EGOV-CeDEM-ePart

Exploring ICT Expenditures and Their Relationship with e-Maturity. The Case of Italian Local Governments

Luca Tangi*, Marco Gaeta**, Michele Benedetti***, Giuliano Noci****

*Joint Research Centre, European Commission. Via E. Fermi, 2749, 21027 Ispra VA, (Italy), luca.tangi@ec.europa.eu.
**EasyGov solutions s.r.l, Via Comina, 39 – 20831 Seregno (MB) Italy, marco.gaeta@easygov.it
***Politecnico di Milano, Department of Management, Economics and Industrial Engineering, via Lambruschini 4b building BL26b 20156 Milan, Italy, michele.benedetti@polimi.it
****Politecnico di Milano, Department of Management, Economics and Industrial Engineering, via Lambruschini 4b building BL26b 20156 Milan, Italy, giuliano.noci@polimi.it

Abstract: The article undertakes a quantitative approach to investigate the relationship between ICT expenditures and e-maturity in local governments. We rely on data belonging to a unique database on 7106 Italian local governments. We propose a way of assessing e-maturity on a large scale, and we test the relation between e-maturity and ICT expenditures. Results partially confirm the existence of a statistically significant relationship between the two factors. In particular, we observe different patterns depending on the size of the organisation. For small local governments, e-maturity is related with ICT expenditures, meaning that the how (the decision on money allocation) is more important than the how many (the total amount of money spent). On the contrary, for medium and large municipalities, this relation exists, hence a higher e-maturity level is associated with higher ICT expenditures.

Keywords: e-government, e-maturity, ICT, expenditures, local government

1. Introduction

Online service provision, digital transformation, and the need for tailored investments in Information and Communication Technologies (ICT) in public administration have gained momentum in recent decades. In particular, since early 2000, scholars start looking at the best way for defining digital maturity (hereinafter e-maturity), defined as the extent to which a public organization is using digital technologies and online channels in order to manage and deliver its public services (Andersen et al., 2020). After more than two decades of research, scholars are still debating on e-maturity. Moreover, in the current body of literature, often scholars focus on theoretical models (Andersen et al., 2020) or specific case studies, leaving a gap of quantitative studies (Budding et al., 2018 & Tangi and Soncin, 2021). Finally, in looking at e-maturity and its

determinants, scholars rarely take into consideration its relation with ICT expenditures (Ashaye and Irani, 2019). The latter is becoming an extremely up-to-date topic due to COVID-19: governments are called to manage a huge amount of resources (the NextGenerationEU) to rebuild a post-COVID-19 Europe, also fostering the digitization of the public sector.

Our research aims at answering the following research question: are ICT expenditures positively related to e-maturity in local governments? In the concept of ICT expenditures, we include the entire amount of money spent in ICT in a year. The answer to this research question is investigated thanks to an original database on Italian local governments (or municipalities, the two terms are used as synonyms) that collects data from 7106 municipalities regarding the adoption of digital services. In order to answer to the question, we also introduce a novel quantitative measure of e-maturity based on the level of adoption of digital services.

2. Literature Review

The first model that traces the path of the research concerning e-maturity was proposed by Layne and Lee (2001). From that time on, several different models were identified (Andersen et al., 2020). All those models are conceived as stepwise subsequent stages. Recently several criticisms has been made on the existing e-maturity models (Andersen et al., 2020). The main criticism is related to the existence of an optimal e-maturity level, that all public organizations are called to reach, and that is independent from the context a public organization is embedded in (Andersen et al., 2020 & Tangi and Soncin, 2021). Moreover, the majority of the models are administration-centered, thus they look at the presence and the quality of the digital service. This perspective is restrictive because it does not take into account the effective usage of the service by the final users (Andersen et al., 2020 & Tangi, Benedetti et al., 2021).

Previous research led to different and sometimes opposing results in understanding which factors influence e-maturity. Those factors can be divided into socio-economic factors (for example income per capita), environmental factors (for example population), and organizational factors (for example political motivation) (Budding et al., 2018 & Tangi, Janssen et al., 2020). Despite the controversial results obtained by previous research, the population is the only influencing factor for which scholars came to an agreement (Budding et al., 2018). Moreover, the relation between e-maturity and ICT expenditures was never tested on a large scale, even though scholars often argued that the implementation of digital services initiatives requires a strong effort in terms of needed investments (Dahiya and Mathew, 2018). On the opposite, the topic is broadly discussed in the private sector literature (see for example Aral and Weill, 2007).

Given these premises, the main contribution of this paper is the test of the following hypothesis:

Hp: ICT expenditures by local governments is positively associated with e-maturity.

We focus on local governments because they are in charge of the delivery of the majority of public services. Thus, they are the optimal sample for assessing e-maturity.

3. Methodology

3.1 Data

The database used for this study is an official, public database that is the results of a survey delivered by the Italian Supreme Audit Institution ('Corte dei Conti') to all Italian public organizations, and represents an official, complete and reliable data source. Data are self-declared by the organizations. The survey compilation was compulsory and remained active for almost one year until 30th October 2019. The survey is divided into thirteen sections. We consider a subset of two sections, related to digital services supply and ICT expenditures.

The first section addresses the topic of digital services supply. The survey considers a sample of 23 services overall. For our study, we select a sub-sample because not all the services were delivered by all the Italian local governments (for example if a local government does not have a school, it does not provide any school-related service). We select the following 10 services: (i) Registry certificate, (ii) Change of residence, (iii) Electoral card, (iv) Disability placard, (v) Building authorization, (vi) Land registry, (vii) Contraventions, (viii) Garbage fee, (ix) Land occupation fee, and (x) Properties fee. For each service, local governments declared whether they were delivering it through the digital channel and the percentage of requests that were issued online out of the total number of requests received by the organization in one year. Hereinafter the latter percentage value is labelled as "penetration". In the second section, local governments had to declare their expenditures in ICT in the time frame ranging from 2016 and 2018. Overall, 7.153 local governments have answered to the survey, and, after data cleaning, 7.106 answers, which consists of almost 90% of the total Italian local governments, represent the sample of the analysis. The size of the sample ensures representativeness.

3.2 Data Cleaning and Analysis

E-maturity is assessed based on the declared penetration. First, for each service, we calculate the descriptive statistics: mean, standard deviation, first and third quartiles. In doing that, we deleted 47 anomalous responses. Second, for each observation, we substitute penetration with a replacing value, as reported in Table 1. This substitution allows to look at penetration in relative terms, thus taking into consideration the overall distribution of the indicator for each service. Third, for each municipality, we calculate the e-maturity score. The score is the arithmetical sum of the replacing values. For the municipalities that do not provide any digital service, the e-maturity score is equal to 0.

Table 1: Assignment of replacing values according to penetration values

Penetration ≥	Penetration <	Replacing Value
0 %	1%	0
1%	Q1	0,1
Q1	Mean	0,3

Penetration ≥	Penetration <	Replacing Value
Mean	Q3	0,6
Q3	**100 %**	**1**

Finally, we segment the sample into five different clusters according to the e-maturity score and we label the clusters accordingly (Table 2).

Table 2: Definition of maturity clusters

Cluster	Replacing value ≥	Replacing value <	Label
1		0%	No Digitals
2	0%	Q1	Beginners
3	Q1	Mean	Moderates
4	Mean	Q3	Believers
5	**Q3**		**Champions**

As the second and more important step, we look at ICT expenditures. We consider the average of the three years of expenditures declared (2016-2018) and we calculate the expenditures per capita by dividing for the population. In this phase, we perform a data check that results in the elimination of 804 answers due to data unavailability.

Finally, for testing the hypothesis, we perform linear regression analyses. First, we divide the sample into 7 categories considering the population. In fact, there is a significant difference between small and big municipalities, thus it was not possible to include all the items in the same regression analysis. Second, for each category, we perform a linear regression analysis between the three-year average ICT expenditures per capita and the identified clusters. The only exception is the cluster that includes municipalities with more than 250k inhabitants.

4. Results

Table 3 summarizes the results given by the separation into clusters. First, we notice that the biggest class is represented by the No Digitals, that account for almost 42% of the Italian municipalities. Only a few municipalities (13%) reach a high e-maturity level. Second, the level of e-maturity is strictly related to the size of a municipality. Small municipalities have more difficulties in reaching a high e-maturity level.

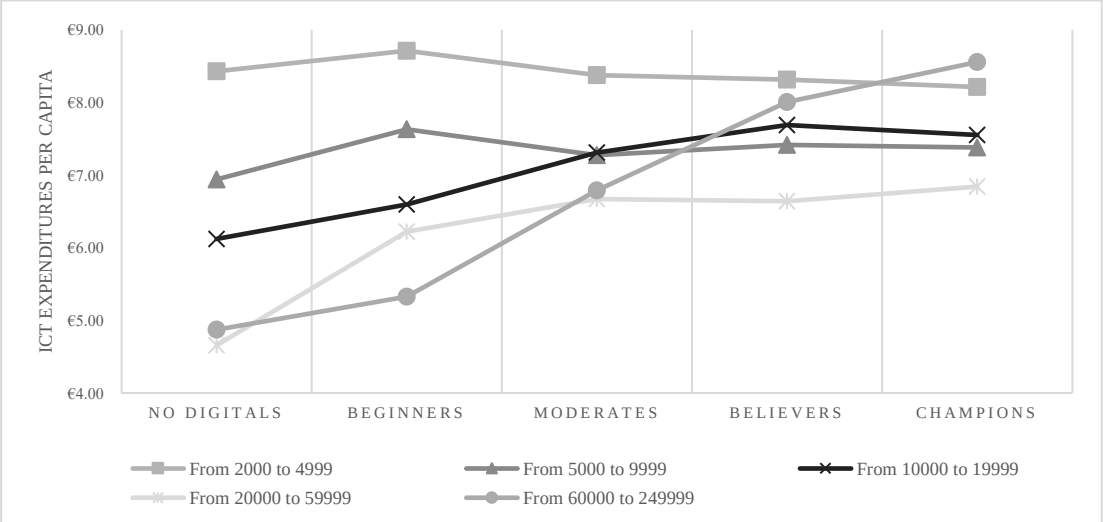
Table 3: Composition of the clusters

Population (inhabitants)	No Digitals	Beginners	Moderates	Believers	Champions
From 1 to 1999	1434	845	189	288	319

From 2000 to 4999	718	554	145	195	215
From 5000 to 9999	370	319	81	144	145
From 10000 to 19999	171	214	65	90	112
From 20000 to 59999	78	120	38	64	94
From 60000 to 249999	13	19	11	12	32
Sum of observations	**2784**	**2071**	**529**	**799**	**923**

The distribution of ICT expenditures per capita varies according to the size. The smallest municipalities (below 2.000 inhabitants) are the most expensive ones, characterized by a U-shape that starts from 19,40€/person for the No Digitals, has the minimum in correspondence with the Moderates cluster (18,05€/person) and finally raises until 20,60€/person for the Champions cluster. Similarly, the biggest municipalities (more than 250k inhabitants) also have remarkably high expenditures in ICT per capita (13,47€/person in the Believers cluster and 18,75€/person in the Champions one). All the other municipalities in the range of population between 2k and 250k inhabitants interact with growing clusters of maturity differently, as specifically disclosed in Figure 1. Municipalities with a higher e-maturity level, have higher ICT expenditures.

Figure 1: Focus of ICT expenditures per capita for population in range 2k – 250k inhabitants



The linear regression (Table 4) confirms the results disclosed in Figure 1. The results confirm what emerged from the first analysis and add statistical significance to previous considerations. Each model of Table 4 corresponds to a subset related to the corresponding range of population.

Table 4: Regression summaries per population subset.

Model	From 0 to 1999	From 2000 to 4999	From 5000 to 9999	From 10000 to 19999	From 20000 to 59999	From 60000 to 249999	From 250000
Beginners	-0.367	0.285	0.689**	0.474	1.565***	0.455	
	(0.877)	(0.331)	(0.342)	(0.356)	(0.546)	(1.594)	
Moderates	-1.343	-0.050	0.333	1.188**	2.013***	1.917	
	(1.571)	(0.526)	(0.561)	(0.496)	(0.720)	(1.810)	
Believers	-0.595	-0.115	0.475	1.568***	1.984***	3.135*	
	(1.287)	(0.465)	(0.437)	(0.446)	(0.626)	(1.726)	
Champions	1.208	-0.215	0.438	1.431***	2.184***	3.685**	
	(1.250)	(0.448)	(0.445)	(0.417)	(0.570)	(1.437)	
Constant	19.396***	8.427***	6.941***	6.121***	4.657***	4.871***	
	(0.543)	(0.219)	(0.235)	(0.268)	(0.441)	(1.220)	
Obs.	2649	1678	982	572	327	82	
R^2	0.001	0.001	0.004	0.034	0.050	0.121	
Df	2664	1673	977	567	322	77	
Res. Sd. Err.	18.816	5.578	4.323	3.208	3.268	4.228	
F Stat.	0.605	0.401	1.060	5.033***	4.265***	2.651**	

Not tested

Signif. codes: '***' 0.01; '**' 0.05; '*' 0.1
Note: The "No Digitals" do not appear in the table, as it is the referring cluster in the models.

For municipalities belonging to the first model (population lower than 2k inhabitants), the ICT expenditures do not depend on maturity level, since associated coefficients result to be not statistically significant. The same considerations can be applied to the second model (population between 2k and 5k inhabitants), which differs from the previous one only in terms of scale of ICT per capita, which are significantly lower than the first subset. Municipalities tested in the third model (population between 5k and 10k inhabitants) start to behave differently. In particulars, the beginners (thus municipalities with low e-maturity level), have significantly higher ICT expenditures. The fourth model (population between 10k and 20k inhabitants) depicts a slightly different scenario. In particular, it has almost all the coefficients statistically significant (except the one associated with beginners) and remarkably different. Thus, higher e-maturity levels correspond to higher ICT expenditures. The fifth model (population between 20k and 60k inhabitants) and the sixth model (population between 60k and 250k inhabitants) report the same trend, that is statistically significant for all the e-maturity clusters. The seventh model (population higher than 250k inhabitants) is not tested because it includes only twelve municipalities that belong to the highest e-maturity clusters (clusters 3 and 4), hence there are too few observations for regression analysis.

5. Discussion and Conclusion

Despite the linearity and simplicity of the research question, results show a complex and fragmented picture. Three insights are here further discussed: (i) local governments' e-maturity; (ii) local governments' ICT expenditures and, most notably, (iii) the presence of a relation between the two.

First, results confirm that e-maturity is extremely context-specific [1]. Several environmental factors can influence the e-maturity level of local governments, in particular the dimension of the municipality. Consequently, policymakers should reflect on how to implement a structural change of course, that is even more urgent nowadays that the COVID-19 crisis is impeding (or at least discouraging) people to physically go to the counter.

Second, per capita ICT expenditures assume a U-shaped trend: extremely small and large municipalities have the highest expenditures. We can hypothesize that structural ICT expenditures inefficiencies are embedded in those municipalities that are too small (less than 2k inhabitants) to reach enough economies of scale. Thus, policymakers should reflect on how to support those municipalities in diminishing their expenditures pro capita. For example, inter-municipal collaboration (Ferro and Sorrentino, 2010) or shared services forms (Paagman and Furtmueller, 2013) can be incentivized for creating economies of scale. On the opposite, for municipalities with more than 250k inhabitants, the complexity of the organization (Tangi, Janssen et al., 2020) is probably the reason behind higher expenditures.

Finally, and most notably, the paper offers novel quantitative insights on the relation between e-maturity and ICT expenditures. We observe that the relation between e-maturity and ICT expenditures varies depending on the size of the municipality. For small municipalities, higher ICT expenditures do not automatically correspond to higher e-maturity. Thus, policymakers should be aware that the sole release of funds to those municipalities is not the proper solution for supporting their digitization process. Rather e-maturity is more related to how administrators decide to spend the money at their disposal. Moreover, small municipalities might need support in their digitization process, for example by upper-tier organizations (such as regional governments). On the opposite, a positive correlation between ICT expenditures and e-maturity is detected for medium and large municipalities. For those municipalities, investing more in ICT is tightly linked to a higher e-maturity level. This confirms and corroborates previous qualitative insights [4]. Moreover, it set the boundaries of the validity of the relation clarifying that a positive relation between e-maturity and ICT expenditures is to be expected only for medium and large municipalities. Policymakers should consider that those municipalities have the capacity to properly use and invest money to grow in terms of e-maturity.

Further research shall keep on investigating in the same direction and overcome the existing limitations. First, even though data were collected by a regulatory authority, they are self-declared by the local governments, thus this circumstance opens to possible mistakes and misinterpretations. Second, we limit to a subset of services and a linear way of assessing e-maturity. Further studies should look also at other types of services and develop more quantitative and detailed models for assessing e-maturity. Third, more efforts are required to obtain more granular and detailed data on ICT expenditures, for example dividing between CAPEX and OPEX. Finally, we limit e-maturity determinants to population and ICT expenditures. We do not include any other factors and, in particular, any other organizational factors. We are aware that, within an organization, ICT expenditures are only one of the aspects that can influence e-maturity. Thus, further studies should identify a proper way for a better understanding of which organizational factors that may determine e-maturity.

References

Andersen, K.N., & Lee, J., & Mettler, T., & and Moon, M.J. (2020) Ten misunderstandings about maturity models. ACM International Conference Proceeding Series, 261–266.

Aral, S., & Weill, P. (2007) IT assets, organizational capabilities, and firm performance: How resource allocations and organizational differences explain performance variation, Organization Science, 18, (5), 763–780.

Ashaye, O.R., & Irani, Z. (2019) The role of stakeholders in the effective use of e-government resources in public services. International Journal of Information Management, 49, 253–270.

Budding, T, & Faber, B. & Gradus, R. (2018) Assessing electronic service delivery in municipalities: determinants and financial consequences of e-government implementation. Local Government Studies, 44(5), 697–718.

Dahiya, D., & Mathew, S.K. (2018) IT infrastructure capability and eGovernment system performance: an empirical study, Transforming Government: People, Process Policy, 12 (1), 16–38.

Ferro, E. & Sorrentino, M. (2010) Can intermunicipal collaboration help the diffusion of E-Government in peripheral areas? Evidence from Italy, Government Information Quarterly, 27 (1), 17–25.

Layne, K., & Lee, J (2001) Developing fully functional E-government: A four stage model. Government Information Quarterly, 18 (2), 122–136.

Paagman, A. & Tate, M. & Furtmueller, E. & de Bloom,J. (2013) An integrative literature review and empirical validation of motives for introducing shared services in government organizations, 21st European Conference on Information Systems (ECIS 2013), 35 (1), 110–123.

Tangi, L., & Soncin, M., & Agasisti, T., & Noci, G. (2021) Exploring e-maturity in Italian local governments: empirical results from a three-step latent class analysis. International Review of Administrative Sciences, in press.

Tangi, L. & Benedetti, M., & Gastaldi, L., & Noci, G. & Russo, C. (2021) Mandatory provisioning of digital public services as a feasible service delivery strategy: Evidence from Italian local governments. Government Information Quarterly, 38 (1).

Tangi, L., & Janssen, M., & Benedetti, M. & Noci, G. (2020) Barriers and Drivers of Digital Transformation in Public Organizations: Results from a Survey in the Netherlands, Viale Pereira G. al. Electron. Gov. EGOV 2020. Lecture Notes in Computer Science, vol 12219. Springer, Cham.

About the Authors

Luca Tangi

Luca Tangi is a project officer at the Joint Research Centre (JRC) of the European Commission. He earned a PhD in Management, Economics and Industrial Engineering at the Politecnico di Milano. His doctoral work focused on understanding how ICTs are affecting public service delivery and transforming the way public organisations are structured and organised. Since June 2021 he collaborates with the JRC carrying out research on the introduction of new, cutting-edge technologies and in particular Artificial Intelligence in public settings.

Marco Gaeta

Marco Gaeta is a researcher in the e-government field at the Department of Management, Economics and Industrial Engineering of the Politecnico di Milano. Here, after his Master's degree in Management Engineering, he started working as a researcher, following the focus and the research interests of his master thesis concerning the digitalization of Italian local governments and innovation in the public sector.

Michele Benedetti

Michele Benedetti is a research fellow and lecturer at the School of Management of the Politecnico di Milano. Since 2001 he has carried out research on digital innovation in the public sector. He also gained almost twenty years of experience in managing complex projects of public sector digital transformation. Since 2009 he has been director of the eGovernment Observatory of the School of Management of the Politecnico di Milano and since 2017 also of the Digital Agenda Observatory.

Giuliano Noci

Giuliano Noci is full professor of Marketing at Politecnico di Milano. At present, he is also: Vice-Rector for China at Politecnico di Milano, member of the Board CEO of Polimilano Educational Consulting Ltd – a company deploying post graduate education and technology transfer projects in China –, member of the Board of Directors of MIP Graduate School of Business and of the Board of Trustee of TongJi University. His main research fields cover the following subjects: marketing, eBusiness, and eGovernment.