Performance Evaluation of Information Systems in Portuguese Municipalities

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Abstract. The success of organizations increasingly depends on the performance of their information systems, and public bodies are no exception. If the service provided to all of us, as citizens, depends on this performance, then it is essential that we can evaluate it. This research evaluates the performance of information systems in the Portuguese municipalities, applying the DeLone and McLean model, which is based on the perceptions of the systems' users. The research is based on a self-administered questionnaire to a representative sample of Portuguese municipalities employees. The six dimensions of the model were: system quality, information quality, service quality, utilization, user satisfaction and impacts. A seventh dimension - demographics - and its relationship with the original model were also analyzed. The results show that DeLone and McLean model is suitable for the Portuguese municipalities context, and it was concluded that the system quality and information quality dimensions have a major effect on user satisfaction and intention to use/use, respectively. It was also found that the user satisfaction dimension has a strong effect, and the intention to use/use dimension has a moderate effect on Impacts. These results provide relevant information for decision-making related to the evolution of information systems in Portuguese municipalities, showing the importance of investing in the systems quality and the quality of the information produced.

Keywords: DeLone and McLean · Information system · Information quality · Intention to use/use · Portuguese municipalities · Service quality · System quality · User satisfaction

1 Introduction

The new Information and Communication Technologies (ICT) are evolving rapidly and today play a fundamental role in the macro sectors of the economy, politics, society, and organisation [1].

In this context of digital revolution, the concept of e-government has emerged: a new management approach, in the case of public administration, which involves ICT [2], linking citizens, companies, public services and public bodies, generating administrative benefits such as improved public services, management efficiency, ethical behavior and transparency [3, 4].

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Although this evolution has been underway for three decades, little is known about the concrete results of its action in public administration. Knowing the impact of Information Systems (IS) is extremely important, since the overall performance of an organisation depends heavily on the performance of it IS, and the case of the public administration is no exception [5].

However, it is difficult to measure the performance of the public administration's IS, because we must not forget that a large part of the objectives and value creation in the public administration are intangible [4]. Among the many entities that the Portuguese public administration covers, it is at the local level (municipalities) that there is the greatest proximity to the citizen, which is why it is important to assess the performance of the information systems used.

The aim of this study is to assess the performance of IS in Portuguese municipalities by applying a widely validated model - the DeLone and McLean model [6]. This model makes it possible to evaluate IS based on the perspectives of its users, in this case municipalities employees, across all their activities and hierarchical levels [7, 8].

2 Literature Review and Research Framework

In this point we will focus the most important aspects of the study: (1) the context of application - Portuguese municipalities; (2) the techniques and metrics to performance assessment of information systems and (3) the application of the DeLone and McLean model to public administration.

2.1 Portuguese Municipalities

The Portuguese municipalities refers to local authorities (territorially based legal entities with their own representative bodies that aim to pursue the interests of their respective populations). Specifically, a local authority is made up of a Municipality and the respective Parish Councils. These entities are more complex from a management point of view than most organizations, and they also have customers to satisfy - citizens and local businesses - who evaluate the services provided and act on their opinion during municipal elections [9]. These customers are increasingly demanding in terms of the response from public services, as they are used to a certain quality and speed in the service provided by the private sector [10, 11].

In order to increase citizens' trust, thus influencing their assessment of local government management and consequently their voting decision, local authorities are increasingly adopting e-government [12], with the aim of making more innovative use of ICT, particularly networked platforms and the Internet, to provide citizens and businesses with more convenient access to information and services, improving the quality of services and providing greater opportunities for participation in democratic institutions and processes [13]. Thus, an e-government system consists of a single, integrated and networked electronic platform, which allows communication between the public administration, citizens, and organizations [14].

It is intended that local authorities use ICT so that they can be directly involved in decision-making processes [15]. In this way, the adoption of local e-government (e-government at local level) offers local authorities the opportunity to simultaneously

improve public services, management efficiency, openness to citizens (transparency), ethical conduct and professionalism, citizen confidence and the general well-being of the population [4].

2.2 Performance Assessment of Information Systems

To measure and evaluate the return on their investments, business organizations often rely on the financial indicator return on investment (ROI). However, it has already been demonstrated in other studies that this indicator is not appropriate for determining the effectiveness and efficiency of IS, as this is a complex, multidimensional task, and dependent on multiple and multidisciplinary criteria [16].

Nevertheless, and considering that the performance of the IS determines the individual performance of its users and, consequently, the overall performance of the organization, it is of the utmost importance that the investment in the IS is sustainable, and its return is countable [17–19].

It turns out that these impacts are difficult to measure given their intangible nature, such as the improvement in the quality of public services, efficiency in management, openness to citizens (transparency), ethical conduct and professionalism, citizen trust or the general well-being of the population [4].

As an aggravating factor, in the case of municipalities administration, investments dedicated to IS often come into direct competition with the amounts invested in issues of profound social importance such as social housing, employment or economic development of the region [20].

A performance assessment model is therefore needed for ISs that calculates the performance of their hardware, software, networking, data quality, but also the achievement of the organization's objectives as a whole [21].

2.3 DeLone and Mclean Model and Public Administration

The DeLone and McLean [6] information systems success model is one of the most widely used and well-regarded models for evaluating the success of information systems (IS). The model has been applied in a variety of contexts, including the public sector, where it has been used to assess the success of a wide range of IS initiatives. This model evaluates the performance of an IS through statistical analysis from the perspective of the system's users and includes six dimensions:

- System quality (SyQ): This dimension refers to the quality of the IS itself, including its ease of use, reliability, and performance.
- Information quality (IQ): This dimension refers to the quality of the information provided by the IS, including its accuracy, completeness, and relevance.
- Service quality (SeQ): This dimension refers to the quality of the support and assistance that users receive from the organization responsible for the information system (IS).
- User satisfaction (US): This dimension refers to the level of satisfaction that users have with the IS.

- Intention to use/Use (U): This dimension refers to the extent to which the IS is used by users.
- Impacts (I): This dimension refers to the ultimate consequences of using an information system within an organization. It encompasses the broader organizational, individual, and societal benefits that result from IS implementation and usage.

Although the DeLone and McLean [6] model has been widely validated when it comes to IS success evaluation, there are studies that focus on public sector and/or on local public administration.

All six factors in the model were considered in evaluating the performance of the newly implemented IS in three public hospitals in Korea [22]. The indicators analyzed were adapted to the hospital context, and the model confirmed that the three quality factors have a significant influence on user satisfaction and that this has a very strong influence on the benefits/impacts for the organization. They also conclude that both system quality and information quality are significant for the intention to use/use factor, but service quality did not show the same relationship, which was associated by researchers with the fact that the implementation was conducted recently [22].

The model was also used to evaluate the performance of a system (governmental IS) in one state in India [21]. This study focuses especially on understanding the effect of exogenous variables on user satisfaction and intention to use/use. There is a strong effect of information quality on intention to use/use. Similarly, there is an effect of the service quality and information quality dimensions on user satisfaction [21].

The e-government system in the Republic of Serbia was studied [8] using the DeLone and McLean [6] model, with employees of the local public administration. In this study, the demographic data of the respondents associated with the intention to use/use dimension were considered as an extra dimension. The results show that all three dimensions of quality (system quality, information quality and service quality) had a positive impact on intention to use/use, and that only service quality had a significant effect on user satisfaction. Intention to use/use had a positive and direct effect on user satisfaction. The intention to use/use and user satisfaction are significant in predicting benefits/impacts [8].

A study carried out in three organizations in the public sector in Belgium [23] to verify its explanatory power for the public sector, shows that the model demonstrates suitability. The researchers concluded that system quality, information quality and service quality have a medium effect on user satisfaction, and user satisfaction is strongly correlated with impacts [23].

Another adaptation of the model was put into practice in evaluating the performance of the Iraqi e-government system [24]. The results shows that dimensions system quality, service quality and information quality have a significant effect on intention to use /use and user satisfaction. It can also be seen that user satisfaction has a strong effect on impacts, while intention to use/use has an insignificant effect on impacts [24].

In a study targeting end users in all public-sector organizations in Kuwait, researchers [25] concluded that information quality has a significant positive effect on intention to use/use and user satisfaction. Intention to use/use did not have a significant effect on IS success, while information quality is more important for maintaining and enhancing IS use.

The DeLone and McLean [6] model was used in Tunisia to evaluate the model of e-government success from the perspective of government employees [26]. The results show that intention to use/use and user satisfaction positively affect impacts. The study also found that government employees' use and of e-government systems had a direct positive impact on intention to use/use and user satisfaction.

The model was also used to evaluate the performance of the IS used for human resources management in the public sector in Morocco [27]. The quality of information, the quality of the system, the quality of service, the use, the user satisfaction, and impacts are the main factors that influence the success of the IS. Finally, it was concluded that intention to use/use and user satisfaction dimensions has a strong effect on impacts [27].

2.4 Research Framework Hypotheses

The possibilities of correlation between the dimensions of the DeLone and McLean [6] model (Fig. 1) which was analyzed in this investigation, are the following:

- Hypothesis 1 (H1): SyQ positively affects U.
- Hypothesis 2 (H2): SyQ positively affects US.
- Hypothesis 3 (H3): IQ positively affects U.
- Hypothesis 4 (H4): IQ positively affects US.
- Hypothesis 5 (H5): SeQ positively affects U.
- Hypothesis 6 (H6): SeQ positively affects US.
- Hypothesis 7 (H7): US positively affects U.
- Hypothesis 8 (H8): U positively affects I.
- Hypothesis 9 (H9): US positively affects I.
- Hypothesis 10 (H10): D positively affects U.
- Hypothesis 11 (H11): D positively affects US.

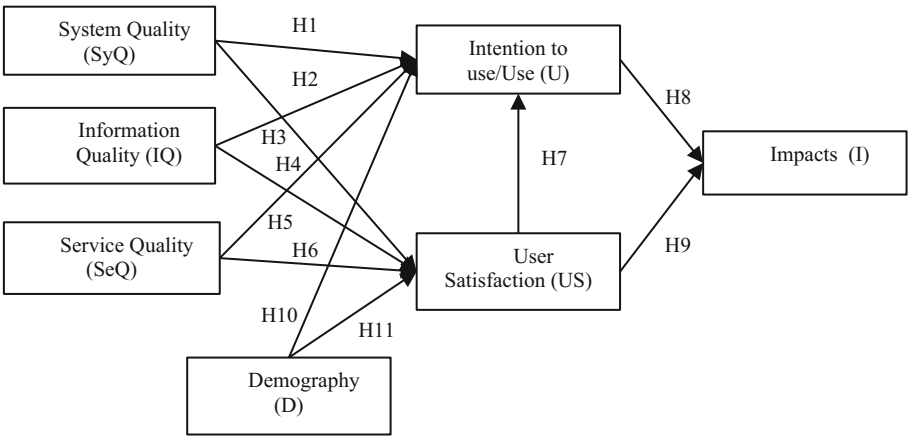

Fig. 1. DeLone and McLean Model [6] adapted.

3 Research Methodology

3.1 Participants and Data Collection

The participants (n = 1.310) where Portuguese municipalities employees, which in 2022 would represent a total of 137.205 employees [28], that were invited to participate in the questionnaire. The link to questionnaire was sent to everyone through e-mail message, along with an introduction about the research objectives.

For large populations, as the population increases, the sample size also increases, but at a decreasing rate, and remains relatively constant after 380 cases, with a margin of error of 5% and a precision of 95% [29]. We can therefore consider that, even though a convenience sampling method was used, the sample is sufficiently representative of the population.

3.2 Local Public Administration Employees Personal Information/Demographic Data

The questionnaire opened with a section dedicated to characterizing the respondents. This section corresponds to the demographic dimension (D) added to the model. The aim of this adaptation to the model was to understand whether the socio-demographic characteristics of Portuguese municipalities employees influenced their level of satisfaction as IS users, as well as their intention to use [8, 30]. The demographic characteristics considered relevant to the study were those that were thought to have the greatest significance in terms of the interaction between a worker and the IS available for carrying out their duties in the local authority.

The percentage of women respondents was 47 %, while men accounted for 53.0 % of the sample. Age stratification showed that 3.9 % of the employees were up to 29 years old, 13.8 % between 30 and 39, 41.0 % between 40 and 49, 32.4 % between 50 and 59 and 8.9 % aged 60 or over. In terms of academic qualifications, 1.5 % of the participants had primary education, 34.7 % had secondary education and 63.8 % had higher education. In terms of their position in the municipality, 9.2 % were operational assistants, 33.4 % technical assistants, 49.5 % senior technicians and 7.8 % hold political or senior positions (Fig. 2).

3.3 Survey Instrument and Structure

Considering the research developed on the conceptual model and considering the specific characteristics of the object under study – IS of the Portuguese municipalities – measurement indicators were defined for each of the six dimensions of the model (Table 1).

3.4 Pilot Study for the Questionnaire

Even knowing that the conceptual model [6] has already been validated numerous times, it is necessary to consider the (previously predicted) disparities in terms of educational qualifications and vocabulary used among the questionnaire participants.

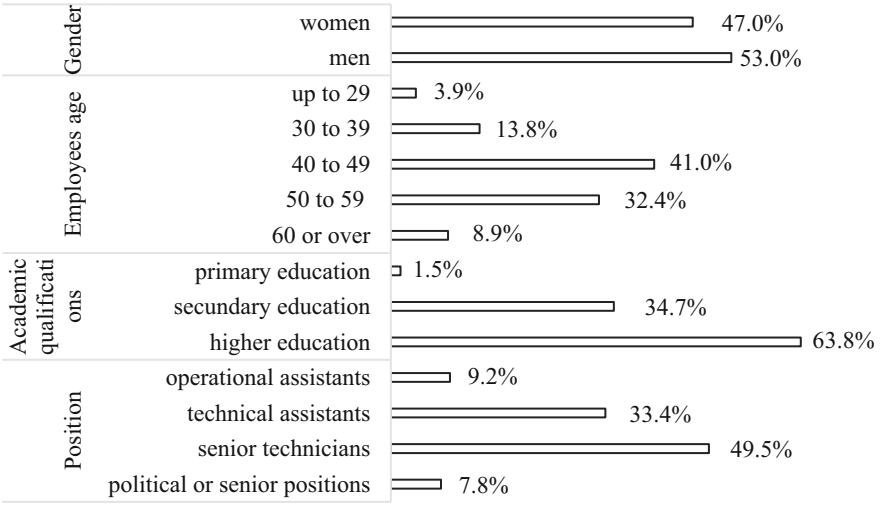

Fig. 2. Characterization of respondents (sample)

Table 1. Measurement Indicators.

Constructs	Items	Variable	Sources
System Quality (SyQ)	Pleasantness Intuition Functionality Celerity Integration	SyQ1 SyQ2 SyQ3 SyQ4 SyQ5	[6–8]
Information Quality (IQ)	Precision Update Trust	IQ1 IQ2 IQ3	[6–8]
Service Quality (SeQ)	Readiness Guarantee Empathy	SeQ1 SeQ2 SeQ3	[6–8, 30]
Intention to use/Use (U)	Dependency Frequency Duration Intention	U1 U2 U3 U4	[6–8]
User Satisfaction (US)	Satisfaction Expectation	US1 US2	[6–8]
Demography (D)	Age Gender Education Position	D1 D2 D3 D4	[8, 30]
Impacts (I)	Utility Efficiency Efficiency Control	I1 I2 I3 I4	[[6–8, 31]

Furthermore, it was necessary to conduct a linguistic adaptation, both in terms of translation in relation to the original model (and respective measurement indicators), and in relation to the context under study and respective target audience.

The method selected was the one in which most researchers place their trust: the Cronbach's Alpha internal reliability estimation technique [32]. This test is considered crucial when dealing with Likert scales [33].

The questionnaire was evaluated on an initial sample of twenty-one respondents, all of them employees of the Portuguese municipalities, selected by convenience.

An alpha value greater than 0.9 was obtained (Table 2), considering the excellent internal consistency reliability of the questionnaire [34].

Table 2. Cronbach's alpha value for pilot study.

Cronbach's alpha	Number of Items
0.928	21

3.5 SPSS and SmartPLS

SPSS Statistics v29 software [35] was used to analyze the demographic data, while SmartPLS 4 software [36] was used to estimate the PLS-SEM models. This tool can handle non-normal data, exploratory research for the same effect size and model complexity, and focus on prediction [37, 38].

3.6 Adjustment Quality for the PLS-SEM Model

The reference values for assessing the quality of the fit of the PLS-SEM model, as suggested in other studies [36–39, 41] were as follows:

- Loadings. Path loads must be above 0.70. The indicator should be discarded if the value is between 0.4 and 0.7 and if removing it improves composite reliability [37–39].
- Variance inflation factor (VIF). Indicates multicollinearity. VIF values should be <5 [38–40].
- Cronbach's Alpha (CA) and Composite Reliability (CR). They evaluate the reliability and internal consistency of the measuring instrument. Values >0.70 are satisfactory [36–39].
- Average variance extracted (AVE). Evaluates the portion of the variance of endogenous variables explained by the structural model. Results above the cutoff point >0.67 "substantial"; >0.33 "moderate"; >0.19 "weak" [37–39].
- R-square. Results with cutoffs 0.67, 0.33 and 0.19 are "substantial", "moderate" and "weak", respectively [37–39].
- Predictive validity (Q-square) or Stone-Geisser Indicator. Establishes the predictive relevance of endogenous constructs. Q-square >0 is good. [39, 41].
- Discriminant validity (DV). Fornell-Larcker criterium. The square roots of the AVEs must be greater than the correlations of the constructs [38, 42].

- F-square (Choen Indicator). Indicates the size of the effect. Values >0.35, >0.15, >0.02 and <0.02 are considered "strong", "moderate", "weak", "non-existent" respectively [37–39].

3.7 Model Adjustment

Analysis of the loadings of each of the factors (items) showed that there existed four items that has a value lower than 0.7. Following the protocol foreseen in these situations, the four variables that presented values lower than 0.7 were removed from the model and a new specification test was conducted. In this specification all weights of variable were greater than 0.7 and composite reliability improved. This meaning that the model has good adjustment characteristics. (Table 3).

Table 3. Adjustment quality for the SEM model.

Constructs	Items	Loadings	VIF	CA	CR	AVE	R-square	Q-square
SyQ	SyQ1	0.864	2.695	0.886	0.888	0.744	–	–
	SyQ2	0.873	2.814					
	SyQ3	0.874	2438					
	SyQ4	0.840	2.197					
IQ	IQ1	0.818	1.534	0.779	0.782	0.693	–	–
	IQ2	0.858	1.701					
	IQ3	0.821	1.628					
SeQ	SeQ1	0.834	1.733	0.809	0.812	0.724	–	–
	SeQ2	0.877	1.939					
	SeQ3	0.841	1.692					
D	D3	0.920	2.081	0.838	0.853	0.860	–	–
	D4	0.934	2.081					
U	U1	0.863	2.074	0.810	0.824	0.637	0.399	0.392
	U3	0.847	2.191					
	U4	0.824	1.496					
US	US1	0.950	2.791	0.890	0.890	0.901	0.685	0.682
	US2	0.948	2.791					
I	I1	0.917	3.603	0.914	0.914	0.795	0.683	0.632
	I2	0.888	2.978					
	I3	0.866	2.347					
	I4	0.893	2.892					

The values of VIF (<5), CA (> 0.70), CR (> 0.70), AVE (>0.67 "substantial" or >0.33 "moderate"), R-square (>0.67 "substantial" or >0.33 "moderate") and Q-square (> 0) presented in Table 3, show that the model has well-fitting conditions.

The discriminating validity (DV) results presents the highest value on the main diagonal, which means that the square roots of the AVEs its greater than the correlations of the constructs (Table 4).

Table 4. Discriminating Validity (Fornell – Larcker criterion).

	D	I	IQ	SeQ	SyQ	U	US
D	0,927						
I	–0,017	0,891					
IQ	0,002	0,736	0,833				
SeQ	0,042	0,611	0,631	0,851			
SyQ	–0,067	0,730	0,732	0,532	0,863		
U	0,067	0,616	0,601	0,515	0,488	0,798	
US	–0,068	0,782	0,707	0,610	0,788	0,489	0,949

The F-square Indicator values show that the effect of the user satisfaction (US) and intention to use/use (U) dimensions on impacts (I) are strong > 0.35 and moderate > 0.15, respectively. The effect of system quality (SyQ) dimension on user satisfaction (US) is strong > 0.35. All remaining effects are low (between 0.02 and 0.15) (Table 5).

Table 5. F-square (Choen Indicator).

Causal Relations	Coefficient Analyses
Demography (D) -> Intention to use/Use (U)	0,002
Demography (D) -> User Satisfaction (US)	0,006
Information Quality (IQ) -> Intention to use/Use (U)	0,083
Information Quality (IQ) -> User Satisfaction (US)	0,028
Intention to use/Use (U) -> Impacts (I)	0,221
Intention to use/Use (U) -> User Satisfaction (US)	0,006
Service Quality (SeQ) -> Intention to use/Use (U)	0,048
Service Quality (SeQ) -> User Satisfaction (US)	0,070
System Quality (SyQ) -> Intention to use/Use (U)	0,009
System Quality (SyQ) -> User Satisfaction (US)	0,413
User Satisfaction _(US) -> Impacts (I)	0,901

4 Results

The results of the test of the adjusted model, conducted using the bootstrapping algorithm so that the relationship between exogenous variables and endogenous variables can be obtained taking moderation into account, were as follows (Fig. 3):

- The system quality (SyQ) dimension has a weak effect on the intention to use/use (U) dimension (0.108) and a strong effect on the user satisfaction (US) dimension (0.538).
- The information quality (IQ) dimension has a strong effect on the intention to use/use (U) dimension (0.365) and a moderate effect on the user satisfaction (US) dimension (0.157).
- The service quality (SeQ) dimension has a moderate effect on both the intention to use/use (U) dimension (0.225) and the user satisfaction (US) dimension (0.197).
- The intention to use/use (U) dimension has a moderate effect (0.309) on the impacts (I) dimension.
- The intention to use/use (U) dimension has a weak effect on the user satisfaction (US) dimension (0.056).
- The user satisfaction (US) dimension has a strong effect on the impacts (I) dimension (0.624).
- The demography (D) dimension has a weak effect on the intention to use/use (U) dimension (0.034) and a zero effect on user satisfaction (US) (-0.043).

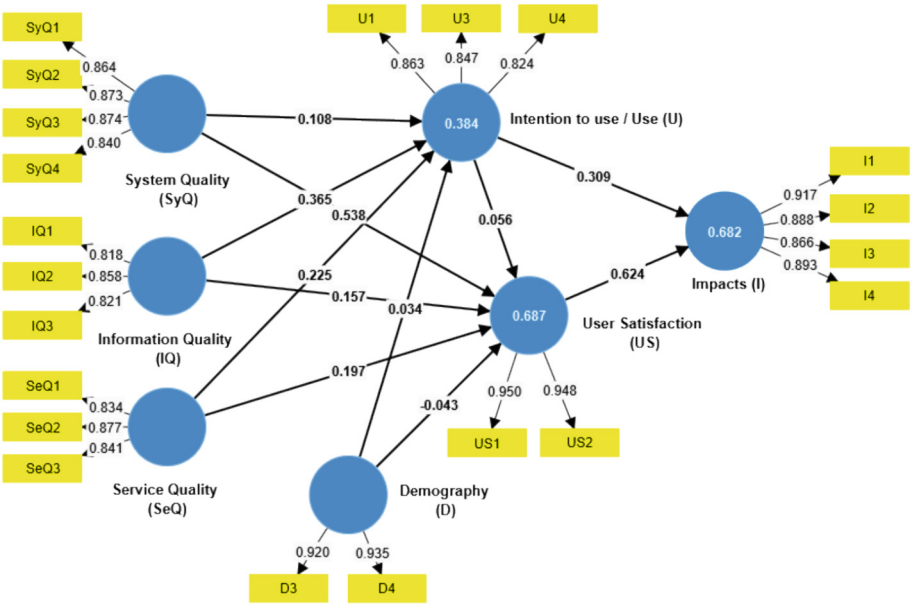

Fig. 3. Partial least square structure model (inner path coefficients and outer weights).

4.1 Specific Indirect Effects

The system quality (SyQ) has a significant indirect effect on user satisfaction (US), which in turn influences impacts (I) (0.335). The service quality (SeQ), through the intention to use/use, and service quality (SeQ), through the user satisfaction (US), have a significant indirect effect on impact (I) (Table 6).

Table 6. Specific Indirect Effects

Causal Relations	Coefficient Analyses
Demography (D) -> Intention to use/Use (U) -> Impacts (I)	0,011
Demography (D) -> Intention to use/Use (U) -> User Satisfaction (US) -> Impacts (I)	0,001
Intention to use/Use (U) -> User Satisfaction (US) -> Impacts (I)	0,035
Demography (D) -> User Satisfaction (US) -> Impacts (I)	−0,027
Information Quality (IQ) - > Intention to use/Use (U) -> Impacts (I)	0,113
Information Quality IQ) -> Intention to use/Use (U) -> User Satisfaction (US) -> Impacts (I)	0,013
Intention to use/Use (U) -> User Satisfaction (US) -> Impacts (I)	0,035
Information Quality (IQ) -> User Satisfaction (US) -> Impacts (I)	0,098
Intention to use/Use (U) - > User Satisfaction (US) -> Impacts (I)	0,035
Service Quality (SeQ) -> Intention to use/Use (U) -> Impacts (I)	0,070
Service Quality (SeQ) -> Intention to use/Use (U) -> User Satisfaction (US) -> Impacts (I)	0,008
Intention to use/Use (U) -> User Satisfaction (US) -> Impacts (I)	0,035
Service Quality (SeQ) -> User Satisfaction (US) -> Impacts (I)	0,123
System Quality (SyQ) -> Intention to use/Use (U) -> Impacts (I)	0,033
System Quality (SyQ) -> Intention to use/Use (U) -> User Satisfaction (US) -> Impacts (I)	0,004
Intention to use/Use (U) -> User Satisfaction (US) -> Impacts (I)	0,035
System Quality (SyQ) -> User Satisfaction (US) -> Impacts (I)	0,335

4.2 Results of Formulated Hypotheses

The results show that only one of the initially predicted correlations was found to be non-existent (H11): demography (D) has no effect on the user satisfaction (US) dimension. On the other hand, demography (D) has an effect (albeit weak, of 0.056) on intention to use/use (U) (Table 7).

The system quality (SyQ) has a greater influence on user satisfaction (US) than on the intention to use/use (U) of the system itself by employees. Information quality (IQ) has a

positive effect on intention to use/use (U) (strong) and user satisfaction (US) (moderate). Service quality (SeQ) has a moderate effect on user satisfaction (US) and intention to use/use (U).

Intention to use/use (U) and user satisfaction (US) dimensions are interdependent, linked, the correlation between these variables is only weak (0.056). Regarding the impacts (I) dimension, intention to use/use (U) exerts influence (moderate), but it is user satisfaction (US) that demonstrates the greatest effect (strong).

The factor that most influences the size of the impacts (I) is user satisfaction (US), which in turn is influenced by the quality of the system (SyQ).

Table 7. Results of Formulated Hypotheses

Hypothesis	Path Coefficients	Results	Effect
H1: SyQ positively affects U	0.108	Confirmed	Weak
H2: SyQ positively affects US	0.538	Confirmed	Strong
H3: IQ positively affects U	0.365	Confirmed	Strong
H4: IQ positively affects US	0.157	Confirmed	Moderate
H5: SeQ positively affects U	0.224	Confirmed	Moderate
H6: SeQ positively affects US	0.197	Confirmed	Moderate
H7: U positively affects US	0.056	Confirmed	Weak
H8: U positively affects I	0.309	Confirmed	Moderate
H9: US positively affects I	0.624	Confirmed	Strong
H10: D positively affects U	0.034	Confirmed	Weak
H11: D positively affects US	−0.043	Not confirmed	Non-existent

5 Results Discussion

The results show the suitability of applying DeLone and McLean [6] model in the context of Portuguese municipalities. The model proved to be adequate for the purpose of the research and only one of the correlations predicted in the model proved to be non-existent (H11): demographics (D) has no effect on the dimension of user satisfaction (US). On the other hand, demography (D) has an effect (weak, of 0.064) on use (U). This result, although weak, differs from that obtained by (Stefanovic et al. [8], which did not find any correlation between these two variables.

The empirical results demonstrate that system quality (SyQ) has a greater influence on user satisfaction (US) that is, Portuguese municipalities employees. This conclusion confirms the results obtained by similar studies [21–24]. It is also verified that the system quality has a weak influence on the intention to use/use (U). Considering the strong effect of system quality (SyQ) on user satisfaction (US), it seems that when the IS of the Portuguese municipalities is easy to use and dependable, employees are likely to feel more motivated and provide better services to citizens.

The study conclude that information quality (IQ) has a positive effect on intention to use/use (U) dimension (strong) and user satisfaction (US) (moderate). The effect on user satisfaction (US) is confirmed in other studies [21–25], while the effect of information quality (IQ) on intention to use/use (U) is like others [8, 21, 22, 24, 25]. The results obtained in this investigation mean that when the information available on IS is accurate, up-to-date, and relevant, Portuguese municipalities employees are more likely to use it, with the possibility of a positive impact on the services provided to citizens.

The service quality (SeQ) has a moderate effect on user satisfaction (US) and intention to use/use (U). This conclusion is confirmed by previous studies [8] but differs from other studies in which only the effect of service quality (SeQ) on user satisfaction (US) [21–23] or intention to use/use (U) [24] is confirmed. These results suggest that when Portuguese municipalities employees have quality of the support and assistance from the IS organisation, they are more likely to get involved and eventually contribute to a better service for citizens.

The intention to use/use (U) dimension exerts influence (moderate) on impacts (I) which is confirmed by previous studies [8, 26] while the study of Attar and Mazouz [27] conclude that the effect is strong and other studies do not confirm this effect [24, 25]. This conclusion shows that there is a probability of the intention to use/use (U) the IS in the future will have an impact on the success of the service provided to citizens.

The findings showed that user satisfaction (US) has the greatest effect (strong) on impacts (I). All the studies analyzed show the effect of user satisfaction (US) on impacts (I), and in most of these studies the conclusion is that, as in this study, there is a strong effect [8, 21–24, 27]. It should be noted that the factor that most influences the impacts (I) dimension is user satisfaction (US), which is influenced by system quality (SyQ) (although other correlations also occur) [43]. The results suggest that Portuguese municipalities should not only focus on systems quality; rather, but they should also continuously improve service quality and information quality to improve user satisfaction and eventually reach full the potential of IS performance. Finally, the results shows that the investment in the quality of the IS will have an impact on user satisfaction with which employees perform their tasks and thus constitute a contribution to improving the service that they provide to citizens.

6 Limitations

It is important to mention the limitations that this study faced related to the lack of data on the reality on which the study was intended to be conducted. Data on the number of Portuguese municipalities employees and their distribution by gender were obtained, but it was not possible to obtain data regarding other demographic aspects. Although the sample was considered representative, it was feared the lack of rigor in relation to the general panorama of the population about the distribution of the variables of the area of activity and the district, so it was decided not to carry out the analysis for these cases, avoiding. Thus, the deviations that could result from inter-municipal diversity and from the fact that many Portuguese municipalities did not participate in this survey. This issue was also addressed in a study of Sirsat and Sirsat [21]. In this study, the authors considered that the administrative and implementation diversity of IS that was felt between regions could have distorted the obtained results.

7 Conclusions

The present study adapted the success of DeLone and McLean [6] model, to evaluate the IS of Portuguese municipalities. The most relevant conclusions of the study are extremely important for decision-makers in the Portuguese municipalities as they reveal that employees express a high degree of satisfaction user satisfaction (US)) in relation to the IS they use. It is also concluded that the technical specificities of the system quality (SyQ) have a preponderant effect on satisfaction of employees and information quality (IQ) as a significant effect on intention to use/use (U).

The obtained results suggest that Portuguese municipalities managers should: (1) ensure that the information provided by the system is accurate, relevant, and accessible; (2) make the system easy to use and flexible; (3) provide effective user support; (4) ensure that users are satisfied with the systems.

By following these recommendations, managers can improve the effectiveness of the IS of Portuguese municipalities and provide a better quality of service to citizens.

To further this investigation, it would be interesting to evaluate the performance of the IS for each municipality individually, using this same conceptual model, with the aim of eliminating the limitation detected in terms of administrative and geographic diversity [21].

This model could also be applied within other public sector entities such as justice, health, education, etc. There is also another perspective that was not evaluated in this investigation, but which could be a source of relevant information in this context: the citizen's perspective.

References

1. Roztocki, N., Weistroffer, H.R.: Information and communication technology in transition economies: an assessment of research trends. Inf. Technol. Dev. **21**(3), 330–364 (2015). https://doi.org/10.1080/02681102.2014.891498
2. Bonsón, E., Torres, L., Royo, S., Flores, F.: Local e-government 2.0: Social media and corporate transparency in municipalities. Govern. Inform. Quar. 123–132 (2018). https://doi.org/10.1016/j.giq.2011.10.001
3. Heeks, R.: Understanding e-governance for development. i-Government Working Paper Series. Institute for Development Policy and Management, pp. 1–25 (2019)
4. Twizeyimana, J.D., Andersson, A.: The public value of E-Government–a literature review. Gov. Inf. Q. **36**(2), 167–178 (2019). https://doi.org/10.1016/j.giq.2019.01.001
5. Aydiner, A.S., Tatoglu, E., Bayraktar, E., Zaim, S.: Information system capabilities and firm performance: opening the black box through decision-making performance and business-process performance. Int. J. Inf. Manage. **47**, 168–182 (2019). https://doi.org/10.1016/j.ijinfomgt.2018.12.015
6. DeLone, W.H., McLean, E.R.: The DeLone and McLean model of information systems success: a ten-year update. J. Manag. Inf. Syst. **19**(4), 9–30 (2003). https://doi.org/10.1080/07421222.2003.11045748
7. Petter, S., DeLone, W., McLean, E.: Measuring information systems success: models, dimensions, measures, and interrelationships. Eur. J. Inf. Syst. **17**(3), 236–263 (2008). https://doi.org/10.1057/ejis.2008.15

8. Stefanovic, D., Marjanovic, U., Delić, M., Culibrk, D., Lalic, B.: Assessing the success of e-government systems: an employee perspective. Inform. Manage. **53**(6), 717–726 (2016). https://doi.org/10.1016/j.im.2016.02.007
9. Ralha, J.: Da Gestão, em Autarquias – Para Melhorar as Competências em Gestão, dos Eleitos, pp. 23–33. Edições Sílabo, Lda, Lisboa (2018). ISBN:978-972-618-942-8
10. Torres, L., Pina, V., Acerete, B.: E-government developments on delivering public services among EU cities. Gov. Inf. Q. **22**(2), 217–238 (2005). https://doi.org/10.1016/j.giq.2005.02.004
11. Pérez-Morote, R., Pontones-Rosa, C., Núñez-Chicharro, M.: The effects of e-government evaluation, trust and the digital divide in the levels of e-government use in European countries. Technol. Forecast. Soc. Change **154**, 119973 (2020). https://doi.org/10.1016/j.techfore.2020.119973
12. Tolbert, C.J., Mossberger, K.: The effects of E-government on trust and confidence in government. Public Adm. Rev. **66**(3), 354–369 (2006). https://doi.org/10.1111/j.1540-6210.2006.00594.x
13. Fang, Z.: E-government in digital era: concept, practice, and development. Int. J. Comput. Internet Manage. **10**(2), 1–22 (2002)
14. West, D.M.: E-government and the transformation of service delivery and citizen attitudes. Public Admin. Rev. **64**(1), 15–27 (2004). http://www.jstor.org/stable/3542623. Accessed 8 Jan 2024
15. Welch, E.W., Hinnant, C.C., Moon, M.J.: Linking citizen satisfaction with e-government and trust in government. J. Public Admin. Res. Theory **15**(3), 371–391 (2005). https://doi.org/10.1093/jopart/mui021
16. Botchkarev, A., Andru, P., Chiong, R.: A return on investment as a metric for evaluating information systems: taxonomy and application. Interdiscipl. J. Inform. Knowl. Manage. **6**, 245–269 (2011). https://doi.org/10.28945/1535
17. Monk, E.F., Wagner, B.J.: Concepts in enterprise resource planning. Course Technology, Boston (2013)
18. Nevo, S., Wade, M.R.: The formation and value of IT-enabled resources: antecedents and consequences of synergistic relationships. MIS Quar. 163–183 (2010). https://doi.org/10.2307/20721419
19. Irani, Z., Abril, R.M., Weerakkody, V., Omar, A., Sivarajah, U.: The Impacts of legacy systems on digital transformation in European public administration: Lesson learned from a multi case analysis. Govern. Inform. Quar. **40.1**, 101784 (2023). https://doi.org/10.1016/j.giq.2022.101784
20. Gouveia, L.B.; Ranito, J.: Sistemas de Informação de Apoio à Gestão. Inovação e Governação nas Autarquias VII. SPI – Sociedade Portuguesa de Inovação, Porto (2004). ISBN:972 8589 43 3
21. Sirsat, S.S., Sirsat, M.S.: A validation of the DeLone and McLean model on the educational information system of the Maharashtra State (India). Int. J. Educ. Learn. Syst. **2016**(1), 9–18 (2016)
22. Cho, K.W., Bae, S.K., Ryu, J.H., Kim, K.N., An, C.H., Chae, Y.M.: Performance evaluation of public hospital information systems by the information system success model. Healthcare Inform. Res. **21**(1), 43–48 (2015). https://doi.org/10.4258/hir.2015.21.1.43
23. Van Cauter, L., Verlet, D., Snoeck, M., Crompvoets, J.: The explanatory power of the Delone & McLean model in the public sector: a mixed method test. Inform. Polity **22**(1), 41–55 (2017). https://doi.org/10.3233/IP-170404
24. Al-Sulami, Z.A., Hashim, H.S.: Measuring the success of e-government systems: applying the success model of the Delone and Mclean information system. J. Theor. Appl. Inf. Technol. **96**(22), 7654–7670 (2018)

25. Rouibah, K., Dihani, A., Al-Qirim, N.: Critical success factors affecting information system satisfaction in public sector organizations: a perspective on the mediating role of information quality. J. Global Inform. Manage. **28**(3), 77–98 (2020). https://doi.org/10.4018/JGIM.2020070105
26. Mellouli, M., Bouaziz, F., Bentahar, O.: E-government success assessment from a public value perspective. Int. Rev. Public Admin. **25**(3), 153–174 (2020). https://doi.org/10.1080/12294659.2020.1799517
27. Attar, A., Mazouz, Y.: Evaluation of human resources information system success in public sector. Int. J. Innov. Appl. Stud. **34**(1), 81–90 (2021)
28. DGAEP. Booletim estatístico do emprego público (BOEP) (2021). https://www.dgaep.gov.pt/index.cfm?OBJID=C0F56E62-5381-4271-B010-37ECE5B31017. Accessed on 25 July 2023
29. Krejcie, R.V., Morgan, D.W.: Determining sample size for research activities. Educ. Psychol. Measur. **30**(3), 607–610 (1970). https://doi.org/10.1177/001316447003000308
30. Jiang, J., Klein, G.: User evaluation of information systems: By system typology. IEEE Trans. Syst. Man Cybern. **29**(1), 111–116 (1999). https://doi.org/10.1109/3468.736366
31. Torkzadeha, G., Doll, W.: The development of a tool for measuring the perceived impact of information technology on work. Omega, Int. J. Mgmt. Sci. **27**, 327–339 (1999). https://doi.org/10.1016/S0305-0483(98)00049-8
32. Marôco, J., Garcia-Marques, T.: Qual a fiabilidade do alfa de Cronbach? Questões antigas e soluções modernas? Laboratório de psicologia, pp. 65–90 (2006). https://doi.org/10.14417/LP.763
33. Gliem, J.A., Gliem, R.R.: Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales. In: Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education, pp. 82–88. Ohio State University, Ohio, EUA (2003)
34. George, D., Mallery, P.: IBM SPSS statistics 26 step by step: a simple guide and reference. Routledge, United Kingdom (2019). https://doi.org/10.4324/9780429056765
35. Marôco, J.: Análise Estatística com o SPSS Statistics. ReportNumber, Lda, Pêro Pinheiro, Portugal (2021). ISBN:9789899676374
36. Ringle, C.M., Wende, S., Becker, J.-M.: SmartPLS 4. SmartPLS: GmbH, Oststeinbek (2022). http://www.smartpls.com
37. Hair, J.F., Jr., Sarstedt, M., Hopkins, L., Kuppelwieser, V.G.: Partial least squares structural equation modeling (PLS-SEM), a emerging tool in business research. Eur. Bus. Rev. **26**, 106–121 (2014). https://doi.org/10.1108/EBR-10-2013-0128
38. Hou, H.-Y., Lo, Y.-L., Lee, C.-F.: Predicting network behavior model of E-learning partner program in PLS-SEM. Appl. Sci. **10**, 4656 (2020). https://doi.org/10.3390/app10134656
39. Martinho, D., Sobreiro, P., Vardasca, R.: Teaching sentiment in emergency online learning—a conceptual model. Educ. Sci. **11**, 53 (2021). https://doi.org/10.3390/educsci11020053
40. Marôco, J.: Análise de Equações Estruturais; ReportNumber, Lisboa, Portugal (20100. ISBN 9789899676336

41. Tenenhaus, M., Vinzi, V.E., Chatelin, Y.M., Lauro, C.: PLS path modeling. Comput. Stat. Data Anal. **48**(1), 159–205 (2005). https://doi.org/10.1016/j.csda.2004.03.005
42. Radomir, L., Moisescu, O.I.: Discriminant validity of the customer-based corporate reputation scale: some causes for concern. J. Prod. Brand Manage. **29**(4), 457–469 (2020). https://doi.org/10.1108/JPBM-11-2018-2115
43. Al-Kofahi, M.K., Hassan, H., Mohamad, R., Intan, T.P., Com, M.P.: Information systems success model: a review of literature. Int. J. Innov. Creat. Change **12**(8) (2020)