

The role of institutional and operational factors in the digitalization of large local governments: insights from Italy

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Abstract

Purpose – This study investigates drivers of local governments' digitalization, focusing on contextual factors that can help explain the level of e-government development. Concretely, it examines financial, socioeconomic, and political factors that represent the local context where e-government initiatives are implemented.

Design/methodology/approach – A composite e-government index was used, adopting a holistic perspective to capture various features of e-government initiatives. The OLS estimator for linear regressions was used for the analysis based on a sample of Italian municipalities in 2023. The Tobit estimator was additionally implemented to check for the robustness of the results.

Findings – Empirical findings suggest that municipalities with higher indebtedness tend to show lower digitalization levels. Economic and social variables are also relevant factors, while the political orientation of the governing party is not significant. This indirectly documents that e-government initiatives play a strategic role despite the political ideology.

Originality/value – This study avoids referring to a technological determinism perspective and examines the role of the institutional and operational context, highlighting the need to unveil and explain differences among local governments rather than focusing on similarities.

Keywords Digitalization, e-government, Local government, Italy

Paper type Research paper

1. Introduction

This study aims to investigate the drivers of the development of local governments (LGs) in terms of digitalization, focusing on the Italian context. The motivations for this study rely on the growing importance of digitalization in the public-sector context, which is attracting increasing scholarly interest (Agostino *et al.*, 2022).

Previous literature investigating e-government development has frequently considered it as a process consisting of several steps (Ingrams *et al.*, 2020). This approach may lead to technological determinism, while the ability of an LG to successfully implement

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e-government initiatives could be affected by local institutional and operational contexts (Di Giulio and Vecchi, 2019). The implementation of e-government initiatives and their development do not necessarily occur linearly as technological changes cannot occur independently of other factors (Coursey and Norris, 2008; Manoharan and Ingrams, 2018). Previous studies have primarily investigated the effect of digitalization on decision-making, transparency, accountability, and relationships with citizens (Vydra and Klievink, 2019). This research aims to contribute to the academic debate by focusing on contextual factors that can help explain the level of development of LGs in terms of digitalization.

The theoretical framework used for this study relies on innovation and diffusion models (Berry and Berry, 2007), which is consistent with the idea that implementing e-government initiatives implies innovating processes through which an LG provides services to its citizens. Based on a large sample of Italian LGs, empirical results document the positive role of good financial conditions and the economic development of the territory, along with certain characteristics of the population, while political variables are less relevant than expected.

The remainder of the paper is structured as follows: Section 2 reviews previous studies, while Section 3 illustrates the theoretical framework and develops the hypotheses. Section 4 explains the research methodology, and Section 5 presents the results, which are discussed in Section 6, along with concluding remarks.

2. Literature

review

Since the early 1990s, governments have been increasingly utilizing the Internet and different online tools to disseminate information and provide services to citizens, implementing strategies to support this transformation (Manoharan, 2013). Conventionally, the starting point of this phenomenon, known as digitalization or e-government, is considered the report "Reengineering through Information Technology", published in 1993 under the Clinton Administration (Lenk and Traunmuller, 2002). Although the term e-government has been conceptualized in different ways, it generally relies on both the use of information and communication technologies (ICTs) and related organizational changes due to the need to redefine the structure and improve the operations of the government (Epstein, 2022). Scholars argue that this process is facilitating a shift from the traditional bureaucratic paradigm to a new approach where network building and collaboration with other actors are considered particularly relevant (Ho, 2002), as occurs when public-sector innovations are implemented (Criado *et al.*, 2023). A more structured and institutional definition (UNDESA, 2001) focuses on the need for developing, sustaining, and providing open and free access to timely, helpful, and relevant information and services for every segment of the population, as well as stimulating close interaction with citizens.

Accordingly, scholars have underlined the intrinsic complexity of e-government initiatives, analyzing related modernization processes (Meijer and Bekker, 2015) and the impacts on organizational changes (Castelnovo and Sorrentino, 2018). Other studies (Bisogno *et al.*, 2022; Gr  nlund and Horan, 2005; Patergiannaki and Pollalis, 2024) have investigated if—and to what extent—e-government innovations can enhance external relationships between a public-sector entity and its citizens.

Several studies have documented e-government development, highlighting that it has been slower than expected (Norris and Reddick, 2013). This development has been mainly conceptualized through sequential stages (Garson, 2003; Layne and Lee, 2001; Moon, 2002; Reddick, 2004; Yildiz, 2007). Schlein (2007) evidenced similarities among models and propounded a further one based on five steps to represent the different levels of governments' web presence. Moving from the approach first proposed by Nolan (1979), the *fil rouge* which links these models is that they are based on an evolutionary process (Andersen and Henriksen, 2006; Layne and Lee, 2001; Lee *et al.*, 2011; Reddick, 2004), which leads to

considering e-government development through stages as inevitable (Ingrams *et al.*, 2020), so to implicitly assuming that the growth stages follow a predefined and linear path to achieving an end state (Janowski, 2015). This may lead to technological determinism.

However, this approach has been criticized, as it has been considered too simplistic and may unveil relevant heterogeneities across different contexts. Esposito *et al.* (2024) suggest that there are no predefined paths to follow while implementing concrete digitalization strategies and policies. Accordingly, technological innovations do not occur in a linearly continuous (Coursey and Norris, 2008; Manoharan and Ingrams, 2018); digitalization should be conceived as an institutional policy (Wollmann, 2004, p. 3) directed at remolding procedures and organizational structures of public administrations, being able to sustain changes if other political, social and organizational factors concur (Kuhlmann and Heuberger, 2023).

A socio-technical perspective should then be adopted to investigate digital transformations (Castelnovo and Sorrentino, 2018). Nevertheless, contradictory results have been recorded. On the one hand, the so-called “cyber-pessimistic” school of thought has documented challenges and barriers (Manoharan and Ingrams, 2018), as governments must consider regulatory/economic issues and the rights of users while implementing e-government initiatives (Jaeger and Thompson, 2003). On the other hand, scholars have evidenced that e-government can favor citizens’ engagement, increase the speed of payments, establish communications with users and improve the quality of services (Andersen *et al.*, 2010).

Several studies concentrated on the role of social media, examining their impact on political communication and electoral success (Bode *et al.*, 2020; Chadwick and Stromer-Galley, 2016; Epstein, 2018; Towner and Munoz, 2020), or the effect that social media can have on the improvement of functions of government (Epstein *et al.*, 2023; Seigler, 2017). Scholars call for further research at a local government level, highlighting the need to distinguish between the adoption and implementation stages (Criado *et al.*, 2023; Manoharan and Ingrams, 2018). Kuhlmann and Heuberger (2023) also suggest considering the institutional context and institutional changes, which are expected to play a relevant role.

Building on this last literature stream, this study avoids using a technologically deterministic perspective, aiming to address the complexity of e-government by considering several institutional features in accordance with a socio-technical perspective (Gasco-Hernandez *et al.*, 2022). Furthermore, it seeks to capture different but related aspects (such as the implementation of online services, including those allowing e-authentication and e-payments, interactions via social media, municipal apps, free access to open data, public WIFI, Internet of Things, and so on) so to take a holistic perspective.

3. Theoretical framework and research hypotheses

In his recent systematic literature review, Terlizzi (2021) claimed that many studies on digital government have not explicitly utilized a theoretical framework pertaining to policy processes. Accordingly, he argued that future research is highly encouraged to adopt a social science framework. Since implementing strategies and policies regarding the digitalization of LG’s processes can be interpreted as a specific form of innovation, this study refers to the innovation and diffusion models framework (Berry and Berry, 2007).

Following Berry and Berry (2007), two forms of explanation regarding the implementation of innovative policies can be used: internal determinants and diffusion models. The first one states that factors explaining innovations are based on the government’s economic, political, and social characteristics; the second one emphasizes the role played by emulations of innovations already implemented by other governments. While previous literature referred to internal determinants and diffusion models separately, scholars (Berry and Berry, 2007) suggest utilizing both approaches to explain innovation policies simultaneously. Accordingly, this study borrows from this literature by adapting those models to compare

LGs and considering digitalization processes implemented by LGs as particular forms of innovation policies.

Scholars argue that organizations with high levels of “slack resources” tend to be more innovative than those with fewer resources (Berry, 1994; Rogers, 1983). In a broader sense, classical organizational studies documented that the higher the availability of resources, the higher the ability of an entity to overcome obstacles to innovations (Mohr, 1969). Indeed, Garcia-Sanchez *et al.* (2012) hypothesized that LGs with more available resources could generate other relevant ways to cover e-government development costs. Financial resources are essential because e-government requires complex technical and administrative infrastructures, so financial position plays a critical role in implementing technological innovations like e-government (Glyptis *et al.*, 2020). Rodríguez-Domínguez *et al.* (2011) concluded that governments with a higher financial capacity tend to show greater e-government development. Accordingly, the following hypothesis is stated:

H1. A good financial situation positively affects the development of LGs' e-government initiatives.

Innovation and diffusion models' theorists also highlight that public-sector entities tend to introduce innovations to emulate other entities as they undergo pressures to conform to national or regional rules. This idea could be interpreted in the light of institutional theory (DiMaggio and Powell, 1983), leading to an explanation of the behavior of organizations by considering the different forms of isomorphism. More specifically, according to the literature on innovation and diffusion models, organizations tend to emulate other organizations perceived as successful and legitimate to improve their own legitimacy. However, referring only to external pressures and isomorphisms could be too simplistic (Berry and Berry, 2007). Accordingly, political science scholars suggest considering similarities and differences between governments regarding political ideology (Nicholson-Crotty, 2004), organizational culture and the attitude towards innovation (Nasi *et al.*, 2011), the motivations of both politicians and managers (Tan *et al.*, 2022), and the role of internal rules and routines (Cinite *et al.*, 2009).

From this perspective, another feature that may affect digitalization is the strength of the governing party. Fragmented governments that need the legislative support of other parties and face substantial competition may find it challenging to achieve consensus regarding the reforms to be made (McNeal *et al.*, 2003). For instance, passing a new law is easier when a single party controls the government (Boehmke and Witmer, 2004). Similarly, Brooks (2005) suggested that party fragmentation is inversely related to successful innovation. Accordingly, we hypothesize that:

H2. The higher the strength of the governing party, the higher the development of LGs' e-government initiatives.

Learning processes that are defended by the isomorphism approach are difficult to test, as they require designating a public-sector entity as the pioneer in adopting specific innovations and other entities as followers (Walker, 1969). Consequently, scholars suggested using testable proxies. For instance, Collier and Messick (1975) identified as pioneers those governments characterized by high economic development. Berry and Lowery (1987) maintain that economic development stimulates increased demand for government services. Furthermore, several studies have documented a positive effect of income per capita on the digitalization level (Budding *et al.*, 2018; Manoharan, 2013). So, the third hypothesis proposed here is the following:

H3. The economic development of an LG positively affects the development of its e-government initiatives.

4. Research methodology

4.1 Sample

Our sample includes 108 Italian municipalities in 2023. This paper focuses on LGs because they have the autonomy to manage expenditure and revenue, and so their decisions can influence their financial health. Previous literature focused on small municipalities, documenting a low digitalization level (Previtali and Bof, 2009). The study concentrates on the largest LGs as they are required to provide many essential public services (e.g. urban waste collection and treatment; cleaning, paving and maintenance of public roads; drinking water supply; social services, etc.). Therefore, implementing digital innovations is particularly significant, as it can affect the quantity and quality of services provided to citizens.

Considering that LGs have similar autonomy in other countries in managing expenditures and revenue and are required to provide similar services whose quality is also affected by the development of their e-government initiatives, results emerging from the Italian context may prove to be relevant also in other countries, especially those characterized by socioeconomic disparities, as occur in Italy.

4.2 Variables

The level of digitalization is represented by the ICity index elaborated by FPA (<https://www.forumpa.it>). Since 1990, FPA has been active in the digitalization field, organizing a national event to bring together public administrations, academics, private-sector entities and civil-society organizations. It monitors the digitalization processes of Italian public administrations on a systematic basis, developing reports and indicators to summarize the state of the art. In particular, ICity index consists of 8 different features that are represented by several indicators, summarized in Table 1. The eight scope indicators can be attributed to three fundamental dimensions:

- (1) The *Digital Administration* dimension refers to citizens, firms, and other stakeholders' digital access to LG's website, through which online services are provided, including those related to e-authentication and e-payments.
- (2) The *Open Municipalities* dimension refers to social media interactions, the development of municipal apps, and free access to open data.
- (3) The *Connected Cities* dimension refers to free public WIFI, IoT (*Internet of Things*) devices to collect and share data, and smart-city platforms.

It is worth noting that previous literature has utilized variables similar to indicators belonging to these dimensions to investigate e-government initiatives. For instance, Epstein (2022) referred to social media, multimedia, and municipalities apps, Feeney and Brown (2017) took into account e-services and civic engagements (among others) as e-government features, Criado *et al.* (2017) investigated the relationship between organizational, institutional, and environmental factors with the successful use of social media in LGs, while Schlein (2007) referred to different facets of web presence. The eight scope indicators used for our analysis can then be framed in previous literature, but we additionally implement a holistic approach to merge diverse features of such a complex phenomenon. After a standardization process, each of the three components (subindexes) takes values between 0 and 100, from the lowest to the highest level of digitalization. In order to create a global index (ICity) we sum the score of each component, so ICity takes values between 0 and 300.

To test the first hypothesis, we need some variables to operationalize the broad concept of "availability of resources" (Berry and Berry, 2007) that Garc'ia-S'anchez *et al.* (2012) used to analyze the e-government development. This study utilizes three indicators that represent the financial situation of LGs: (1) *Autonomy* refers to financial autonomy that is represented by

the ratio of revenue obtained from local taxes and other additional local revenue to total current revenue; (2) *Current Balance* represents the ability of current revenue to cover current expenses, and it is represented by the ratio of current revenue to current expenses; and (3) *Indebtedness* is the ratio of total debts to total current revenue. Indicators were calculated by using data that was hand-collected from an open portal (<https://www.openbilanci.it>), based on official data provided by the Ministry of the Interior.

The [second hypothesis](#) is tested through the variables called *Strength*, calculated by dividing the number of councilors who belong to the party (or coalition of parties) that won the last municipal election and the total number of councilors in the LG.

The **third hypothesis** refers to the economic development level. To represent this feature, this study uses two variables (Barro, 2001): the gross domestic product per capita (*GDP*), in

logarithmic terms; and the level of education (with *Education* being expressed through the percentage of the population with high schools leaving qualifications or higher).

The empirical analysis includes several control variables that may also affect the level of digitalization. Concretely, scholars have provided evidence regarding the role of political factors and characteristics of the population (Budding *et al.*, 2018; Jacob *et al.*, 2019). Accordingly, this study considers: *Population*, which is the number of inhabitants (in logarithmic terms); *Density* that is the number of inhabitants per km2 (in logarithmic terms); *Elderly* refers to the percentage of the total population that is aged over 65, expecting they have poor digital skills. Finally, *Ideology* refers to the political orientation of the city's government (Gallego-Ivarez *et al.*, 2010; Rodr'iguez-Dom'inguez *et al.*, 2011; Tolbert *et al.*, 2008), taking the value 0 if it is Centre-left and 1 if it is Centre-right. Data for control variables was hand-collected from several sources based on official data provided by the Ministry of the Interior.

4.3 Model of analysis

Bivariate correlations are analyzed to decide how to include each variable in the model, avoiding multicollinearity problems. Table A1 (see Annex 1) shows the bivariate correlations between explanatory variables to understand if multicollinearity problems—the main drawback that prevents the OLS solution to an economic problem from being adequate (Wooldridge, 2009)—would appear in the regression analysis. The most salient coefficients between the independent variables suggest a high correlation between *Current_balance* and *Indebtedness* as well as *GDP* and *Education*, so they should not be included simultaneously in the same equation to avoid multicollinearity problems.

Considering these correlations, the following equations are proposed:

$$\text{Digitalization}_i \sim \beta_0 + \beta_1 \text{Autonomy}_i + \beta_2 \text{Current_Balance}_i + \beta_3 \text{Strength}_i + \beta_4 \text{GDP}_i + \beta_5 \text{Ideology}_i + \beta_6 \text{Population}_i + \beta_7 \text{Elderly}_i + \varepsilon_i \quad (1)$$

$$\text{Digitalization}_i \sim \beta_0 + \beta_1 \text{Autonomy}_i + \beta_2 \text{Indebtedness}_i + \beta_3 \text{Strength}_i + \beta_4 \text{GDP}_i + \beta_5 \text{Ideology}_i + \beta_6 \text{Population}_i + \beta_7 \text{Elderly}_i + \varepsilon_i \quad (2)$$

$$\text{Digitalization}_i \sim \beta_0 + \beta_1 \text{Autonomy}_i + \beta_2 \text{Current_Balance}_i + \beta_3 \text{Strength}_i + \beta_4 \text{Education}_i + \beta_5 \text{Ideology}_i + \beta_6 \text{Population}_i + \beta_7 \text{Elderly}_i + \varepsilon_i \quad (3)$$

$$\text{Digitalization}_i \sim \beta_0 + \beta_1 \text{Autonomy}_i + \beta_2 \text{Indebtedness}_i + \beta_3 \text{Strength}_i + \beta_4 \text{Education}_i + \beta_5 \text{Ideology}_i + \beta_6 \text{Population}_i + \beta_7 \text{Elderly}_i + \varepsilon_i \quad (4)$$

The subindex *i* refers to each Italian municipality included in the sample; β_j are the *j* parameters to be estimated; ε is the error term. *Digitalization* refers to the four indexes that were previously described: *ICity*, *Digital Administration*, *Open Municipalities*, and *Connected_Cities*. Then, each model is estimated for each digitalization indicator. The sample includes the year 2023, so all the equations are estimated by using the ordinary least-squares (OLS) estimator for linear regression analysis.

Table A2 in the Annex shows the correlations between dependent variables. These show that the four indexes are highly correlated. However, these large correlations are not an issue for our study; conversely, what they show is that the dimensions that make up the global index (*ICity*) are related to each other, and therefore, they represent the same concept (digitalization), but from different edges or with different prisms. Accordingly, it is essential to use not only the global

index (*ICity*) but also the three subindexes (*Digital_administrations*, *Open_municipalities*, and *Connected_cities*), which ultimately measure the same broad concept but consider different specificities of digitalization. In addition, this table shows correlations between dependent and explanatory variables, suggesting the links that we can expect to find in the regression analysis.

5. Results

5.1 Descriptive analysis

Table 2 shows the descriptive statistics of the variables previously described.

Focusing on *ICity*, the mean value is 168.26. In a range from 0 to 300, it is roughly in the middle, so there is still much to do to improve the digitalization level of Italian cities. The lowest value is shown by the index *Open_Municipalities*, whose mean value is 52.13, while the best score is given by *Digital_Administrations*, with a mean value of 59.73 (both ranging between 0 and 100). Nevertheless, some cities stand over the rest. **Figure 1** shows that cities in the center-north have higher levels of digitalization than cities in the south of Italy.

Turning to **Table 2**, the mean value of *Autonomy* is about 0.57, suggesting that revenue from taxes is around 57% of total current revenue. Furthermore, current revenue is higher than current expenditures since the variable *Current_balance* has mean values higher than 1. Besides, the level of indebtedness is relatively higher than current revenue because the mean value is slightly higher than 1. Regarding the political factors, *Strength* has an average of 0.63, which means that, on average, a mayor is supported by 63% of the total councilors.

Regarding economic development, the mean value of GDP per capita is 21,312.01 euros. Milan has the maximum GDP (31,777.70 euros per capita), while Andria has the minimum value (12,963.10 euros per capita). The mean value of *Education* suggests that about 55% of the total population has passed secondary education.

Regarding control variables, the mean value of *Ideology* is 0.45, which suggests that about 45% of cities are governed by center-right parties. The mean value of *Population* is 163,788 inhabitants, who are relatively aged, as the mean value of *Elderly* indicates that 25% of the total population is over 65 years old.

5.2 Empirical

analysis

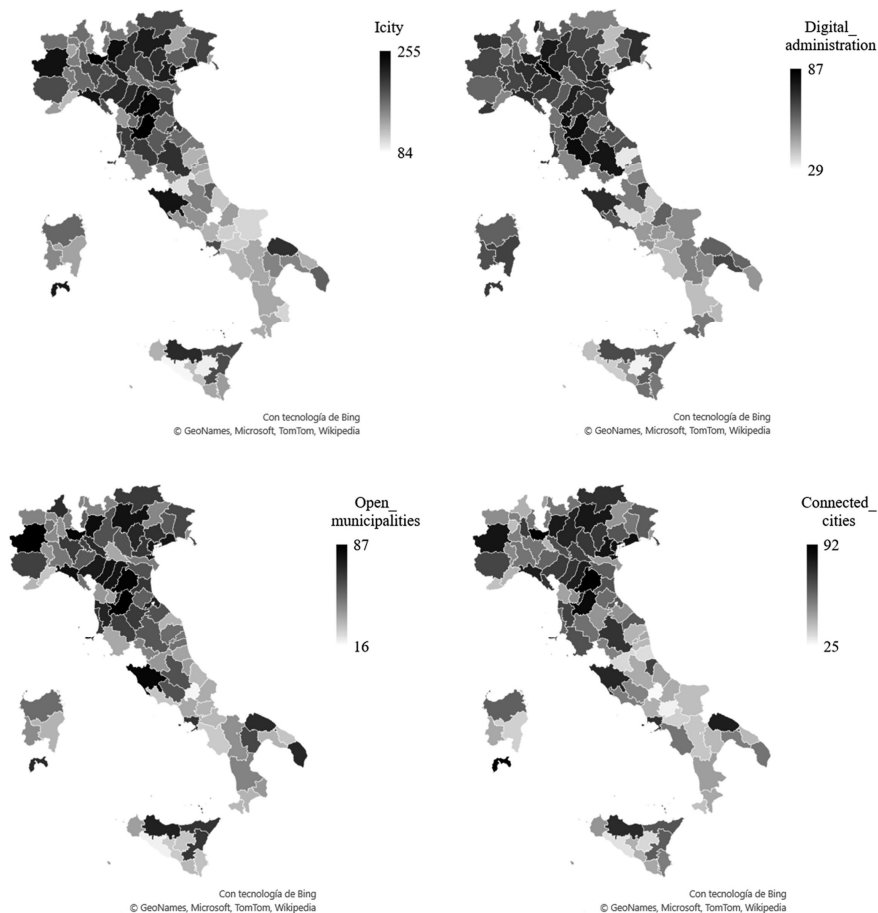
Table 3 shows the empirical results obtained for all previously described equations, using the *ICity* index as the dependent variable. Furthermore, **Tables 4–6** show the results by considering the three subindexes, *Digital_Administrations*, *Open_Municipalities*, and

Variable	Mean	Std. Dev	Min	Max
ICity	168.26	40.17	84.00	255.00
Digital Administrations	59.73	12.53	29.00	87.00
Open Municipalities	52.13	17.61	16.00	87.00
Connected Cities	56.40	16.33	25.00	92.00
Autonomy	0.57	0.12	0.21	0.75
Current_balance	1.20	0.18	1.04	1.75
Indebtedness	1.05	0.66	0.22	2.86
Strength	0.63	0.06	0.47	0.84
GDP	21,312.01	2,772.12	12,963.10	31,777.70
Education	0.55	0.05	0.34	0.65
Ideology	0.45	0.50	0.00	1.00
Population	161,788.30	312,238.40	20,748	2,749,031
Elderly	0.25	0.02	0.19	0.31

Table 2.

Descriptive statistics

Source(s): Authors' own work



Source(s): Authors' own work

Figure 1.
ICity score

Connected_Cities, respectively. The four tables show the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity. When p -value < 0.05 , errors are not homoscedastic, so robust standard errors are shown to solve heteroskedasticity problems. In these cases, the test has not been recalculated since it is not possible with robust errors. In addition, the adjusted R-squared has been included, but it is replaced by the traditional R-squared when robust standard errors have been used. Finally, all the tables show the highest Variance Inflation Factor value in each model, complying with the rule of being less than 5 to ensure that there are no multicollinearity problems.

Focusing on [Table 3](#), *Autonomy* is not statistically significant in any equations. However, *Current_balance* and *Indebtedness* variables are statistically relevant in all cases and are negatively related to *ICity*. This means that municipalities with higher current revenues compared to current expenses and higher levels of indebtedness show a lower level of digitalization.

Regarding political fragmentation, *Strength* is not statistically significant in any case, so there is not enough evidence to support our [second hypothesis](#).

Table 3.
Explaining *ICity* index

	Eq. (1)		Eq. (2)		Eq. (3)		Eq. (4)	
	Coef	Std. Err	Coef	Std. Err	Coef	Std. Err	Coef	Std. Err
Autonomy	-12.1732	21.5512	-7.4769	19.0724	-10.2375	23.5376	-2.2670	20.6390
Current balance	-36.4392 ^y	20.5316			-70.5423**	20.7116		
Indebtedness			-18.1439***	3.3830			-23.0509***	3.5074
Strength	-7.0458	43.2925	-5.3578	38.4173	25.7083	46.8078	17.4458	41.2875
GDP	101.1664***	23.8189	90.5457***	19.8599				
Education					0.4233	0.5387	0.9478*	0.4632
Ideology	1.6113	5.1316	2.7176	4.5097	-0.0026	5.5949	1.3532	4.8815
Population	28.6286***	3.3121	30.0704***	2.9317	34.3289***	3.2957	34.9377***	2.8977
Elderly	0.5452	1.4208	0.8470	1.2196	1.6224	1.5241	2.1325	1.2738
_cons	-11.2499***	2.3064	-10.7305***	1.7825	-2.1250*	0.8168	-3.2331***	0.6003
Adj. R ²	0.6422		0.7202		0.5741		0.2864	
Het. Test	Prob > χ^2_5 0.4021		Prob > χ^2_5 0.3670		Prob > χ^2_5 0.4283		Prob > χ^2_5 0.2154	
Max. VIF value	1.64		1.46		1.36		1.24	

Note(s): (1) ^y, *, **, and *** represents statistical relevance at 90, 95, 99, and 99.9% of confidence level
 (2) The dependent variable is *ICity* in all equations
 Source(s): Authors' own work

	Eq. (1)		Eq. (2)		Eq. (3)		Eq. (4)	
	Coef	Robust Std. Err	Coef	Robust Std. Err	Coef	Robust Std. Err	Coef	Std. Err
Autonomy	2.1032	8.5863	2.9908	8.4812	1.8872	8.7319	3.5077	9.5951
Current_balance	-7.6511	11.2937			-16.8036	11.6134		
Indebtedness			-6.8287***	1.5590			-7.4813***	1.6306
Strength	-22.9635	18.6133	-22.7028	19.3876	-12.4358	18.7468	-15.8435	19.1945
GDP	20.0279	12.1817	13.6332	12.1121				
Education					-0.1979	0.2601	-0.0693	0.2154
Ideology	1.5845	2.4123	2.2165	2.2320	1.4203	2.4108	2.0970	2.2694
Population	5.5882***	1.4170	6.3226***	1.3097	6.9843***	1.2846	7.2557***	1.3471
Elderly	0.5047	0.5906	0.4661	0.6034	0.7491	0.6212	0.7351	0.5922
_cons	-1.9422	1.1788	-1.4117	1.1765	-1.1704	36.8485	-22.8673	27.9064
Adj. R ²	0.2490		0.3632		0.2291		0.2201	
Het. Test	Prob > χ^2 5 0.0099		Prob > χ^2 5 0.0627		Prob > χ^2 5 0.0114		Prob > χ^2 5 0.1665	
Max. VIF value	1.64		1.46		1.36		1.24	

Note(s): (1) γ , *, **, and *** represents statistical relevance at 90, 95, 99, and 99.9% of confidence level
(2) The dependent variable is *Digital_administration* in all equations
Source(s): Authors' own work

Table 5.
Explaining *Open_*
municipalities index

	Eq. (1)		Eq. (2)		Eq. (3)		Eq. (4)	
	Coef	Std. Err	Coef	Std. Err	Coef	Std. Err	Coef	Std. Err
Autonomy	-9.5544	10.7439	-7.6218	10.2839	-8.1095	11.3420	-4.8217	10.7078
Current_balance	-17.9052y	10.2356			-30.3592**	9.9803		
Indebtedness			-5.8815**	1.8241			-8.3420***	1.8197
Strength	-10.6933	21.5826	-10.4603	20.7147	-0.4749	22.5552	-3.1069	21.4206
GDP	44.0912***	11.8744	43.7061***	10.7085				
Education					0.4671y	0.2596	0.6837**	0.2403
Ideology	0.0575	2.5582	0.4289	2.4317	-0.8018	2.6960	-0.3214	2.5326
Population	10.2371***	1.6512	10.5361***	1.5808	12.4530***	1.5881	12.6720***	1.5034
Elderly	-0.4895	0.7083	-0.3023	0.6576	-0.0512	0.7344	0.2378	0.6609
_cons	-4.5719***	1.1498	-4.7860***	0.9611	-0.7194y	0.3936	-1.2248***	0.3114
Adj. R ²	0.5179		0.5572		0.4639		0.5193	
Het. Test	Prob > χ^2 5 0.6914		Prob > χ^2 5 0.8833		Prob > χ^2 5 0.6099		Prob > χ^2 5 0.8500	
Max. VIF value	1.64		1.46		1.36		1.24	

Note(s): (1) y, *, **, and *** represents statistical relevance at 90, 95, 99, and 99.9% of confidence level
(2) The dependent variable is *Open_municipalities* in all equations
Source(s): Authors' own work

Note(s): (1) γ , *, **, and *** represents statistical relevance at 90, 95, 99, and 99.9% of confidence level
(2) The dependent variable is *Connected_cities* in all equations
Source(s): Authors' own work

Regarding economic development, *GDP* is relevant in all the equations, as is *Education*, showing a positive link with *ICity*. This supports the [third hypothesis](#), suggesting that the higher the level of development and education, the higher the level of digitalization.

Finally, *Population* has positive coefficients, indicating that more populated cities tend to show higher levels of digitalization. *Elderly* is not statistically relevant in most equations. The political ideology is not statistically relevant either, indicating that parties of all ideologies attempt to promote e-government initiatives ([Gallego-Alvarez et al., 2010](#)).

[Tables 4–6](#), where the dependent variables are *Digital administrations*, *Open municipalities* and *Connected_Cities* respectively, show similar results. However, the *Digital administrations* index is explained by fewer factors, just *Indebtedness* and *Population*, suggesting that less indebted and most populated municipalities tend to show higher levels of digitalization. *Strength* is statistically significant in explaining *Connected_Cities*, and it has positive coefficients. This suggests that the greater the strength of the governing party, the greater the number of IoT (Internet of Things) devices to collect and share data, smart-city platforms, and free public WIFI, which is according to our [second hypothesis](#).

Bearing in mind that the *ICity* index takes values between 0 and 300, and the other three indicators (*Digital administrations*, *Open municipalities*, and *Connected_cities*) take values between 0 and 100, all of them may be considered as censored variables. Accordingly, the Tobit estimator is used to check for the robustness of our empirical findings. The results are completely similar to those that have emerged from the OLS estimator. Although they are not tabulated here, they are available upon request.

6. Discussion and conclusion

This study aimed to investigate the level of digitalization of a large sample of Italian LGs. Following Terlizzi's call for using a theoretical framework to investigate e-government issues ([Terlizzi, 2021](#)), we referred to innovation and diffusion models ([Berry and Berry, 2007](#)), with the basic idea being that e-government initiatives are considered specific forms of innovation ([Criado et al., 2023](#)). The analysis was based on secondary data, and its availability led us to use an OLS technique, limiting the possibility of using more sophisticated techniques like panel data.

Findings from the analysis show that, in general, the implementation of e-government innovations can be facilitated if an LG has a low level of indebtedness. This result is consistent with e-government literature ([Garc'ia-S'anchez et al., 2012](#); [Glyptis et al., 2020](#); [Rodr'iguez-Dom'inguez et al., 2011](#)) and the theoretical framework utilized here ([Berry, 1994](#); [Berry and Berry, 2007](#)); indeed, a positive financial condition could be considered a requisite for several public policies implemented at the local level. However, in the case investigated here, important additional features are worth mentioning, and several implications deserve to be considered. First, we refer to strategic innovations towards digitalization and not to public policies in general. This means that the implementation of online services, municipal apps, IoT, and other digital innovations requires adopting a long-term perspective, and long-term investments are needed. This could explain the prevalent focus on the level of indebtedness rather than the current balance. In this respect, it is worth observing that Italian LGs can obtain new loans to finance long-term investments (as those required by e-government innovations) only if their level of indebtedness is low (namely, it does not exceed certain thresholds periodically indicated by the central government). Therefore, LGs with a high level of indebtedness—as occurs for the vast majority of Italian LGs—cannot improve their level of digitalization because they suffer limitations in contracting new loans devoted to financing innovative digitalization strategies. From a theoretical perspective, this emphasizes the need to consider contextual factors (such as the limitation in obtaining new loans) while

investigating e-government innovations at an LG level, supporting our approach of avoiding technological determinism. From a practical perspective, this can also underline the need to support innovations in digitalization processes with adequate planning of resources to be achieved and invested in long-term initiatives. However, we acknowledge that this could be considered a limitation of the study; therefore, future research could utilize additional variables or refer to a concept broader than that of financial condition, referring to financial sustainability.

Regarding political factors, results show that political ideology is not statistically relevant, while the strength of the government is statistically relevant only for the *Connected-cities* index. The main implication emerging from this result is that digitalization innovations implemented at a local level can be considered crucial strategic goals despite the political orientation. Future studies could further investigate the effects of additional variables, to examine the motivations of politicians (Tan *et al.*, 2022) or the role of internal rules and routines (Cinite *et al.*, 2009).

According to the literature on innovation and diffusion models (Berry and Berry, 2007; Mooney and Lee, 1995), this study has also investigated the effect on digitalization of economic development, considered as a testable proxy of learning processes (Berry and Lowery, 1987). Indeed, previous literature has essentially focused on income per capita (Budding *et al.*, 2018; Manoharan, 2013). This study, in addition to GDP, has also referred to education, documenting the positive effects of both variables. It is also worth noting that Italian northern regions are, on average, more economically developed than southern regions; therefore, our results implicitly support the relevance of geographical proximity in explaining the diffusion of innovations (Berry and Berry, 2007; Mooney and Lee, 1995), as recent studies have documented (Donatella and Bisogno, 2024).

To conclude, several implications emerge from the analysis. First, while the existing literature predominantly concentrates on national agencies (Gasco-Hernandez *et al.*, 2022; Kuhlmann and Heuberger, 2023), this study focuses on LGs, contributing to the debate on digital transformation in the public sector context at a local level. Second, it underlines the importance of avoiding adopting a technological determinist perspective while examining the development of e-government initiatives. Third—and accordingly—this study embraces different social and political features that have been proven to be relevant while explaining the development of e-government initiatives so as to take a holistic approach. Such an approach is consistent with suggestions coming from the socio-technical perspective (Castelnovo and Sorrentino, 2018), allowing contextual factors to be taken into account. Concretely, the institutional and operational contexts that characterize the implementation stage of policy processes are considered (Di Giulio and Vecchi, 2019; Terlizzi, 2021) and embedded into an appropriate framework, merging e-government studies with social scientists' approaches.

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(The Appendix follows overleaf)

	Autonomy	Current_ balance	Indebtedness	Strength	GDP	Education	Ideology	Population	Elderly
Autonomy	1								
Current_ balance	0.0019	1							
Indebtedness	0.0454	<i>0.4730</i>	1						
Strength	-0.3263	-0.0068	-0.0455	1					
GDP	-0.0653	-0.2902	-0.279	0.2708	1				
Education	-0.1044	-0.0943	-0.0114	0.2359	<i>0.6940</i>	1			
Ideology	-0.0758	-0.0101	-0.0147	0.0426	-0.0142	0.0943	1		
Population	0.0842	-0.0694	0.0798	0.1018	0.2946	0.0479	-0.2415	1	
Elderly	-0.1673	-0.1754	-0.1286	0.0571	0.2322	0.1894	0.3225	-0.3373	1
Source(s): Authors' own work									

Table A1.
Correlations between
independent/control
variables

					International Journal of Public Sector Management
	ICity	Digital_ administrations	Open_ municipalities	Connected_ cities	
ICity	1				
Digital_ administrations	<i>0.7493</i>	1			
Open_ municipalities	<i>0.9026</i>	<i>0.4924</i>	1		
Connected_ cities	<i>0.9113</i>	<i>0.5445</i>	<i>0.7638</i>	1	
Autonomy	-0.0318	0.0444	-0.0593	-0.0478	
Current_ balance	-0.2491	-0.1529	-0.2505	-0.2201	
Indebtedness	-0.3255	-0.3610	-0.2486	-0.2505	
Strength	0.1946	0.0355	0.1658	0.2736	
GDP	<i>0.6055</i>	<i>0.3928</i>	<i>0.5618</i>	<i>0.5820</i>	
Education	0.2178	0.0556	0.2595	0.2132	
Ideology	-0.1143	0.0006	-0.1309	-0.1418	
Population	<i>0.6896</i>	<i>0.4016</i>	<i>0.6047</i>	<i>0.7359</i>	
Elderly	-0.0212	0.0526	-0.0460	-0.0430	
Source(s): Authors' own work					Table A2. Correlations between dependent and independent/control variables

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