitudes and influences significantly changes in organisations – both in companies and in the public sector. On the increase are also citizens' expectations towards the public administration, which should be efficient and effective but also should affect the forming of the processes of democratisation of life, involving citizens, businesses and non-profit organisations[1]. Furthermore a contemporary state is supposed to be more transparent and to enable citizens' general participation[2].

The modern model of public administration is supported by information technologies (IT)[3]. They have a special role to play, in particular at the level of a local government unit (LGU).

On one hand, a technological development involves a general concept of *smart cities*[4]. The main assumptions of this concept consist of possibly holistic approach to city governance and providing the information flow between all participants of urban life[5] by using appropriate information systems[6]. The residents of large towns with a population at least 100 thousand inhabitants[7] are the beneficiaries of smart cities. However, the citizens of the small and medium cities can also take advantage of the elements of this concept[8].

[1] J. M. Bryson, B. C. Crosby, L. Bloomberg, *Public Value Governance: Moving beyond Traditional Public Administration and the New Public Management*, „Public Administration Review", vol. 74, iss. 4, The American Society for Public Administration 2014, pp. 445 – 456.
[2] B. Szafrański, *Główne wyzwania związane z modernizacją funkcjonowania państwa*, „Roczniki" KAE, vol. 29, Oficyna Wydawnicza SGH, Warszawa 2013, pp. 309 – 324.
[3] J. Papińska-Kacperek, K. Polańska, *Obecność administracji publicznej w mediach społecznościowych*, „Roczniki" KAE, vol. 33, Oficyna Wydawnicza SGH, Warszawa 2014, pp. 437 – 453.
[4] Ł. Kowalski, *Inteligentne miasta – przegląd rozwiązań*, w: M. Soja, A. Zborowski (Eds.), „Miasto w badaniach geografów", Uniwersytet Jagielloński, Instytut Geografii i Gospodarki Przestrzennej, Kraków 2015, pp. 105 – 121; P. Jać, K. Zapolska, W*spomaganie zarządzania zrównoważonym rozwojem polskich metropolii przy wykorzystaniu narzędzi „miasta inteligentnego"*, „Białostockie Studia Prawnicze" vol. 18, Wydział Prawa Uniwersytetu w Białymstoku, Temida 2, Białystok 2015, pp. 237 – 248; D. Szymańska, M. Korolko*, Inteligentne miasta. Idea, koncepcje i wdrożenia,* Wydawnictwo Naukowe Uniwersytetu Mikołaja Kopernika, Toruń 2015.
[5] J. Gołuchowski, M. Korzeb, P. Weichbroth, *Perspektywy wykorzystania architektury korporacyjnej w tworzeniu rozwiązań smart city*, „Roczniki" KAE, vol. 38, Oficyna Wydawnicza SGH, Warszawa 2015, pp. 85 – 98.
[6] M. Muraszkiewicz, *Ku nowej utopii, ku inteligentnym miastom*, in: D. Gotlib, R. Olszewski (Eds.), „Smart City. Informacja przestrzenna w zarządzaniu inteligentnym miastem", Wydawnictwo Naukowe PWN SA, Warszawa 2016, pp. 14 – 28.
[7] Smart City Forum, *Dlaczego smart city warto tłumaczyć jako użyteczne miasto*, http://smartcityforum.pl/dlaczego-smart-city-warto-tlumaczyc-jako-uzyteczne-miasto/ (accessed: 2016.01.20).
[8] M. Konkel, *Wieś ze sztuczną inteligencją*, „Puls Biznesu" 2015, online edition, http://samorzad.pb.pl/4295397,45561,wies-ze-sztuczna-inteligencja (accessed: 2016.01.20).

On the other hand, the increasing popularity of the web services gives more and more importance to *cloud computing* (CC)[9]. One of the most cited definition provided by The National Institute of Standards and Technology (NIST), states that "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"[10].

There are four basic deployment models of cloud computing: *public cloud*, *community cloud*, *private cloud* and *hybrid cloud*[11].

Considerations in this dissertation focus on LGU's private cloud. The private cloud is dedicated for an exclusive use by a single organisation or a group of organisations[12]. It may be built, managed and operated by internal IT departments of that organisation or supplied by the external provider (but the cloud is supervised by representatives of the cloud-owning institution)[13]. This kind of cloud can support the implementation of the assumptions of the smart city concept in small and medium towns. It also allows to obtain the benefits that are associated with the cloud while allowing public authorities to maintain full control of processed data. It makes easier for the government units, to meet the requirements of safety and security from legal and organisational points of view.

The following three service models are distinguished most often[14]:

- SaaS *(Software as a Service*) means capability of using provider's applications running on a cloud infrastructure;
- PaaS (*Platform as a Service*) means sharing with users the environments to create and manage their own applications;
- IaaS (*Infrastructure as a Service*) concerns with the sharing with the users the fundamental computing resources, necessary for processing and storage of the resources, including operating systems and applications.

[9] In the literature there are different translations of "cloud computing" – „chmura obliczeniowa", „przetwarzanie w chmurze" or „przetwarzanie w chmurze obliczeniowej" (T. Parys, *Bariery wdrożeniowe związane z wykorzystaniem cloud computing oraz ich przejawy w ocenie użytkowników*, „Problemy Zarządzania" vol. 13, No 2 (52), t. 1, Wydawnictwo Wydziału Zarządzania Uniwersytetu Warszawskiego, Warszawa 2015, pp. 217 – 227, A. Skrzypek, *Model cloud computing w społeczeństwie informacyjnym*, „Nierówności Społeczne a Wzrost Gospodarczy", No 44 (4/2015), part 2 „Społeczeństwo, przedsiębiorstwa i regiony w dobie gospodarki elektronicznej", Katedra Mikroekonomii Wydziału Ekonomii UR, Rzeszów 2015, pp. 223 – 238). All three ways of translation are used in the disertation.

[10] P. Mell, T. Grance, *The NIST Definition of Cloud Computing Recommendations of the National Institute of Standards and Technology*, National Institute of Standards and Technology U. S. Department of Commerce, Special Publication 800 – 145, Gaithersburg 2011, pp. 1 – 3.

[11] Ibid.

[12] Ibid.

[13] Ibid.

[14] Ibid.

Because the cloud services provided by LGU are mainly based on sharing the applications, considerations in this dissertation focus on the SaaS model.

The use of cloud computing can bring many benefits. In the literature there is a view that the cloud gives similar benefits to public organisations as to commercial entities[15]. The most frequently mentioned advantages of using a cloud, which can also be applied to the public sector, are[16]:

- lower IT investments expenditures,
- ongoing IT maintenance cost reduction,
- scalability and flexibility of using computing power,
- improved efficiency and effectiveness of information systems,
- increased security of the data in the context of the ability to create integrated security systems,
- enhancing professionalism of IT system administration,
- encouraging the dissemination of good practices, conducive increasing the quality of services provided by the public administration,
- standardizing business processes,
- opening to greater cooperation and improving interoperability between the units,
- the benefits of economies of scale use of standardized IT solutions,
- positive environmental effects caused by e.g. saving electricity.

In the case of a private cloud of local administration obtained benefits may not be as profound as the advantages listed. Building a private cloud will require from LGU higher capital expenditure (in relation to the option of using a public cloud) as a result of the implementation and maintenance of new systems and increased responsibility for the security of data processing.

Because as much as approx. 70% of the cases relating to services in the public sector are carried out at the local level[17], where inhabitants and businessmen exercise their basic life

[15] J. Cypryjański, *Rozwój zastosowań chmury obliczeniowej w administracji publicznej – prognozy, bariery, korzyści*, „Roczniki" KAE, vol. 29, Oficyna Wydawnicza SGH, Warszawa 2013, pp. 79 – 90.
[16] The list of benefits of using cloud computing provided by many authors. This specification is based on: W. Cellary, S. Strykowski, *E-Government Based on Cloud Computing and Service-Oriented Architecture,* Proceedings of the 3rd International Conference on Theory and Practice of Electronic Governance, Bogota, Colombia, ACM, New York 2009, pp. 5 – 10; J. Cypryjański, op.cit.; P. Czerwonka, *Chmura obliczeniowa jako rozwiązanie dla małych OSD – możliwości i zagrożenia*, „Rynek Energii", nr 1/2013, KAPRINT, Lublin 2013, pp. 50 – 55; Z. Handzel, *Cloud computing – czyli chmura obliczeniowa i możliwości jej wykorzystania w mediach*, „Problemy Zarządzania", vol. 11, No 4 (44), Wydawnictwo Wydziału Zarządzania Uniwersytetu Warszawskiego, Warszawa 2013, pp. 183 – 194; T. Haralambos, M. Themistocleous, *Cloud Computing and eGovernment a Literature Review*, European and Mediterranean and Middle East Conference on Information Systems, Greece, Athens 2011, pp. 154 – 164; D. C. Wyld, *Moving to the Cloud: An Introduction to Cloud Computing in Government*, IBM Center for The Business of Government, Washington 2009.
[17] *Program Zintegrowanej Informatyzacji Państwa*, MAC, 2014, p. 81.

and economic functions, it is very important to be able to analyze the IT influence – including cloud computing – on the effects of the work of local administration.

Services provided to citizens and society as a whole by public organisations are of the intangible nature, difficult to present only in financial terms. It is therefore necessary to establish dedicated mechanisms which allow us to analyze selected aspects of public sector organisations. An attempt to solve this problem is made by M. H. Moore's concept of *public value* (PV), understood as the achievement of a public organisation in terms of providing benefits to citizens and society[18]. Public value has been discussed all over the world (mainly in the United States, Great Britain, Australia, New Zealand) for many years[19]. This dissertation adopted its own definition that explains the concept of public value in the IT context. The definition states that public value is obtainable with the use of information systems by public organisations and it is reduced by costs and disadvantages (such as more data security threat or the reluctance to use new technologies resulting from the human factor).

In case of local government units, public value analysis requires specificity of the units and the impact of direct participation of members of the community on the governance at local level[20].

Information about the public value created by public administration with the use of information systems can be provided by evaluation of these systems. The reason to conduct

[18] M. H. Moore, *Creating Public Value – Strategic Management in Government,* Harvard University Press, Cambridge MA 1997.

[19] The issue of public value was discussed by: J. Benington, M. H. Moore, *Public Value in Complex and Changing Times,* in: J. Benington, M. H. Moore (Eds.), „Public Value Theory and Practice", Palgrave Macmillan, New York, 2010, pp. 1 – 30; A. Dahl, J. Soss, *Neoliberalism for the Common Good? Public Value Governance and the Downsizing Democracy*, „Public Administration Review", vol. 74 iss. 4, 2014, pp. 496 – 504; T. Meynhardt, *Public Value – Turning a Conceptual Framework into a Scorecard*, Paper submitted for the Conference: Creating Public Value in a Multi-Sector, Shared-Power World, Minneapolis, 2012, 20 – 22 September, pp. 1 – 28; R. A. W. Rhodes, J. Wanna, *The Limits to Public Value, or Rescuing Responsible Government from the Platonic Guardians*, „The Australian Journal of Public Administration", vol. 66, iss. 4, 2007, pp. 406 – 421; C. Talbot, *Paradoxes and prospects of 'public value'*, „Public Money & Management", vol. 31, iss. 1, 2011, pp. 27 – 34.
In Poland, judging by the number of available publications, the concept of public value is still poorly covered. This object has been researched by: M. Ćwiklicki, *Wprowadzenie do koncepcji wartości publicznej*, in: S. Mazur (Ed.), „Reformowanie polskiej administracji publicznej – wybrane aspekty zagadnienia", Uniwersytet Ekonomiczny w Krakowie, Małopolska Szkoła Administracji Publicznej, Kraków 2011, pp. 9 – 20; D. Miłaszewicz, *Problemy społecznej efektywności sektora publicznego*, „Studia Ekonomiczne. Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach", No 180, part 2, Katowice 2014, pp. 163 – 173; G. Musialik, R. Musialik, *Kreacja wartości publicznej*, „Współczesne Zarządzanie" No 2, Wydział Zarządzania i Komunikacji Społecznej Uniwersytetu Jagiellońskiego, Kraków 2013, pp. 141 – 148; M. Rydzewska-Włodarczyk, *Teoretyczne aspekty pomiaru wartości publicznej jednostek samorządu terytorialnego*, in: E. Nowak, M. Nieplowicz (Eds.), „Rachunkowość a controlling", „Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu", No 291, Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu, Wrocław 2013, pp. 481 – 493.

[20] M. Rydzewska-Włodarczyk, op.cit.

the evaluation is the necessity of including in the analysis factors such as common goods and proper management of public funds[21].

The concept of evaluation is defined as the systematic study of the value or characteristics of a particular object or issue from the point of view of the criteria adopted, aimed at streamlining, development and a better understanding[22]. It should be noticed, however, that the evaluation is not identical to making an assessment, because it also covers the use of the results in order to improve the quality of products or activities[23]. In addition, according to K. Ekiert, many evaluation theorists claim that evaluation should not have the character of an assessment, but it should be a way of conducting negotiations and making mutual improvements between the evaluation team and the subject of evaluation[24].

The literature review allowed to state that a method that would serve evaluation of IT in the context of the creation of public value and at the same time would be well suited to the realities of the functioning of local government and computerisation carried out by such units - including processing in a private cloud has not worked out. However, as the research conducted by the author in the local governments proves, the management of the units of local administration very often has difficulty in identifying real opportunities and potential benefits gained through the cloud computing.

In practice, this can lead to insufficient level of the opportunities or failure of IT investments. The necessity to make a thorough analysis of the effects of the implemented information systems indicates the need a method, which would allow to carry out evaluation of the possibility of using private cloud computing in order to create public value by the local government including the technological aspect and reflecting the real activities of local administration.

The thematic area outlined above became the basis for the formulation of objectives and the scope of this dissertation.

2. Objectives and research area

The main objective of this dissertation was to **develop author's scientific research method of the evaluation of possibility of using private cloud computing (EChO) in order to create public value by local government units**.

[21] *Standardy ewaluacji*, Polskie Towarzystwo Ewaluacyjne, Warszawa 2008, p. 3.
[22] B. Ciężka, J. Chojecki, J. Ratajczak, *Ewaluacja funduszy strukturalnych*, Polskie Towarzystwo Ewaluacyjne, Warszawa 2003, p. 5.
[23] Ibid.
[24] K. Ekiert, *Ewaluacja w administracji publicznej – funkcje, standardy i warunki stosowania*, Rządowe Centrum Studiów Strategicznych, Warszawa 2004, pp. 6 – 7.

The main objective has been decomposed into the following secondary research objectives.

1. Cognitive objectives:
    1.1. Analysis of the current situation and study of the development prospects for cloud computing in local government units.
    1.2. Analysis of the possibilities of using evaluation methods already existing in IT in the context of the creation of public value by local government units by means of private cloud computing.
2. Methodical objectives:
    2.1. Providing an approach to classification and comparative analysis of evaluation methods of IT in the context of the creation of public value by local administration by means of these systems.
    2.2. Development of the component procedures of the EChO method enabling the evaluation of the possibility of using private cloud computing in order to create public value by local government units.
3. Utilitarian objectives:
    3.1. Empirical verification of the EChO method.
    3.2. Providing an approach for supporting awareness of local authorities concerning the need to obtain knowledge of public value creating with private cloud computing.

The developed method is intended mainly for small and medium-sized municipal or county local governments which use or plan to use private cloud computing. The choice of this kind of entities is due to the need to provide mechanisms to support rational decision about investing in this type of IT solutions. Small and medium-sized municipalities or counties with small towns are the group of potentially interested in using the selected elements of the smart city conception. Since in such a case, a local government unit must obtain modern information technology (and appropriate resources to support it), one way to provide such solutions could be to implement private cloud computing. Hence, there is a need to analyze whether private cloud computing helps to contributes to the gain of the benefits assumed benefits and whether it is an appropriate way of implementing some of the assumptions of smart city in a small or medium-sized local government.

In this model, the institution responsible for the construction and management of the cloud is the city hall / municipality or county authorities (or a dedicated entity subordinate, established as a provider of services in the cloud). Resource management is supplied by

internal IT departments of that unit (or a dedicated subordinated entity). Therefore, a local government maintains total control over the transferred data to the cloud.

Because of the nature of the tasks carried out by the public administration there is a need to use applications designed to perform specific functions. Thus, the municipalities or the county will provide most of the services running in the SaaS model. The services provided by means of the cloud can be used by the institutions subordinated (e.g. city / county or municipal social assistance centre, a network of schools, kindergartens, educational institutions, public libraries, city / municipal or district cultural centres). The group of potential cloud users includes the management of the local government office employees and institutions subordinate to the selected local government stakeholders: (e.g. associations, municipal or county sports clubs, voluntary fire brigade units, entrepreneurs running in the area of local businesses, residents).

3. Research problems and hypotheses

The achievement of objectives required resolving following research problems:

- **P1:** detailed specification of evaluation demands and criteria, including the conditions of local government units' work, ways of using private cloud computing;
- **P2:** performing an analysis of the adaptability to selected requirements of evaluation methods already existing in IT;
- **P3:** identifying factors which influence the process of creation of public value by local governments, as a result of using private cloud computing;
- **P4:** development, implementation and verification author's scientific research method allowing to evaluate the possibility of using private cloud computing in order to create public value by local government units.

Presented issues were the basis of formulation the main research hypothesis.

MH: It is possible to make, by means of the author's own EChO method, the evaluation of possibility of using private cloud computing in order to create public value by local government.

The main hypothesis was clarified by means of the auxiliary hypotheses.

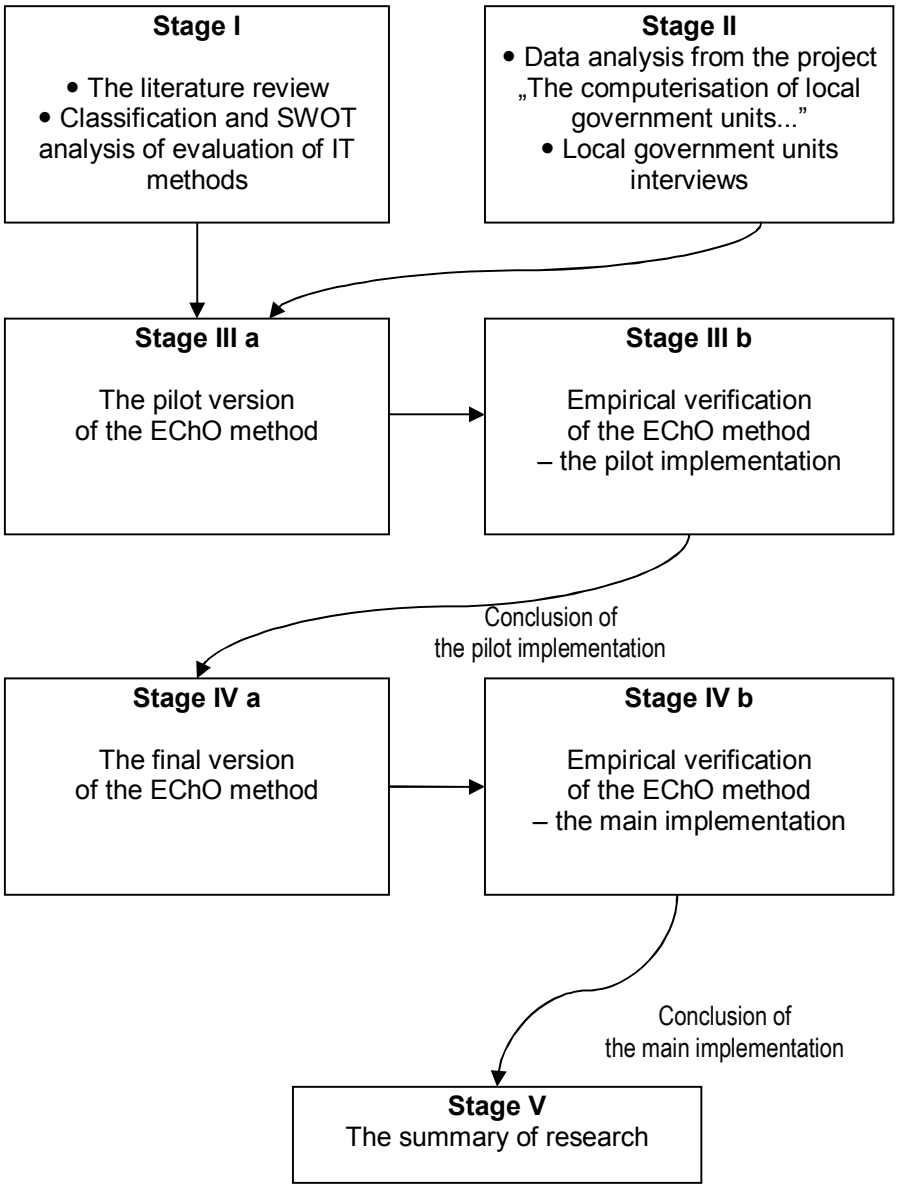
AH1: Using private cloud computing enables local government units to create public value.

AH2: Public value is determined by financial and non-financial benefits, the non-financial benefits are considered in three categories: benefits for the organisation, benefits for citizens and benefits for the whole society.

AH3: Having knowledge about how to create public value by local government units achieved by the use of private cloud computing conduces to making rational decisions regarding the IT development of local administration.

4. The research approach applied

The objectives accomplishment and the proof of the hypotheses were done in five stages. The research process is shown on the scheme 1.



Scheme 1. The research of the doctoral thesis
Source: own elaboration.

The literature review formed the basis for the first stage. This stage included analysis of legal and organisational aspect of local government units computerisation, description of

cloud computing and an overview and classification of IT evaluation methods in the context of the public value creation. This part of the work, using SWOT analysis, judged the possibility of adaptation of technological aspects involved in cloud computing and government units circumstances.

The second stage covered raw data analysis from MAC[25], obtained from the web-based survey being a part of the project: "Computerisation of LGU using cloud computing". Next, the author conducted the expert interviews in local government units concerning the possibility of using private cloud in these units. Then, on the basis of the interviews the conclusions were presented. The results indicated serious doubts of local administration whether the use of private cloud computing is an appropriate means of computerisation in the government units. This confirmed the need to develop an effective way of analysing the effects of the implementation of cloud computing.

The third stage developed and verified in the pilot version the procedures of the EChO method. The method is dedicated to the evaluation of possibility of using private cloud computing in order to create public value by local government units. The EChO method refers to the concept of public value proposed by M. Moore[26]. As a template of the structural form, the *Balanced Scorecard* (BSC) by R. Kaplana and D. Norton[27] was used. This part of the work required formulation of assumptions and guidelines, and also creation of procedures of the method in which the *Analytic Hierarchy Process* (AHP)[28] was adapted. The key factor here was to identify the benefits of creating public value and also estimating their impact. The pilot implementation was in a municipality in Eastern Poland and it covered municipal systems. In the implementation a description of conclusions and further recommendations were affixed.

The findings of the pilot implementation were used to prepare the final version of the EChO method. The main implementation was in a municipal office in a town in central Poland. The implementation concerned the system of public services provided by the municipal office for citizens, entrepreneurs and for its own internal needs. The evaluation procedures included the examination of the dossier of the units, experts' opinions and the cost analysis. Similar to the pilot implementation in the main implementation description, the recommendations and conclusions of the evaluation were included.

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[25] Ministerstwo Administracji i Cyfryzacji, for the time being Ministerstwo Spraw Wewnętrznych i Administracji (MSWiA) and Ministerstwo Cyfryzacji (MC). Currently the project "The computerisation of LGU..." was taken over and redefined by MC.

[26] M. H. Moore, *Creating Public Value*..., op.cit.

[27] R. S. Kaplan, D. P. Norton, *Putting the Balanced Scorecard to Work*, „Harvard Business Review", 1993, vol. 71, No 5, pp. 134 – 147.

[28] T. L. Saaty, *Decision Making With The Analytic Hierarchy Process*, „International Journal of Services Sciences" 2008, vol. 1, No 1, pp. 83 – 98.

The fifth stage included a summary of the work and an indication of further research.

5. Layout of the dissertation

The dissertation contains 9 chapters, 4 appendixes and the list of literature items.

In the first chapter there is an introduction to the context of the research. It also includes the objectives and hypotheses. Key issues are defined and the layout of the dissertation is described.

The second chapter presents the characteristics of computerisation of local government units in programming documents and law regulations. The chapter also includes the conclusions involving local administration computerisation from MC and NIK[29] reports. Next, the smart city concept is described. The smart city concept is a vision of a modern city management.

The third chapter concerns cloud computing. It provides a definition, essential characteristics, service and deployment models of clouds. Additionally, it discusses the issue of using cloud computing in public sector in a law and organisational regulations context and data security problem. Further part of the chapter contains considerations about the private cloud of a local government unit.

The fourth chapter begins with a presentation of the public value concept proposed by M. Moore[30]. This chapter also covers the review of evaluation of IT methods related to public value analysis. In a summary of the chapter there is a synthetic analysis of the possibilities of adapting selected methods to the needs and local governments' conditions and to the specifics of a private cloud. The deepened analyses of the chosen methods, including SWOT analysis, were performed. The deepened analyses are included in appendix B. It also presents the eligibility criteria for a detailed review.

The fifth chapter describes the statistical analysis of data collected as a part of a survey of the MAC's project "Computerisation of LGU...". Besides the statistical analysis, this chapter shows a discussion of semi-structured expert interviews conducted by the author in local government units. Both the results of data analysis and the conclusions of the interviews became the basis for the formulation of general recommendations which helped to develop the evaluation methods of the possibility of using private cloud computing in order to create public value by the local government.

[29] Najwyższa Izba Kontroli.
[30] M. H. Moore, *Creating Public Value...*, op.cit.

The sixth chapter presents a description of the method developed. As the results of the literature review and the conclusions from interviews prove, previously used methods for IT evaluation are not adaptable or are insufficiently adaptable to the needs of local governments using a private cloud. This is caused by the weak adaptation of these methods to the legal territorial system regulations in Poland and to a non-traditional approach to computerisation. This is a starting point for a development of a new method. This chapter discusses key factors affecting the IT evaluation in respect of legal, organizational and funding specifics of computerisation in local government units. The biggest part of this chapter covers the characteristics of the EchO method. It identifies the objectives and benefits of the evaluation, assumptions and implementation steps.

The issue of the seventh chapter is an empirical verification of the EChO method. It presents the pilot implementation and the resulting conclusions. There is also a description of the main implementation. These descriptions contain the results and the recommendations after the evaluation.

The eight chapter includes final conclusions.

The ninth chapter 9 is devoted for to the summary and proposals for further research (including the development of the EchO method).

In the last part of the dissertation appendixes are placed and reference literature items are listed.

The appendixes include:

- A – an initial classification of evaluation IT methods,
- B – the deepened analyses of the chosen IT evaluation methods,
- C – questions of the MAC survey,
- D – the structure of the interviews conducted in LGU,
- E – questionnaires used during the implementation of the EchO method.

Chapters 2 – 4 contain a description prepared on the basis of literature analysis concerning computerisation of LGU, using cloud computing by public local administration and issue of public value. Chapters 5 – 8 present the author's own work, however, for the analysis in the fifth chapter raw data obtained from a survey of MAC project: “Computerisation of LGU...”was used. The ninth chapter discusses the directions of further research.

6. The rationale for the development of the EchO method

There are some reasons behind the need to obtain knowledge about public value creating by local government units using cloud computing.

1. Technological development forces public institutions – including local authorities – to make decisions to implement and use the most innovative technological solutions such as cloud computing. Therefore, it is necessary to obtain information about benefits and dangers resulting from using the cloud. In this regard, the specificity of local administration requires consideration in terms of not only the technological context but also the law and organisational circumstances as well as to pay attention to the issues of particular sensitivity for public sector e.g. data processing security. At the same time, the knowledge how public value is created, can support local unit's management in decision-making on computerisation and simplify communication with citizens concerning promoting new services.

2. The development of services provided electronically by public administration has been entered in European and national programme documents. Because one of the ways of providing electronic services is the use of the cloud, this has resulted in programmes and projects including cloud computing. LGU can be both partners and beneficiaries of these programmes. Cloud computing has become a subject of discussion in the EU institutions, e.g. The European Economic and Social Committee (EESC), which in January 2013 expressed the opinion that cloud computing is a good way of increasing the capacity and improving the competitiveness of the economy[31]. Thus the Committee recommends creating strategies and taking actions by members of European Union which support the development of this technology[32]. In 2016 EESC expressed the opinion supporting of creating European cloud computing, which is a way to better exploit the potential of the data[33]. In Poland the main document concerning the development of computerisation is the Program Zintegrowanej Informatyzacji Państwa Programme of Integrated National Computerisation (PZIP)[34] adopted by the Council of Ministers in January 2014. In 2016 MC provided its modified version[35],

[31] Opinia Europejskiego Komitetu Ekonomiczno-Społecznego w sprawie komunikatu Komisji do Parlamentu Europejskiego, Rady, Europejskiego Komitetu Ekonomiczno-Społecznego i Komitetu Regionów *Wykorzystanie potencjału chmury obliczeniowej w Europie* z dnia 16 stycznia 2013, Europejski Komitet Ekonomiczno-Społeczny (Dz.U. UE z 14.03.2013 r. Nr 2013/C 76/11), pp. 59 – 65.
[32] Ibid.
[33] Opinia Europejskiego Komitetu Ekonomiczno-Społecznego w sprawie komunikatu Komisji do Parlamentu Europejskiego, Rady, Europejskiego Komitetu Ekonomiczno-Społecznego i Komitetu Regionów *Europejska inicjatywa dotycząca przetwarzania w chmurze – budowanie w Europie konkurencyjnej gospodarki opartej na danych i wiedzy* z dnia 21 września 2016, Europejski Komitet Ekonomiczno-Społeczny (Dz.U. UE z 28.12.2016 r. Nr 2016/C 487/14), s. 86 – 91.
[34] *Program Zintegrowanej...,* op.cit.
[35] *Opis projektu, Program Zintegrowanej Informatyzacji Państwa do 2020 r.*, MC, 2016, https://mc.gov.pl/projekty/program-zintegrowanej-informatyzacji-panstwa-do-2020-r/opis-projektu (dostęp: 04.09.2016).

aligned to the European strategy Digital Single Market (DSM)[36], focused on the development of digital services[37].

3. As it was indicated earlier, one of the most important benefit of cloud computing is the cost reduction. This is most common in the public cloud, in which investment and ongoing systems maintenance are transferred to the provider. However, in case of private clouds of local governments the provider's role is usually played by the entity's institutions – the units are supposed to cover the costs associated with building and maintaining the cloud as well as the administration of resources. Therefore, the way to make financial savings, as well as the adequacy of inputs to the benefits of cloud each time require a deeper verification. As the interviews conducted by the author in LGU prove, the additional financial support, the source of which are subsidies from the European Union budget, are perceived by the local government as a benefit. The preferred goal for developing financial forecasts for more than 60% of the local government units is to maximize expenditures on investments with the greatest possible support from EU[38]. IT systems developed with the participation of European funds need to focus on the study of the links between planned effects and the effectiveness of obtaining funds for investment[39]. It is therefore necessary to include, in the part of financial analysis, the possibilities of financing IT projects from EU funds. Knowledge obtained in this way can be helpful for planning and execution of the budget.

4. Creating citizen-friendly information space and motivation to increase public participation requires the involvement of local governments. Such a possibility is created by the implementation of elements the concept of smart city, for which it becomes necessary to use new technologies such as cloud computing.

5. Administration of local government units should not only provide a quality service, but also consciously seek to improve the interoperability. The analysis of public value will verify the compliance of the directions of activities of local governments with the desired result.

The literature review showed that on a practical level there are many IT evaluation methods all over the world, which were used in the context of public value creation. Initially more than 60 of such methods were selected. Seven of them were chosen for a detailed

[36] *Konsultacje, Program Zintegrowanej Informatyzacji Państwa, 1. Strategiczny kontekst europejski i krajowy*, MC, 2016, https://mc.gov.pl/konsultacje/program-zintegrowanej-informatyzacji-panstwa/1-strategiczny-kontekst-europejski-i-krajowy-0 (dostęp: 04.09.2016).
[37] Ibid.
[38] K. S. Cichocki, L. Kruś, *Zastosowanie optymalizacji wielokryterialnej w zarządzaniu finansami jednostek samorządu terytorialnego*, „Studies & Proceedings of Polish Association for Knowledge Management" vol. 76, Polskie Stowarzyszenie Zarządzania Wiedzą, Bydgoszcz 2015, pp. 32 – 46.
[39] T. Dziurbejko, *Planowanie rozwoju gminy jako instrument pozyskiwania funduszy pomocowych Unii Europejskiej*, Difin, Warszawa 2006, p. 185.

review. The analysis ensured that none of them was suitable to evaluate the possibility of using cloud computing by LGU. The most important reasons for this can be:

- difficulties in adapting particular methods to Polish legal and administrative system;
- insufficient flexibility of these methods in terms of social and economic realities of LGU;
- ignoring the specifics of the financing of IT by local public administration;
- insufficient support for the analysis of technological and organisational aspects of the uses of cloud computing by local governments.

At the same time local governments do not have enough information to assess the benefits and risks of implementation and using a private cloud. There are no tools that would enable accurate study of this issue at the level of local administration. Such a conclusion results from the structured expert interviews conducted by the author from July to October 2014 in LGU[40].

A similar conclusion involving the lack of a clear opinion of the usefulness of a private cloud for LGU results from the survey conducted by MAC "Computerisation of LGU using cloud computing". More than 49% of respondents could not decide whether their unit should be involved in the project of the implementation of a private cloud.

Therefore, it is difficult for the local government authorities to decide whether using a private cloud is a good way of computerisation. The EChO will allow to determine public value created by the local government using the cloud and the knowledge gained during the evaluation can support the managers of these entities to make decisions related to computerisation.

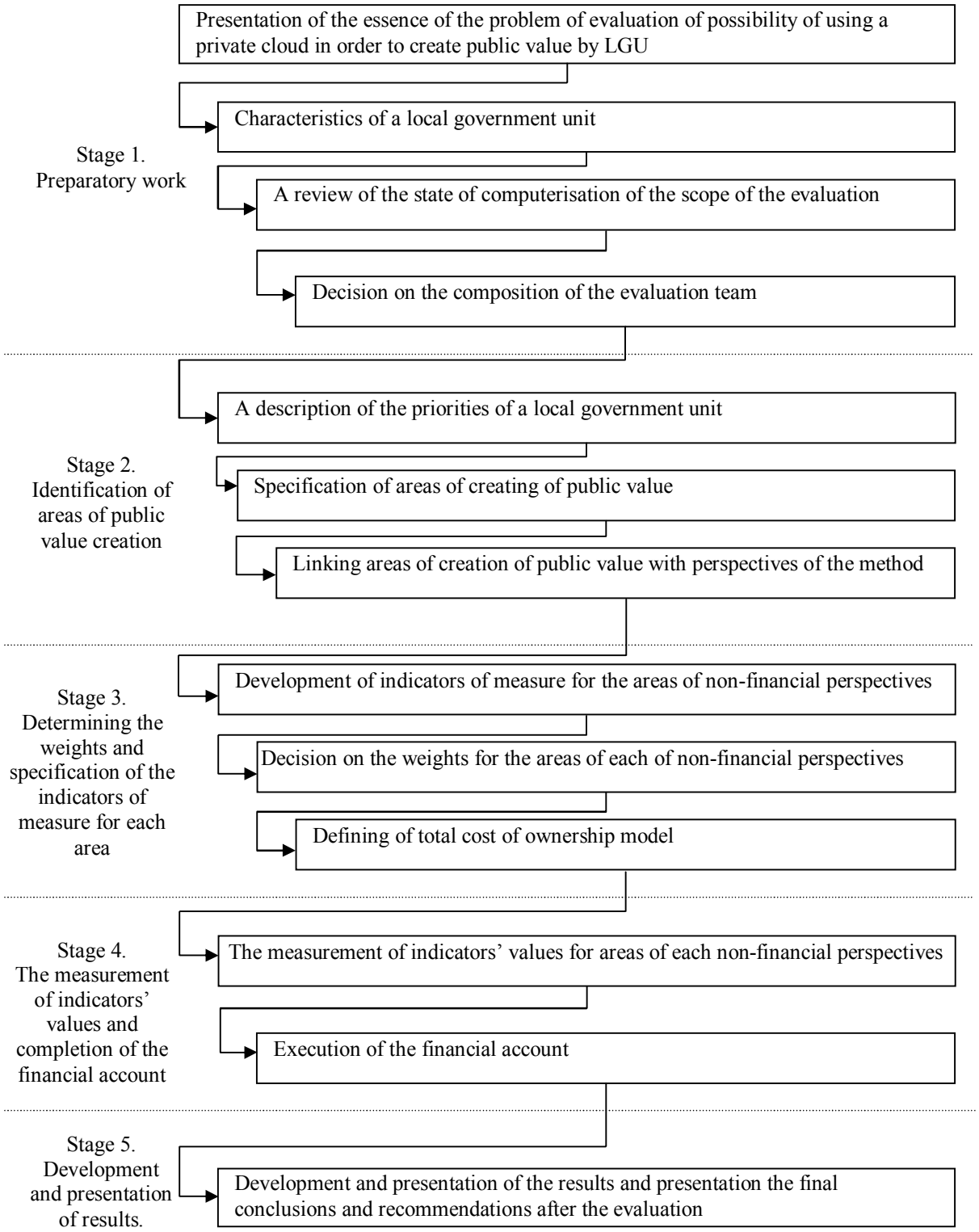
7. The EChO method specification

The EChO method is intended for local governments at all administrative levels - in particular for small and medium-sized municipalities or counties – and it is designed to evaluate the possibility of using a private cloud. Its task is to study public value which is created by local governments using cloud computing.

Implementation of the EChO method enables to obtain information about the actual value of the services provided in the cloud by the local administration, which in turn leads to the improvement of public services: easier identification of stakeholders' expectations and the benefits and concerns associated with a new technology, the increase of the awareness of local

[40] Interviews covered 10 entities of the local administration. Among them there were two counties, seven municipalities and one commune office. Persons who respond to the questions, belonged to the management of IT departments or local authorities. Selection was made from among small and medium-sized local governments to gather data that informs how small municipalities perceive their opportunities to use the potential offered by cloud computing. Choice a group of respondents resulted from the observation that information technology - including cloud computing - is a significant factor in the construction of smart city. Although the concept of smart city was designed for large cities, but the medium and small towns can also take advantage of it.

government bodies concerning the complexity of the problems which are connected with the management of a city (municipality or county) and to see the cloud as a way of co-ordination carried out by local government tasks.



Scheme 2. The stages of the EChO method

Source: own elaboration.

The EChO method is divided into five stages (compare the scheme 2).

1. Preparatory work.
2. Identification of areas of public value creation.
3. Determining the weights and specification of the indicators of measure for each area.
4. The measurement of indicators' values and completion of the financial account.
5. Development and presentation of results.

These steps are performed sequentially, and the information obtained at the end of the particular stage is used in the next one.

The task of the first stage is to make the management of local government units aware of importance of public value and the need to gain knowledge in this field. Then, in this stage the characteristics of the local government unit, where the evaluation is carried out, is developed. In this part of work there is a review of the current state of computerisation of the unit and the description of the evaluated systems. At the end of the stage the composition of the team involved in the evaluation is determined.

Performance of the second stage requires listing the areas important for the creation of public value, and link them with specified benefits, which include both financial as well as non-financial benefits. In the group of non-financial benefits, there are three categories: internal benefits for the organization, benefits for citizens and benefits for the whole society. The result of this stage is assigned areas of creating of public value to one of the four perspectives of the method: operational capacity, citizen and social environment, learning and growth and the financial perspective. The structure of the use of the perspectives refers to the concept of the Balanced Scorecard by Kaplan and Norton[41].

On the third stage the weights for each area of the non-financial perspectives are determined and the indicators of measure are indicated. Weighting procedure is made with the use of the AHP[42] method. In the part concerning the financial perspective the necessary documents should be collected and a cost classification model for IT solutions prepared.

[41] R. S. Kaplan, D. P. Norton, op.cit.

[42] Choosing AHP implies several reasons.

1. Using AHP produces standardized weights, clearly defining the significance of the factor for each perspective, so it allows to identify the priority areas.
2. The algorithm of the AHP method provides with a high probability the achievement of results in a finite time.
3. Due to the large number of redundancy, AHP is resistant to errors that may result from vulnerability of assessments subjectivity involved experts.
4. AHP has clearly defined procedures, so its use does not require subjective interpretation of complexities.
5. There are tools to facilitate the process of prioritizing weights using AHP.

On the basis: T. L. Saaty, L. G. Vargas, *The Seven Pillars of the Analytic Hierarchy Process*, Chapter 2 in: „Models, Methods, Concepts & Applications of the Analytic Hierarchy Process", vol. 34, Springer Science +

The tasks of the fourth stage should be to measure the indicators for each area of non-financial perspective and to prepare the financial characteristics. On the basis of the value of indicators and weights, the results for each of the non-financial perspectives are calculated. Financial Characteristics should include the cost specification and detailing the sources of investment financing the grant – especially the funds of the European Union – and estimating saving (or loss) amounts in IT and beyond IT that result from using cloud computing.

The fifth and the last stage is the final calculation of results based on the data collected so far. The ultimate statement is a combination of results for all four perspectives. The results of non-financial perspectives are expressed in points, while the cost are presented as amounts related to the particular parts of the financial characteristics. The final documentation contains interpretation of the findings, conclusions and recommendations from the conducted evaluation.

8. The results of the implementation of the EChO method

In order to make an empirical verification of the EChO method, two implementations were carried out – the pilot and the main one. In both cases the implementations were carried out in small local government units with less than 30 thousand citizens.

The evaluation of the pilot implementation was carried out in the comparative variant, in which the analysis covered IT systems in commune office before and after cloud computing implementation with a view to the planned development of these.

The application of the EChO method during the pilot implementation proved its usability. The main objectives of the evaluation were achieved. It helped to obtain the knowledge of public value created by the local government by the use of cloud computing, the benefits significantly affecting the value have been identified and recommendations for further computerization were given.

The results obtained show that the chosen direction of computerisation has brought the increase of public value for the unit in all non-financial perspectives. In this particular case, the use of the cloud did not reduce municipal expenditures on maintenance of IT (which results from the fact that the implementation of the new system related to areas that have not been computerised yet, which in turn requires additional costs). There was no significant

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Business Media, New York 2012, 2001, pp. 27 – 46; T. L. Saaty, *Decision Making*..., op.cit.; O. Downarowicz, J. Krause, M. Sikorski, W. Stachowski, *Zastosowanie metody AHP do oceny i sterowania poziomem bezpieczeństwa złożonego obiektu technicznego*, in: O. Downarowicz (Eds.), „Wybrane metody ergonomii i nauki o eksploatacji", Politechnika Gdańska Wydział Zarządzania i Ekonomii Zakład Ergonomii i Eksploatacji Systemów Technicznych, Gdańsk, 2000, pp. 7 – 42; A. Sobczak, *Definiowanie wymagań dla systemów informatycznych typu eGovernment*, Materiały III Ogólnopolskiej Konferencji Naukowej, „Multimedialne i Sieciowe Systemy Informacyjne", Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2002.

effect of computerisation on the level of expenditure in areas beyond IT (e.g. reduction of costs of traditional pen and paper correspondence).

Recommendations for the unit after the evaluation included carrying out the actions to increase the interest of the inhabitants in electronic way of dealing with the administrative matters. Increased use of new services could lead to the further increase of public value in non-financial perspectives. In a longer perspective this could also affect creating financial savings in the local government.

Conducting the pilot implementation also helped to improve the EChO method itself (e.g. by taking into account the specifics of financing investments by local governments).

The main implementation of the EChO method was in a municipal office in a town in central Poland. The evaluation concerned the already implemented modules of a system of public service and SaaS offerings a portal of information exchange for the municipality, residents and businesses in the town. The main idea of building the system was to provide a better alternative way of contact with the municipal office by creating the platform of exchange of information with business, similar to social networks and supported by the local government administration activating citizens in the local environment and increasing social participation. This system was administered by established dedicated organisational entity operating within the IT department of the municipal office.

The evaluation provided the information about the public value created by the use of system of public services, which uses cloud computing. The identification of benefits, which have had a significant influence on the generated value was made. The managing board of the unit also realized the importance of having information about the public value, possibilities of creating it by the local government and potential directions of further improvement and development of the resulting solution.

The direction of computerisation adopted by the municipal office brought, in the operational capacity and learning and growth perspectives, a high score of public value – over 70 out of the 100 potential points. This reflected the improvement of the working conditions of the municipal office, as well as the quality of the electronic services provided. In contrast, the greatest scope for improvement was revealed in the perspective of the citizen and the social environment. In this respect merely 41 points out of 100 were obtained. This resulted in little interest in new services from the citizens. A very low score – only 6 points out of possible 100 – was achieved in the area of building of information society. One of the important reasons for this is the significant influence of so-called human factor and the commitment to dealing with administrative matters in a traditional way.

After the completion of the investment, the fluctuations in the level of expenditure of ongoing IT maintenance was noticed. In 2014 there was an increase in IT costs. At the same time, beyond the IT area there were no savings that could be associated with the implementation of the new IT system. It resulted of little interest in the implemented services by residents and businesses. The system also included new areas that previously were not computerised whatsoever, which resulted in additional expenditures on IT. Thus, mainly non-financial potential benefits and the need to meet the requirements of technological progress stood for the direction of development of computerisation. However, there is the possibility of savings in financial terms.

One of the recommendations after the evaluation concerned carrying out actions among the citizens that would promote the new possibilities of contact with the municipal office via electronic way (the promotional campaign should take into account the specificity of a small town). However, the effects should be expected after a long time, since positive changes in this area need to break the barriers of mentality, which is a long process.

It is worth noticing that the main service, which have already been implemented, was addressed to entrepreneurs (e.g. the portal of information exchange, announcements database, companies database). Therefore, another recommendation concerned the expanding of the offer of electronic services addressed directly to citizens in case of the decision of the municipal office to develop the system. The recommendations also paid attention to the need to promote greater community involvement in a city life by using of IT.

9. Final conclusions from the conducted research

1. There is a need for knowledge – especially local government decision makers – about how to create public value by LGU by using a private cloud.

2. The literature review proved that there are no IT evaluation methods, which would be possible to implement in the local administration offices, using private cloud computing and that would allow to obtain information about the public value created by LGU.

3. The EChO method proposed in the dissertation is a way to carry out evaluation of IT including the conditions of the local government units and the specific private cloud.

4. The developed method allows to identify the areas of creating public value that are significant for local governments. The methods' procedures include strategic priorities of the unit and the needs and expectations of the local community.

5. The analysis of building public value discusses both financial and non-financial factors, and is carried out in four perspectives: operational capacity, citizen and social environment, learning and growth and the financial perspective. The methods' procedures of

non-financial categories allow the identification of internal benefits for the units, benefits for individual citizens and benefits for the whole society.

6. The final result is given as three indicators belonging to the <0, 100> interval in the case of non-financial perspectives and cost savings (or losses) for the financial perspective.

7. This method helps the management of the local government to make decisions concerning the possibility of implementation and development of the private cloud. The method can also be used for the analysis of computerisation carried out by the local government.

8. Applying the EChO method goes beyond the traditional approach to the judgement of information systems. The EChO method makes it possible to:

- take into account the role of the local government as an institution providing public service as high quality as possible;
- increase awareness of the local government unit's management in respect to the needs and the ability to provide public value by the unit;
- enable the analysis of the effects of the implementation of cloud computing for non-financial factors such as: increasing social participation, transparency of the office, the degree of interoperability or creating a friendly - open for information - local administration.

10. Summary and directions for further research

In the light of the considerations the research hypothesis in this dissertation should be considered proven.

An original EChO method proposed by the author allowed the evaluation of the possibility of using a private cloud in order to create public value by a local government unit. It proved that the main research hypothesis (**MH**) is true. The empirical verification relied on conduction of the pilot and main implementations.

Development of the EChO method was preceded by the review of the literature. On the basis of the review an in- depth analysis of 7 chosen methods was performed. The role of the review was to demonstrate existing practical approaches to evaluation of IT in the context of creating of public value and explore ways to adapt them to local governments using the private cloud. The considerations allowed to specify a set of characteristics for the requested method and also they proved lack of methods complying with the specified requirements. Thereby, it indicated the need to develop a new method, which could be useful for the local government units using private cloud computing.

Proving the main hypothesis was supported by proving the auxiliary hypotheses.

Using cloud computing by LGU supports the process of providing public services by the local administration, leading to the creation of public value (hypothesis **AH1**). In the theoretical context it was proven by the analysis of the state of computerisation of government entities and the potential for use of cloud computing. Theoretical conclusions were supplemented by empirical material. There are local governments, which recognized the potential possibilities of using the private cloud and those that have implemented or are planning to implement cloud computing. In the municipal offices where the research was conducted, the benefits of using the cloud were observed. Obtained benefits influenced the public value created by the unit.

In order to prove the second auxiliary hypothesis (**AH2**) the categorization of benefits was made. The benefits are divided into internal benefits for the units, benefits for individual citizens, benefits for the whole society and financial benefits. The division presented in the first section of the chapter formed the basis for classification of evaluation methods of IT. It also showed that those categories of benefits also describe the factors constituting public value. The research of benefits was carried out in four perspectives:

- operational capacity,
- citizen and social environment,
- learning and growth,
- financial perspective.

Empirical verification demonstrated the possibility to identify benefits with the use of the perspectives mentioned above.

According to information obtained directly in the units or on the basis of the analysis of data from MAC it seems that a large percentage of local governments (over 49%) has difficulty to take a position on the applicability of cloud computing. This indicated the need to have an approach allowing to obtain knowledge on the potential use of cloud computing by the government units and the impact of this technology on the creation of public value. Both interviews conducted in the municipal offices, as well as conclusions of the implementation of the EChO method showed that the knowledge obtained in the process of evaluation of using cloud computing conduces to rational decisions concerning the computerisation of the local administration. The evaluation process itself increases the awareness of unit's decision-makers in the area of possibilities and effects of the units computerisation. Thus the third auxiliary hypotheses (**AH3**) was proven.

The analysis of the computerisation of local government units and the indication of the prospects for cloud computing helped to achieve the **objective 1.1**.

The review of the evaluation methods of IT and the proposed approach of classification of these methods led to the achievement of the **objectives: 1.2. i 2.1**.

The development and the presentation of the EchO method characteristics helped to achieve the **objective 2.2**.

Practical verification of the developed method enabled the fulfilment of **objectives 3.1. i 3.2**.

Performance of all the particular objectives with a positive result proves the achievement of the **main objective of the dissertation**.

The author's own research that contributes to the development of science is:

- developing the author's approach to the comparison of already existing methods of evaluation of IT and conducting such comparisons,
- carrying out a depth analysis of the needs and constraints of implementation of cloud computing by local administration based on data obtained from MAC and from interviews conducted in the government units,
- developing and verification author's EChO method.

The developed EChO method is intended for local governments, but using cloud computing is of interest to various public institutions. Adaptation of the EchO method could take place without a lot of work for large academic or polyclinic centres. Adaptation works are connected with defining the legal and organisational framework of functioning of particular public institutions. This would allow to identify the priorities of the organisation and to indicate the set of necessary documents.

The method could also be adapted to the needs of local administration in other European countries (in particular belonging to the European Union). In this case it would be necessary to perform a proper analysis of laws and administrative regulations applied in the particular countries. Then it might be required to align the method's procedures to the implementation and financing of IT within the system's administrative rules. It would also be possible to change the approach to carry out the implementation (e.g. in the wording used, the design of the questionnaires, the conduct of interviews with decision makers and employees of a municipal office according to the regulations, standards and habits of the local culture.

An attempt to adapt the method in the United States would entail more work. The American approach to the computerisation of the public sector requires a precise analysis of risk and compliance with certain standards in this respect. This would require including additional procedures and building a new perspective.

It is planned that further research would focus on expanding the analysis of public value, which is created in urban areas by networking effects. Besides technological innovation including the use of cloud computing, the analysis should contain the cooperation between local governments and other organizations (taking into account the commercial sector, such as banks or private universities), which contribute to the public value.

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