Factors affecting cloud storage adoption by Greek municipalities

Niki Kyriakou
University of the Aegean
Samos, Greece
nkyr@aegean.gr

Loukis Euripides
University of the Aegean
Samos, Greece
eloukis@aegean.gr

Dimitropoulou Paraskevi
University of the Aegean
Samos, Greece
icsd12049@icsd.aegean.gr

ABSTRACT

The public sector in many countries is initially experimenting with and then adopting various forms of Cloud Computing (CC) services, in order to take advantage of the important benefits it can offer over the traditional 'on-premises' model concerning the electronic support of their operations. This study empirically investigates the extent of use of the simplest form of CC services, the Cloud Storage (CS), by the Greek Municipalities, as well as the factors that affect it. Our theoretical background is Rogers' 'Diffusion of Innovation Theory'. The study is based on data collected through a questionnaire from 121 Greek Municipalities. The results of this study paint an encouraging picture: some important steps have been taken concerning the utilization of this technology by the Greek Municipalities, and also there are positive future trends. But at the same time, they indicate a rather defensive and conservative approach of the Greek Municipalities towards the adoption of CS. We have found that its adoption is mainly affected by the perceptions of the Municipalities about the level of threats that this technology poses (mainly the risks of loss, destruction or improper modification of their data), its compatibility with existing procedures, needs and culture, as well as its application complexity and difficulty. However, CS adoption does not seem to be affected by Municipalities' perceptions about the extent of comparative advantages (in comparison with the traditional 'on-premises' model) it offers.

CCS CONCEPTS

• **Applied computing** → **Computers in other domains** → Computing in government → *E-government*

KEYWORDS

Cloud storage, Greek municipalities, cloud computing, e-government

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1. INTRODUCTION

In the last few decades we have experienced revolutionary technological evolutions in several fields, which led to the emergence as well as dramatic improvements of some important information and communication technologies (ICT), such as mobile communications, data analytics, and cloud computing. This opens up significant opportunities for organizations, both in the public and private sectors, to make highly beneficial improvements and innovations in their internal operations, as well as in their products and services. Especially for the public sector the exploitation of these emerging ICTs can provide highly important benefits, such as operating cost reduction, increase of productivity,
as well as better coordination and cooperation among government organizations; furthermore, it will increase the capacity of government organizations to foster economic development, innovation and entrepreneurship, contributing to new jobs, more competitive firms, and better quality of life.

One of these emerging ICT is definitely cloud computing (CC) [5, 17, 20, 31]. It is a new model of providing the ICT services required by organizations for supporting their activities, quite different from the traditional 'on-premises' model, in which these ICT services are delivered by the ICT unit of the organization; in the CC model these ICT services are delivered by an external provider on an on-demand basis over the Internet, independent of device and location, with user firms paying for the ICT services they really use, as an operating expense, without having to make

significant ICT capital expenditures (e.g. for servers and software), and also without having to incur ICT operation, support and maintenance costs [20]. The CC services currently offered can be grouped into three main categories: Infrastructure as a Service (IaaS) (= use of provider's remote storage and computing facilities), Platform as a Service (PaaS) (= remote use of provider's platform, including the above and also software development languages and tools for the development and deployment of applications) and Software as a Service (SaaS) (= remote use of software applications running on provider's systems and supported/maintained by them).

CC literature [5, 16, 17, 20, 31] describes extensively the substantial benefits it can provide: reduction of the costs of these ICT services, and therefore of the operating costs of organizations, improvement of productivity, improvement of products and services, better co-operation with other organizations, higher flexibility and scalability, as well as reduction of required ICT investments (conversion of them to ICT operational expenses). However, the same literature mentions that it can also pose some risks, concerning data loss, destruction or improper modification, data confidentiality (i.e. access by unauthorized entities), data availability (i.e. unavailability for some time periods, e.g. due to Internet problems), or even low speed in the access of data.

Governments around the world are increasingly considering solutions such as CC, as part of their continuous effort to provide lower cost, efficient and better public services [18, 32], and in general develop 'e-government'. The term e-government characterizes the use of ICT by public bodies in order to support and enhance their internal operations as well as the way services are delivered to citizens. E-government is an innovative mechanism that could be used to improve interactions and in general relations between citizens and public organizations and provide to them better quality services [4]. However, the integration of new or more recent ICT into e-government is a difficult task, since there are various factors that have to be considered, such as applications and systems interoperability [9], stakeholder diversity, bureaucracy culture and low propensity for innovations adoption [32].

The emergence of CC can be a good basis for addressing some of the challenges and difficulties in exploiting new ICT in the public sector, so it can create important opportunities for many public organizations, especially the smaller ones. In particular, it is reported that it can revolutionize e-government and public organizations in general, and at the same time save valuable economic resources [18]. CC has a great potential for reducing the high costs of investing in software and/or hardware. For these reasons it has now gained significant prominence in various areas of e-government, and there are many examples of using it to enable the idea of a lower cost, and higher efficiency interconnected government [28, 32].

Extensive empirical research is being conducted concerning the factors that affect the adoption of CC in the private sector, by small, medium-sized or large organizations [e.g. 5, 6, 8, 12, 17, 20, 21]. However, there are not many empirical studies focusing on the factors that affect the adoption of CC in various layers of the public sector (e.g. in central government, regional government, local government, etc.).

This study contributes to filling this research gap. It investigates empirically the extent investigates the extent of use of the simplest form of CC services, the Cloud Storage (CS) (which constitute the simplest type of IaaS services) by the Greek Municipalities, as well as the factors that affect it. Its theoretical background is the widely recognized and used Rogers' Diffusion of Innovation (DOI) Theory [25, 26]. Our study is based on data collected through a questionnaire from 121 Greek Municipalities.

It should be noted that this study is conducted in a national context quite different of the ones of the highly developed countries, both technologically and economically, in which most technology adoption studies are conducted. With respect to ICT development Greece is still behind most of the member states of the European Union: it has low scores for 65 out of the 84 ICT indicators (77%) of the European Digital Agenda [11]. Low broadband penetration and Internet use, along with very small volume of electronic transactions and electronic procurement, are some of the factors that put Greece in this position. Furthermore, Greece in the last decade has experienced a long and severe economic crisis [23, 24], which has reduced the available financial resources as well as the investment (including the ICT ones) in both private and public sector organizations. Furthermore, government organizations had to take many actions in order to address the multiple problems caused by the crisis to the citizens, the firms and the society in general, however having dramatically reduced budgets (in comparison with the pre-crisis period). Especially the Municipalities had to implement various programs for supporting their citizens as well as their local firms that had been most strongly hit by the crisis, with limited financial resources (as the 'austerity programs had reduced dramatically the state finance for the Municipalities); these have put strong pressure on the Municipalities to reduce their operating costs and increase their efficiency of all their activities, including ICT-related ones, and the adoption of CC seems to be a very good option for responding to these options and achieve the above conflicting objectives ('doing more with less money').

This paper consists of six sections. In Section 2 the literature review and the theoretical framework of our study are presented. Then, in Section 3 research hypotheses are formulated. In Section 4 the data and the method of this study are described. The results are presented and discussed in Section 5. Finally, Section 6 concludes with a summary and future research directions.

2. LITERATURE REVIEW

2.1. Cloud Computing Adoption in the Public Sector

There has been extensive research for identifying factors affecting the adoption of CC in general, or specific types of CC services (mainly SaaS ones, as they constitute the most complex forms of CC services) [e.g. 5, 6, 8, 12, 17, 20, 21], by private sector firms; and also for supporting the multi-criteria evaluation of existing alternative CC services provided by different competing service providers, and finally for the selection of the most appropriate one

[1, 29]. However, there are only limited similar studies for the public sector, despite the great potential that CC has for the public sector, and the important opportunities it generates for government transformation [32].

Shin [28] studied the adoption of CC services by government agencies, based on and extending the Technology Acceptance Model (TAM), by incorporating CC perceived availability, access, security and reliability as possible antecedents of the two main factors that according to the TAM determine the degree of acceptance of technologies: the perceived ease of use and the perceived usefulness. The results indicate that all these four CC features are significant antecedents of CC perceived ease of use and the perceived usefulness for government agencies and affect the behavioral intention to use CC and finally its usage.

Hailu [13] examines why ICT leaders in developing countries decide to adopt CC by evaluating their perceptions of security effectiveness, organizational needs, reliability and cost-effectiveness of CC. The results of this research showed that perceptions of security effectiveness, need, reliability and cost-effectiveness of CC correlated positively with ICT leaders' willingness to propose the adoption of CC.

Kuiper et al. [15] develop models of factors influencing CC adoption, by using previous relevant literature and results obtained via desk research and surveys. They conclude that several factors require further research, such as the culture in countries, climate, legislation, economics and politics, ICT staff shortage and feelings of uncertainty, fear and impatience.

Sallehudin et al. [27] investigate empirically the factors that may influence the adoption of CC by public organizations in Malaysia. For this purpose, they developed a model by integrating the DOI with characteristics of ICT personnel (innovativeness and knowledge). The results indicate that CC relative advantage and compatibility, as well as ICT staff knowledge, influence positively the adoption of CC in the public sector.

Polyviou and Polulodi [22] conducted an interview-based research across six European countries aiming to gain a deeper understanding of CC adoption decisions in the public sector, by investigating the technological, organizational and environmental contexts of this adoption. The study concludes that most of the factors that hinder CC adoption in the public sector are mainly relevant to the environmental context (mainly bureaucratic processes, political as well as legal issues); however, there are technological factors (such as CC relative advantages associated with cost savings) as well as organizational factors (such as capabilities for improving interoperability, focusing on core activities and meeting security, environmental and transparency of processes standards) that facilitate and promote CC adoption in the public sector.

Finally, Ali et al. [4] based on the Technology, Organization, Environment (TOE) framework [30] and the Diffusion of Innovation (DOI) model [25, 26], performed an interview-based study concerning the factors that are perceived likely to affect the adoption of CC by Australian municipal governments. The results show that the main factors that affect CC adoption included relative advantage, compatibility, cost, technology readiness, and competitive pressure.

Our study adds to this limited empirical literature concerning factors affecting the adoption of CC in the public sector, focusing on a minimally researched from this perspective layer of it, the Municipalities, in an interesting national context (the Greek one, which does not belong to the most technologically and economically developed countries, and recently experienced a long and severe economic crisis).

2.2. Diffusion of Innovation Theory

The Diffusion of Innovation Theory (DOI) developed by Rogers is definitely the most widely recognized and used theory concerning the dissemination of innovation within organizations [25, 26]. It defines innovation as an idea, process or technology that is perceived as new by an individual, or a firm, or any other unit of adoption; this theory concerns the four main elements that influence the spread of an innovation: the innovation itself, the communication channels, the time, and the social system. In other words, the DOI theory is dealing with 'how', 'why', and 'at what rate' new ideas, technology, and process innovations spread throughout an organization, a society, or a country. The "how" relates to the innovation process. Especially important is the "why", meant as the justification of why organizations are adopting or rejecting an innovation, referring specifically to the perceived attributes of the innovation that determine its adoption.

According to the DOI theory it is five key features of an innovation that mainly determine the degree of its adoption, diffusion and use:

a) its relative advantage, defined as the degree to which an innovation is perceived as better than the idea, work practice or object it supersedes;

b) its complexity, defined as the degree to which an innovation is perceived as difficult to understand, implement and use;

c) its compatibility, defined as the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters;

d) its trialability, defined as the degree to which an innovation may be experimented with in a limited scale, before proceeding to a larger scale adoption/application of it;

e) its observability, defined as the degree to which the results of an innovation are visible by the external environment.

In this study we view the use of CS by the Municipalities as a technological innovation, and we analyze it from the perspective of the DOI theory. In particular, we examine the perceptions of the Municipalities concerning the main aspects of its comparative advantage as well as disadvantage, its complexity and its compatibility; furthermore, we examine to what extent these perceptions affect the adoption of the CS. We do not examine the perceptions of the Municipalities concerning the other two features proposed by the DOI theory, the trialability and the observability, of the CS, as this would be meaningless for this specific technological innovation: i) CS is absolutely trialable, as it provides capabilities for meaningful small-scale experimentations with it, before proceeding to a larger scale adoption/application of it; and ii) CS is not at all observable by the external environment, as it is an exclusively technological intervention, which concerns ICT infrastructure (storage), so it is visible (and dealt with) only

by the ICT unit, and the transition from the traditional internal 'on-premises' storage to the external CS is not visible at all by the external environment (e.g. Municipality employees, local firms and citizens, etc.).

3. RESEARCH HYPOTHESES

Therefore, we have formulated four research hypotheses: the first two of them concern the effects of the perceived CS relative advantages and disadvantages respectively on its adoption (sub-section 3.1); the other two research hypotheses concern the effects of the perceived CS compatibility and complexity on its adoption (sub-sections 3.2 and 3.3 respectively).

3.1. Relative Advantage - Disadvantage

Relative advantage is, as mentioned in the previous section, perceived as the advantage provided by an innovation for an organization over previous ways of performing the same task [2, 19, 25, 26]. According to the DOI theory this is the most important determinant of the rate of adoption of an innovation in an organization, which can be shaped by a variety of positive or negative sub-factors [6, 7, 25, 26]. Such factors can be the magnitude of the time, effort and cost savings that will result from the application of the innovation.

Borgman et al. [6] found that the relative advantage of CC is positively associated with the adoption of it. However, a second notion of relative advantage is that of the technological features offered, which include the simplicity of the business process (mobilization, coordination, and communication). However, the level of confidence will be low if organizations are inexperienced or relatively new to cloud computing [7].

With respect to this specific CS innovation we expect that the extent of the relative advantages of it over the 'traditional' on-premises storage perceived by the Municipalities, such as cost reduction, productivity increase and better cooperation with other municipalities or organizations [5, 16, 17, 20, 31], will affect positively the adoption of CS. However, the same literature states that it has also some relative disadvantages over the 'traditional' on-premises storage, such as the risks it poses concerning loss, destruction or improper modification of data, data confidentiality violations (i.e. access by unauthorized entities), data unavailability for some time periods (e.g. due to Internet problems), or even low data access speed (e.g. due to variations of Internet speed). We expect that the extent of these relative disadvantages perceived by the Municipalities will affect negatively its adoption. Thus, our first two research hypotheses are:

Hypothesis 1: *The perceived relative advantages of Cloud Storage have a positive effect on its adoption by the Municipalities.*

Hypothesis 2: *The perceived relative disadvantages of Cloud Storage have a negative effect on its adoption by the Municipalities.*

3.2. Compatibility

According to the DOI [25, 26] an innovation that is understood to be compliant with previous experience and practice of an organization, with its work processes, procedures and practices, as well as with its culture and values, will have a high adoption rate. The rate of adoption of a technological innovation by an organization can be slowed down or accelerated depending on the compatibility of the innovation with pre-established systems or technologies. According to Alam et al. [3], organizations should promote the adoption of innovation after defining their specific requirements from it, concerning meeting their specific needs. If the innovation is compatible with the needs, then the rate of adoption will be faster and higher.

For the CS innovation we expect that the extent of the perceived compatibility of it with the processes, the procedures and the work practices of Municipalities (which exist for long time, and most of them are defined by law), especially the ones related with procurement, will impact positively its adoption. Furthermore, we expect also that the extent of the perceived compatibility of it with the mentality, the culture and the values of the Municipalities will impact positively its adoption. So, our third research hypothesis is:

Hypothesis 3: *The perceived compatibility of Cloud Storage has a positive effect on its adoption by the Municipalities.*

3.3. Complexity

The degree of complexity of innovation, measured through the degree of difficulty and effort requirements for understanding and using it, is according to the DOI theory [25, 26] one of the main determinants of its adoption and diffusion rate. One of the biggest barriers to adopting an innovation is the difficulty of understanding and the complexity of using it. CC is a new business model for external sourcing ICT services, which is quite different from the traditional model of internal sourcing of ICT services (i.e. delivery of them by the internal ICT unit of the organization), so there is much less knowledge of and familiarity with it, and this increases its perceived complexity by organizations interested in adopting it. Especially for the case of the CS innovation the lack of knowledge and experience about sourcing this new kind of service (defining requirements, selecting CS service providers, negotiating with them, writing contracts, and then monitoring performance and managing the contracts), as well about its interconnection and interoperability with 'on-premises' ICT resources, increases the complexity of CS that perceived by the Municipalities. So, we expect that the extent of the perceived complexity of CS will affect negatively its adoption. Thus, our final research hypothesis is:

Hypothesis 4: *The perceived complexity of Cloud Storage has a negative effect on its adoption by the Municipalities.*

4. DATA AND METHOD

In this study, we have used data collected through a questionnaire, titled "Usage of Cloud Storage by Greek Municipalities", which was sent to all 332 Greek Municipalities. We received filled questionnaires from 121 Greek municipalities (response rate 36,45%.), from 43 among the 54 Greek counties. We should note that the sample of our study consists of both small and large size municipalities. Almost half of the Municipalities (51,3%) of our sample were small (with 1-150 employees), while the remaining (48,7%) were large (with more than 150 employees). The number of Municipalities per county in our sample is shown in Figure 1.

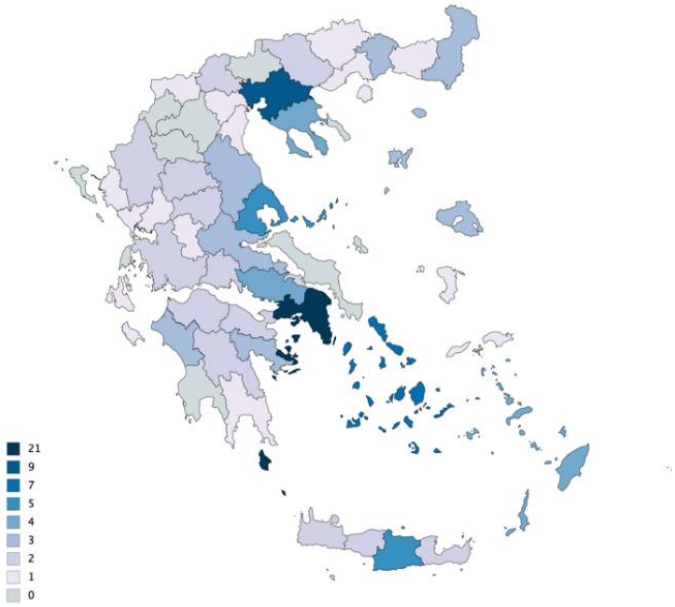

Figure 1: Number of Municipalities per County

Our questionnaire included several questions for each of the core variables of our study, which are shown in the Appendix. In particular, it includes one binary (yes/no) question concerning the current use or not of CS, which has been used as dependent variable. Furthermore, it includes three questions concerning the perceived relative advantages of CS; they aim to assess to what degree the respondents agree that CS provides advantages concerning provides advantages with respect to operating cost reduction, productivity increase as well as better cooperation with other municipalities or organizations. Then follow four questions concerning the perceived relative disadvantages of CS: they aim to assess the degree of agreement of the respondents that CS poses risks of data access by unauthorized entities, data loss/destruction or improper modification, data unavailability and low speed of access to the data. Next, we have two questions concerning the perceived complexity of CS; they aim to assess the degree of agreement of the respondents that CS is difficult and complicated, and that it needs significant effort. Finally, we have two questions concerning the perceived compatibility of CS; they aim to assess the degree of agreement of the respondents that CS is compatible with the processes and the way that the Municipality works, as well as with the culture and mentality of the Municipality. All these questions were used as independent variables (they were all in a 5-point Likert scale, where 1: strongly disagree, 2: disagree, 3: neutral, 4: agree, 5: strongly agree). Also, there was also one question concerning the size of the Municipality, measured through the number of its employees.

As mentioned earlier, in this study we focus on the first three features of an innovation that according to the DOI theory [25, 26] determine the degree of adoption and diffusion of an innovation (relative advantage, complexity and, compatibility), which are more applicable to CS, i.e. the particular technological innovation we study; the other two innovation features proposed by the DOI theory are not applicable for our case, since CS by nature allows an organization to experiment with it in small scale, and also is not visible at all by the external environment.

Four stages of processing of the collected data were conducted:
a) Initially, we calculated descriptive statistics for all our variables: relative frequencies for the CS adoption dependent variable, and for the eleven relative advantages', relative disadvantages', complexity and compatibility independent variables; and also average for the number of employees.
b) Then, we proceeded to the calculation of the correlations of the above eleven variables with CS adoption dependent variable, which provide a detailed picture of the impact of these specific aspects of CS relative advantage and disadvantage, complexity and compatibility on its adoption.
c) Next, using Principal Components analysis with Varimax rotation from the above eleven independent variables we extracted components/factors, which as described in the following section 5.3 correspond to the four main independent variables of our study: CS relative advantage, relative disadvantage, complexity and compatibility.
d) For these four components/factors we calculated their correlations with the dependent variable, and then we used them for estimating the following regression model:

$$Cloud\_Storage\_Adoption = b_0 + b_1*size + b_2*comp\_advantage + b_3*comp\_disadvantage + b_4*complexity + b_5*compatibility + b_6*size + e_i \quad (1)$$

5. RESULTS AND DISCUSSION

5.1. Descriptives

In Figure 2 we can see the calculated relative frequencies of the independent variables; with respect to the dependent variable 23,1% of the Municipalities of our sample use CS, while another 38,8% plan to use this technology in the near future. The average of the size (number of employees) variable is 211,18.

From Figure 2 we can see that 74% of the respondents strongly agree or agree that CS can provide advantages concerning productivity improvement, and only 3,3% strongly disagree or disagree; these percentages are 60% and 14% respectively for operating costs reduction, and also 63% and 9% for the improvement of cooperation with other municipalities or

organizations. Therefore, Municipalities' perceptions about the benefits that CS can provide seem to be positive: they believe that CS can contribute to the reduction of their operating costs, the improvement of their productivity and also to the increase of their capacity to co-operate with other Municipalities or other public organizations.

Furthermore, with respect to the comparative disadvantages we can see that 61% of the respondents strongly agree or agree that CS poses the risk of data confidentiality violations (i.e. access to their data by unauthorized entities, and only 17% strongly disagree or disagree; these percentages are 52% and 17% for the risk of lower data access speed, and become 44% and 25% for the risks of data loss/destruction/improper modification and data unavailability. Therefore, the Municipalities perceive CS as risky, mainly concerning the unauthorized access of their data and also problems of low speed access to their data, e.g. at some points in which their Internet connections' speed falls (causing to them operational problems, delays in citizens' service, etc.); and to a lower degree concerning data loss/destruction/improper modification, probably because they trust the technological infrastructures of CS services providers (e.g. having sufficient storage and datacenter redundancy) as well as their procedures (e.g. for data back-up), and data unavailability.

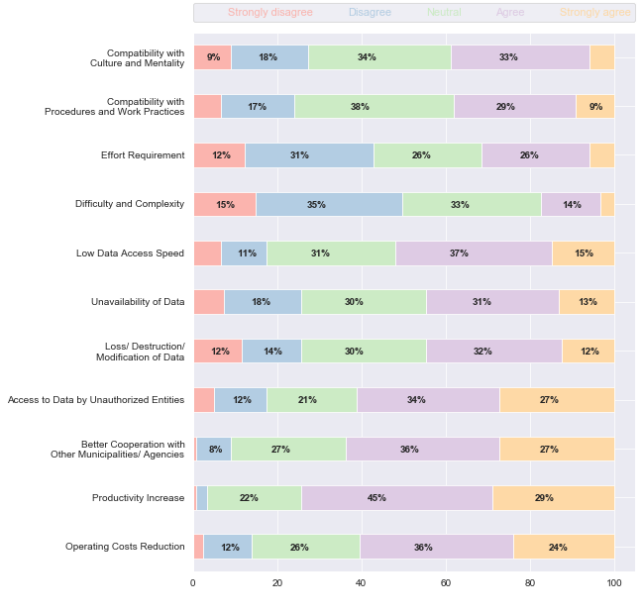

Figure 2: Relative Frequencies of Independent Variables

On the contrary, the perceptions of the respondents are positive with respect to the complexity and effort requirements of CS are positive: 50% of the respondents strongly disagree or disagree that the use of CS by the Municipality is difficult and complicated, and only 17% strongly agree or agree; also, 43% strongly disagree or disagree that the practical application of CS needs significant effort, while 31% strongly agree or agree.

Finally, with respect to CS compatibility the perceptions of the respondents are rather positive: 38% of the respondents strongly agree or agree that CS is compatible with the processes and work practices of the Municipality, while 24% strongly disagree or agree; similar are these percentages concerning the compatibility of CS with the culture and mentality of the Municipality (39% and 27% respectively).

5.2. Correlations

The second column of Table 1 shows the Pearson correlations of all independent variables with the dependent one, while the third and the fourth column show the corresponding values of the Kendall tau-b and Sommers' D coefficients respectively (the statistically significant ones are shown bold and shaded).

We can see that three of our independent variables have positive and statistically significant correlations, as well as Kendall tau-b and Sommers' D coefficients, with the dependent variable, which indicate positive impact on CS adoption: the perceived compatibility of CS with the procedures and work practices of the Municipalities has the highest values, followed by the perceived contribution of CS to productivity increase, and its perceived compatibility with the culture, mentality and attitudes of the Municipalities.

Also, there are three independent variables that have negative and statistically significant correlations, as well as Kendall tau-b and Sommers' D coefficients, with the dependent variable, which indicate negative impact on CS adoption: the perceived risks posed by CS concerning data loss/destruction/improper modification, its perceived difficulty and complexity, as well as the perceived effort required for using it.

Table 1: Pearson Correlation, Sommers' d and Kendal tau-b Coefficients of the Dependent Variable Independent Variables with

	Pearson	Kendall tau-b	Sommers' d
Operating Costs Reduction	095	.111	.104
Productivity Increase	**.147**	**.190**	**.181**
Better Cooperation with other Municipalities/Agencies	-.096	-.043	-.040
Access to Data by Unauthorised Entities	-.043	-0.37	-.035
Loss/Destruction/Modification of Data	**-.243**	**-.196**	**-.182**
Unavailability of Data	-.121	-.106	-.099
Low Data Access Speed	-.092	-.044	-.042
Difficulty and Complexity	**-.150**	**-.149**	**-.140**
Effort Requirement	**-.173**	**-.158**	**-.147**
Compatibility with Procedures and Work Practices	**.178**	**.166**	**.156**
Compatibility with Culture and Mentality	**.144**	**.139**	**.131**

The above results indicate that among the examined independent variables the one that has the strongest influence on the adoption of CS is the perceived level of risk posed by it concerning loss, destruction or improper modification of data

(having a statistically significant negative Pearson correlation coefficient – 0.243). The Municipalities are the layer of government that has most of the direct contact and interaction with citizens (providing a wide variety of services) and firms (for licensing most of their activities and also for provision of various services). For this purpose, they collect and manage large quantities of data about local firms and citizens, as well as relevant licensing and services' provision. If these data are lost/destroyed the Municipalities will not be able to carry out the most important of their competences and responsibilities; furthermore, if these data are improperly modified (due to a technical mistake, or intentionally) this can lead to incorrect or illegal decisions or actions, with quite negative consequences (leading even to legal action by firms or citizens, or sanctions by higher levels of government). For the above reasons the Municipalities feel that the loss of direct control of these data, due to their storage in ICT infrastructures of external service providers, generates high risks of loss/destruction of them, or improper modification of them (44 % of the respondents strongly agree or agree to this, as reported in 5.1 – see Figure 2), and this due to its abovementioned quite negative consequences affects negatively their propensity to use external CS services.

The independent variable that has the second strongest influence on the adoption of CS is its perceived compatibility with the processes and work practices of the Municipalities (having a statistically significant positive Pearson correlation coefficient 0.178). Both the processes and work practices of the administrative units, and the ones of public procurement, and also the ones of the ICT unit, are oriented mainly to/based on 'on-premises' storage of the critical data of the Municipality (on computers owned and fully controlled by the Municipality); so the transition to external storage of these data might give rise to important problems of incompatibility with existing processes and work practices, which will necessitate substantial changes of them, and this can affect negatively their propensity to use external CS services.

On the contrary, we can see that the perceived level of benefits provided by CS with respect to operating costs reduction does not seem to influence the CS adoption decision. Despite the long and severe economic crisis that Greece experiences in the last decade [23, 24], which increases the pressure on Municipalities to take additional actions and implement programs in order to assist the local firms and citizens who have been hit most strongly by the crisis, however with significantly reduced financial resources (due to the government 'austerity programs'), thus necessitating dramatic efficiency improvements and operating costs reductions, the important benefits that CS can offer in these directions do not seem to be strong drivers of its adoption.

5.3. Principle Components Analysis

For the above 11 'detailed' independent variables we conducted Principal Component Analysis (PCA), with Varimax rotation, in order to extract a smaller number higher order factors-components from them, which incorporate and summarize most of the information of the initial variables' set, and also are uncorrelated, so they are more appropriate to used in a regression as independent variables [14]. Four factors-components have been extracted (having eigenvalues > 1), which capture 71,65 of the variance their rotated component matric is (after the Varimax rotation) is shown in Table 2. For determining the interpretation – meaning of each factor we examine the loadings of the initial variables in Table 2, focusing on the ones having loadings higher than 0.5 that influence it most, and discard the ones having loadings lower than 0.3, as recommended by relevant statistical literature [14]. From these loadings we can conclude that the four extracted factors-components 1 to 4 correspond to the four main variables of this study: CS perceived relative disadvantage (component 1), compatibility (factor 2), complexity (factor 3) and relative advantage (factor 4).

Table 2: Rotated Component Matrix

	Component			
	1	**2**	**3**	**4**
Operating Costs Reduction	-.091	.284	.181	**.755**
Productivity Increase	.112	.381	-.125	**.611**
Better Cooperation with other Municipalities/Agencies	.069	-.043	-.159	**.787**
Access to Data by Unauthorised	**.781**	-.078	-.081	.227
Loss/Destruction/Modification of Data	**.859**	-.055	.050	-.015
Unavailability of Data	**.823**	-.028	.063	-.001
Low Data Access Speed	**.706**	.156	.212	-.089
Difficulty and Complexity	.121	-.170	**.880**	-.030
Effort Requirement	.065	-.081	**.913**	-.066
Compatibility with Procedures and Operating Mode	.050	**.872**	-.160	.212
Compatibility with Culture and Mentality	-.076	**.888**	-.091	.128

These four factors-components and their corresponding items are shown in Table 3; in the final column of it we can see their correlations with the dependent variable. The CS compatibility has positive and statistically significant correlation with CS adoption (0.187), while CS complexity and relative disadvantage have negative and statistically significant correlations with CS adoption (-0.129 and -0.151 respectively); on the contrary, the correlation of the CS relative advantage factor-component with CS adoption is not statistically significant.

Table 3: Factors, Variables and Correlations

Factor		Name	Pearson Correlation
Factor 4	Operating Costs Reduction	CS Relative Advantage	.014
	Productivity Increase		
	Better Cooperation with other Municipalities/Agencies		
Factor 1	Access to Data by Unauthorised	CS Relative Disadvantage	**-.151**
	Loss/Destruction/Modification of Data		
	Unavailability of Data		
	Low Data Access Speed		
Factor 3	Difficulty and Complexity	CS Complexity	**-.129**
	Effort Requirement		

Factor 2	Compatibility with Procedures and Work Practices	CS Compatibility	**.187**
	Compatibility with Culture and Mentality		

5.4. Regression

Finally, in Table 4 we can see the estimated model (1) (see section 4) of the CS adoption, using logistic regression since the dependent variable is binary (in the second column we can see the exp(b) for each independent variable; values higher than 1 indicate positive effects, while values lower than 1 indicate negative effects; statistically significant ones are shown bold and shaded). From this model, we can see that CS perceived compatibility has a statistically significant positive effect on the adoption of CS, while CS perceived relative disadvantage and complexity have statistically significant negative effects. The perceived relative advantage does not have a statistically significant effect on CS adoption. Also, the size of the Municipality is not playing an important role on the adoption of CS as its effects appears to be statistically non-significant. The above results indicate that the adoption of this simplest form of CC services, the CS ones, by Greek Municipalities is driven mainly by their perceptions about the levels of the relative disadvantages (risks) its poses, and also its application complexity and difficulty, as well as its compatibility with existing procedures and mentalities, but not by their perceptions about the relative advantages (benefits) it can provide.

Table 4: Estimated Model of Adoption of Cloud Storage

Factor	Pearson Correlation
CS Relative Disadvantage	**.704**
CS Compatibility	**1.710**
CS Complexity	**.718**
CS Relative Advantage	1.023
Size	1.558
N	119
Wald chi^2	29.746
R^2	0.125

6. CONCLUSION

In the previous sections of this paper an empirical study has been conducted concerning the factors that affect the adoption of the simplest form of CC, the CS, by Greek Municipalities, having as theoretical foundation the widely recognized and used DOI theory [25, 26]. It has been based on data collected through a questionnaire from 121 Greek Municipalities, both small and large ones, from various geographical areas.

The analysis of these data has given interesting insights concerning the level of current use of CS Greek Municipalities, their perceptions about various aspects of CS, as well as the factors that affect its adoption. A positive conclusion is that already there is some activity as well interest in this direction: 23,1% of the Municipalities of our sample already use CS, while another 38,8% plan to use this technology in the near future. Also, the respondents have positive perceptions concerning the advantages and benefits that the use of CS of data can offer in comparison with the traditional 'on-premises' storage: they believe that it can contribute to operating costs reduction and productivity increase, as well as to an improvement of the capacity of the Municipality to co-operate with other Municipalities or other public organizations. At the same time they believe that CS poses some important risks, due to the loss of control of direct control of their data assets, which are mainly associated with access to their data by unauthorized entities, but also loss/destruction/improper use of these data, loss of their availability or low speed access to them for some time periods (e.g. due to problems or low speed in their Internet connections). Finally, they do not find the application and use of the CS as particularly complex and difficult of CS application and perceive it in general as rather compatible to their processes, work practices and mentalities.

However, when it comes to CS adoption, the level of the perceived relative advantages and benefits it can offer (especially with respect to operating costs reduction and better support of the co-operation with other Municipalities or other public organizations) does not seem to influence the decision to adopt it. This is not in agreement with the findings of other previous empirical studies concerning the factors affecting the adoption of CC in the public sector, reviewed in section 2.1, such as [4, 13, 22, 27, 28], which have found positive effects of the perceived advantages, benefits and usefulness of CC on its adoption. On the contrary, we have found that CS adoption is influenced mainly: a) by the perceptions about the level of potential threats it poses (e.g. risk of data access by unauthorized entities, or data loss, destruction, or improper/undesirable data modification); b) by the perceptions about the difficulties and effort requirements of its adoption, as well as about its compatibility with existing processes, work practices and mentalities (which is also associated with possible difficulty and effort requirement for adaptations of some processes and work practices, and also education for changing relevant attitudes and obtaining relevant skills). The above indicate a rather defensive and conservative approach of the Greek Municipalities towards the adoption of CS, which does not place much emphasis on the opportunities, advantages and the benefits it can provide, but place emphasis mainly on the threats-risks it poses, and also on the effort it will require. We should recognize that public organizations do not experience the intensive competition that private firms face, which increases the pressure and motivation for adopting efficiency-increasing technologies and innovations in general. However, public organizations face to some extent pressure from society to become more efficient, to provide more and better services to citizens and firms, and to address the big problems and challenges of modern societies, without spending too large amounts of financial resources; this creates some pressure and motivation (though not as much as in the private sector) for adopting efficiency-increasing technologies and innovations. So, we would expect that Greek Municipalities, facing a strong pressure from the society to take a wide range of actions and implement programs for assisting and relieving significant parts of it (e.g. firms and citizens) that have been strongly hit by the long and severe Greek economic

crisis [23-24], however with limited financial resources (due to the long austerity programs in progress), might place more emphasis on the opportunities generated by new technologies for improving its efficiency and productivity, and reducing its operating costs.

Our study has interesting implications for research and practice. It makes a contribution to the existing limited empirical research concerning the use of CC in the public sector, and the factors affecting it, in a national context quite different from the ones of the few technologically and economically developed countries, in which most similar studies are conducted: the Greek national context, which is characterized by lower levels of technological and economic development, and also a long and severe economic crisis that has hit large parts of the Greek society and economy. With respect to practice, it highlights the need for placing more emphasis (both from technological and organizational perspectives, by both the CS service providers and the Municipalities) on addressing the main barriers to the adoption of CS: the risks it poses concerning unauthorized access to the data as well as data loss, destruction or improper/undesirable modification.

Further research is required for gaining a better understanding of the perceptions about CS, and other kinds of CC services a well, as well as factors affecting their adoption, in the context of public sector. It is particularly important to investigate the effects of a wider range of factors, probably based on the TOE framework [30] (so investigate a wide range of technological, organizational and environmental factors), on the adoption of different kinds of CC services (such as IaaS, PaaS, SaaS), by different layers of government (e.g. central, regional, local government) in different national contexts.

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APPENDIX: Questionnaire - Variables

Variable	Question	Scale
Size	Number of employees.	number
Cloud_storage_adoption	In your municipality, do you use cloud storage?	1-Yes, 0-No
Relative Advantage	To which degree do you agree or disagree that cloud storage provides advantages concerning operating cost reduction?	5-point Likert scale
	To which degree do you agree or disagree that cloud storage provides advantages concerning productivity increase?	5-point Likert scale
	To which degree do you agree or disagree that cloud storage provides advantages concerning better cooperation with other municipalities or organizations?	5-point Likert scale
Relative Disadvantage	To which degree do you agree or disagree that cloud storage usage poses the risk of data access by unauthorized entities?	5-point Likert scale
	To which degree do you agree or disagree that cloud storage usage poses the risk of loss/destruction or improper modification of data?	5-point Likert scale
	To which degree do you agree or disagree that cloud storage usage poses the risk of data unavailability sometimes?	5-point Likert scale
	To which degree do you agree or disagree that cloud storage usage poses the risk of low speed access to the data?	5-point Likert scale
Complexity	To which degree do you agree or disagree that cloud storage usage by municipalities is difficult and complicated?	5-point Likert scale
	To which degree do you agree or disagree that cloud storage usage by municipalities needs significant effort?	5-point Likert scale
Compatibility	To which degree do you agree or disagree that cloud storage usage by municipalities is compatible with the processes and the way that the municipality works?	5-point Likert scale
	To which degree do you agree or disagree that cloud storage usage by municipalities is compatible with the municipality's culture and mentality?	5-point Likert scale