Demographic Profile of Citizens' Interest, Evaluation and Opinions of Local Government Apps in Smart Cities

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Abstract. Smart cities are fostering the interaction, collaboration and involvement of citizens in the city management models. To achieve this aim, technological tools like city mobile apps are being used for redefining the way citizens interact with smart cities. This paper seeks to analyse the demographic profile of citizens regarding the use of local government Apps for participation in public affairs and the digital divide through the evaluation, opinions and interest of citizens in these Apps in European smart cities. To achieve this aim, this paper focuses on an empirical research on Apps created by European smart cities included in the IESE Business School project. Findings indicate that the education level, gender and ages of the citizens can be factors to download, evaluate and opine about local government Apps, although its influence depend on the smart dimension in which the Apps are running.

Keywords: smart city, e-participation, citizen engagement, Apps.

1 Introduction

The implementation of information and communications technologies (ICTs) in smart cities (SCs) is proposed as a solution to urban challenges. Indeed, the availability of ubiquitous ICTs in SCs stimulates the development of new services and applications by various types of users (Khodabakhsh et al., 2016) and have caused a revolutionary transformation in urban service delivery, creating more efficient and easily accessible environments to promote collaboration in problem-solving issues and innovation (Rodríguez Bolívar, 2017a).

The apps provide one of the building blocks of today's smart city infrastructure (Solomon et al., 2016) because they are thought as a tool for crowdsourcing collaboration with the local governments to improve service efficiency and effectiveness, increasing the transparency and accountability of public services (Pack et al., 2017). Also, they can facilitate real-time interaction with the local government and enhance community-based public service (Tang et al., 2019).

In any case, the SCs are not focused only on technical aspects, but also recent scientific publications increasingly more emphasize the inclusion of "people aspects" in the conceptualization and governance models of SCs (Rodríguez Bolívar, 2018a and 2018b). In this regard, citizens' acceptance of ICTs for SC apps is very important

nowadays in the SCs environment since citizens are one of the main stakeholders of the resulting urban apps ecosystem within a city (Aguilera et al., 2016). Nonetheless, there is a lack of research regarding techniques of the use of demographic profile of citizens for designing and creating urban apps. In this regard, it could be interesting to analyse whether the demographic profile of citizens is influencing on the downloads (interest), score (useful) and opinions (collaboration) of the urban apps.

Therefore, to gain a better understanding of the reality outside the academic literature regarding the application of apps in SCs, and particularly, the demographic profile of citizens that use these technological tools in SCs, this paper seeks to test whether the gender, education level and the age of citizens could influence on the downloads, score and opinions about the use of local government Apps in European SCs.

To achieve this aim, we focus our analyses in European SCs included in the project "Cities in motion version 2018" headed by the IESE Business School University of Navarra, that ranks all SCs according to some indicators in different areas. The remainder of the paper is, therefore, as follows. The next section describes the hypothesis formulation, the sample selection and the methodology of the research. Then, we present the results of the study and finally, the conclusions section comes the paper to an end.

2 Empirical Research

The capability theory (Heres et al., 2005) explains the need to analyse the fitness between the personal profile (person's technological, economic and social situation) and the technology offered by governments, with the aim at understanding the acceptance and use of technological advances by citizens. In fact, this theory supports that the whole process of adoption of new technologies is influence by the demographic, educational and cultural factors in society.

Therefore, this paper formulates some hypothesis to be tested using an OLS regression analysis regarding the demographic profile of citizens in their use of local government Apps. Concretely, we consider demographic factors such as gender, age, and level of education of the citizens and the analysis of their influence on Smart City Apps.

To achieve this aim, this research is focused on European smart cities and the local government Apps created by these governments. The next subsections try to specifically explain and support all these issues of the research.

2.1 Hypothesis formulation

2.1.1. Gender

Previous studies highlighted that gender plays an important role in the technology acceptance model, offering different evidences (Wang and Shih, 2009; Venkataseh et al., 2012), given that men and women use different socially constructed cognitive structure in the making decisions process. Previous research (Wang and Shih, 2009;

Ahmand Khalid, 2017) highlighted that women trust more on the opinions of the others because they are more empathetic and aware of the other's feeling compared to men. However, other studies concluded that the intention to use Internet technologies is not different in men and women (Wang et al., 2009).

On the other hand, previous studies (Alotaibi and Roussinov, 2016; Hogue, 2016) found that gender influences on the adoption of M-Government and the user intention to adoption this M-Government. While others (Lian, 2015) showed that gender did not moderate in the relationship between trust and adoption of e-invoice. Otherwise, there are studies that highlighted that male web users show higher open government platform activity that women, although the findings achieved also show that the gender had not effects on the intensity of the use of mobile phone and apps (Schmithuber et al., 2017; Thomas and Streib, 2003). Therefore, taking into account these previous different evidences, we think that could be appropriate and add value to the field of knowledge to analysis the influence of gender on behaviour with Smart Cities' apps, thus we propose the following hypothesis:

H1.1. Gender influences on the Smart City apps downloads.
H1.2. Gender influences on the Smart City apps score.
H1.3. Gender influences on the Smart City apps opinions.

2.1.2. Age

Another of the variables widely analysed in the previous literature is the age of use and its influence on the use of technology, mobile systems, apps and so on (Phang et al., 2006; Chung et al., 2010; Liébana-Cabanillas et al., 2014; Schmidthuber et al., 2017). According to Ahmad and Khalid (2017) and Liébana-Cabanillas et al., (2014), user's age is particularly useful for explaining variation their behaviour in the use of new technologies, systems and tools.

Previous studies highlighted that age is a moderator of the relationship between factors influenced the adoption of M-Government and the intention to adopt M-Government (Alotaibi and Roussinov, 2016; Ohme, 2014). However, other studies evidenced age does not moderate the relationship between social influenced and the adoption M-Government and the relationship between trust and the adoption of M-Government (Chopar and Rajan, 2016; Lian, 2015). In this sense, Dimitrova et al. (2006) and Nam (2012) found that younger age people use Internet more frequently for using e-Government, but Schmidthuber et al. (2017) found significative evidences that old people use Open Government Web and apps more frequently that younger people.

Given that, the findings on age are different in the previous studies we think that could be interesting to analysis the influence of age on behaviour with Smart Cities' apps, thus we propose the following hypothesis:

H2.1. Age influences on the Smart City apps downloads.
H2.2. Age influences on the Smart City apps score.
H2.3. Age influences on the Smart City apps opinions.

2.1.3. Level of Education

Finally, level of education is considered as the most important drivers in the analysis of the acceptance and usage of technology (Choudrie and Papazafeiropoulou, 2006), because the users that have educational qualification are more likely to attain better jobs and are more likely to adopt new innovations (Dwivedi and Lal, 2007).

In this sense, Al-Shafi and Weerakkody (2010) found significant evidences among adopters and non-adopters of e-Government depending on the users' level of education. Meanwhile, Dimitrova and Chen (2006) evidenced that the level of education has a positive significant relation with media use for public affairs, but a negative significant relation with frequency of use of e-Government services. In this way, Schmidthuber et al. (2017) showed that high-educated users use the platform les actively via app that low educated ones.

Taking into account, these previous studies showed conflicted results when they analysed the influence of education for the use of Internet and e-Government, we think that could be interesting to analysis the influence of education on behaviour with Smart Cities' apps, thus we propose the following hypothesis:

H3.1. Level of education influences on the Smart City apps downloads.

H3.2. Level of education influences on the Smart City apps score.

H3.3. Level of education influences on the Smart City apps opinions.

2.2 Sample selection and data collection method

In this study, we focused on local governments because in recent years, the local governments around the world are undergoing numerous reforms that have transformed these organizations to enhance the effectiveness, efficiency, and legitimacy of their public value creation processes. The implementation of new technology and organizational changes are complex processes that have developed into difficult problems that are often too difficult to be solved by local governments (Sørensen and Torfing, 2011).

Together with the aforementioned, the local governments are considered the closest level of the government with the citizens, managing the largest number of services provided (Rodríguez Bolívar, 2017b; Saiz, 2011). Given that, they are the governments that most influence the daily life of citizens, the citizenship demands more public information to know how to manage the public resources, implement the public policies and adopt the decision-making.

In this sense, the local governments have made different communication channels (social media, platforms and mobile web services) available to citizens to interact with them and favour their participation in public affairs (Bonsón et al. 2015; Hung et al., 2011). The smart-phones and tablets offer greater data storage capacity, activities, systems, software and greater connectivity in real time, favouring e-democracy (Höffken, and Streich, 2013). Also, the governments have designed service platforms and mobile applications that enable citizens to report incidents and interact with them while on the move (Reuver et al., 2013).

This process of technological innovation has been accelerated in the context of the Smart Cities (Gil-García et al., 2016), which has posed continuous challenges for governments. The local governments have adapted their traditional structures and

processes to the technological and innovative advances to create public value (Wirtz et al., 2019). But the smart context offers the necessary conditions to achieve of improved information, service provision, citizen engagement, and legitimacy (Yeh, 2017), which create more affordable, participatory and transparent public sector management models.

Taking into account everything previously described, our study is focused on cities labelled as "Smart" in the project undertaken by the IESE Business School University of Navarra (see http://www.iese.edu/research/pdfs/ST-0396.pdf). In this paper, a SC is defined based on the European Union definition, as "a place where traditional networks and services are made more efficient with the use of digital and telecommunication technologies, for the benefit of its inhabitants and businesses" (Eurostat 2016). And the data collection method of this paper was based on an examination of the official websites of local governments in European Smart Cities during February 2019 with the specific purpose of collecting data about mobile applications offered by the city government. Thereafter, we accessed from the mobile phone via Apple Store (IOS software) or Google Play Store (Andoid software) to know the information about downloads volume, score obtained and number of users' opinions. In these platforms, each mobile application offers the information to satisfy the citizens' needs depending on the type of application concerned. For example, a Smart Mobility application provides information about where the nearest bike is, which is the faster route, which is the nearest free parking, and so on. In short, useful information to make the daily life of the citizens more comfortable and efficient management of the city's resources.

2.3 Research methodology

Based on section 2.1., and considering the factor that could influence on downloads of mobile applications, assigned score and number of users' opinions, we have selected three variables as factors that may influence on downloads, score and opinions in the sample local governments, which have been linked with hypotheses defined in section 2.1. (see Table 1).

Table 1. Descriptive Statistics.

Variables	Acronym	Description	Calculation
Downloads	DOWN	Apps' downloads	Total of apps' downloads
Score	SCORE	Score assigned by users	Apps' Score
Opinions	OPIN	Total of opinions	Total of opinions
Gender	FEM/MAL	[1]Population residing in the municipality	Percentages of females and males
Age	AGE_15/64	[1]Population residing with age from 15 until 64 years	Percentages of population with age from 15 until 64 years
Fiscal pressure	Edu_UPP/ Edu_HIGH	[1]Population residing with upper education and high school education	Percentage of population with these levels of education

Source: Own elaboration

[1] EUROSTAT (https://ec.europa.eu/eurostat)

The first one is gender (FEM and MAL) (H.1) which can be defined as the population residing in a municipality and are measured using the percentages of females and males who reside in the municipality. The second one is age (AGE_15/64) (H.2) which is the population residing in the local government with age from 15 until 64. The last one is the level of education (Edu_UPP and Edu_HIGH) (H.3) which is the population residing in the city with upper education and high school education and are measured using the percentages of population with these levels of education who reside in the city.

Taking into account the structure presented by the dependent variables (DOWN, SCORE and OPIN), the association between the dependent and independent variables were tested using OLS regression analysis (STATA version 15), which produced the following equations:

Model 1 – Downloads = ß0 + ß1 FEM or MALi + ß2 AGE_15/64i + ß3 Edu_UPPi
Model 2 – Score = ß0 + ß1 FEM or MALi + ß2 AGE_15/64i + ß3 Edu_HIGHi
Model 3 – Opinions = ß0 + ß1 FEM or MALi + ß2 AGE_15/64i + ß3 Edu_UPPi

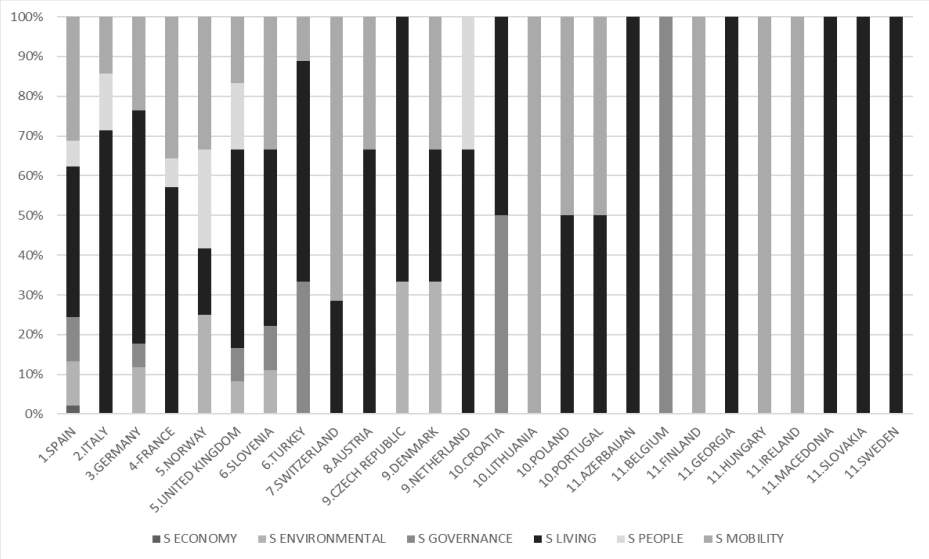
3 Analysis of results

Having explained the data collection and research methods, this section shows the descriptive analysis about the Apps created by European Smart Cities. Firstly, we show an overview of the current state of the art (countries with more Apps as well as the type of mobile applications most offered by the Smart European municipalities) and we perform the hypotheses testing analysis to obtain interesting findings and insights regarding the citizens' demographic profile in the use of the Apps.

3.1 Descriptive analysis

Taking into account the previous data collection criteria, our sample is composed of 26 European countries with 51 Smart Cities. Spain (13.72%), Germany (9.80%), France (7.84%), Italy (7.84%) and United Kingdom (7.84%) are the countries that host more Smart Cities. In this Also, these cities are those the more mobile applications offer (see Figure 1): Spain (25.28%), Italy (11.80%), Germany (9.55%), France (7.87%), and United Kingdom (6.74%).

Figure 1. Ranking of countries with Apps.



Source: Own Elaboration

In this sense, Spain offer all application categories: Smart Living (37.78%), Smart Mobility (31.11%), Smart Environmental (11.11%), Smart Governance (11.11%), Smart People (6.67%) and Smart Economy (2.22%). In this case, the main Smart Cities are Barcelona (40.00%), Malaga (22.22%) and Valencia (13.33%). However, the rest of main Smart Cities offer mostly Smart Living applications, except Norway that offer Smart Mobility applications, highlighting Firenze (38.09%), Berlin (58.82%), Paris (62.50%), Oslo (100%) and London (58.33%). All these cities are characterized by being very tourist cities.

In general terms, the European Smart Cities bet on Smart Living (48.31%) and Smart Mobility (28.65%) apps (see Table 2). In the case of Smart Living apps, Spain (19.77%), Italy (17.44), France (9.30%) and United Kingdom (6.98%) are the cities that lead the ranking, highlighting Barcelona (58.82%), Firenze (40.00%), Marseille (50.00%) and London (66.67%). On other hand, Spain (27.45%), France (9.80%), Switzerland (9.80%), Germany (7.84%) and Norway (7.84%) are the main cities that offer Smart Living apps, where Barcelona (28.57%), Malaga (28.57%), Paris (80.00%), Zurich (80.00%), Berlin (75.00%) and Oslo (100%) are the cities that stand out from the rest.

Table 2. Apps categories.

APPS CATEGORIES					
Smart Living	48.31%	Smart Environmental	7.87%	Smart People	7.30%
Smart Mobility	28.65%	Smart Governance	7.30%	Smart Economy	0.57%
SMART LIVING APPS				**SMART MOBILITY APPS**	
Spain	19.77%	Italy	17.44%	Spain	27.45%
France	9.08%				

France	9.30%	United Kingdom	6.98%	Switzerland	9.80%	Germany	7.84%
Austria	4.65%	Slovenia	4.65%	Norway	7.84%	Italy	5.88%
Turkey	5.81%	Others	31.40%	Slovenia	5.88%	Others	25.49%

Source: Own Elaboration

3.2 Statistical tests of the models

In the case of all mobile applications, we can observe (see Table 3) that the education level has a negative and significant relation (β= -0.164 and β= -0.029; ρ <0.050) with the number of downloads' mobile applications, when we analysed women and men, but the coefficient is stronger in the case of women. So, we cannot reject the H.3.1, because the citizens with upper education level are less likely to download mobile apps. In this case, the women have a positive and significant relation (β= 0.113; ρ <0.15) with the number of downloads' mobile applications. So, we cannot reject the H1.1, because the gender influences on the downloads of the applications. The age show a negative and not significant relation with the downloads (we reject H2.1).

When we analysed the mobile applications' score and the number of opinions, we can observe that none of the variables analysed has a significant relation, so we reject H1.2, H1.3, H2.2, H2.3, H3.2 and H3.3. The gender, age and education do not influence on the mobile applications' score and the number of opinions.

Table 3. Statistical results of the models for all Apps.

Variables	**Dependent Var: DOWNLOADS**				**Dependent Var: SCORE**			
	Coef.	**t**	**Coef.**	**t**	**Coef.**	**t**	**Coef.**	**t**
Gender	0.11	1.50	-	-	0.05	0.63	-	-
Gender	-	-	-0.12	-0.67	-	-	-0.06	-0.79
Age	-0.02	-0.30	-0.01	-0.30	-0.02	-1.18	-0.10	-1.27
Level of Education	-0.16	-2.18**	-0.03	-2.25**	-	-	-	-
Level of Education	-	-	-	-	-0.02	-1.03	-0.08	-1.03
R^2	0.044**		0.033*		0.015		0.016	
Variables	**Dependent Var: OPINIONS**							
	Coef.	**t**	**Coef.**	**t**				
Gender	-30.45	-0.14	-					
Gender	-	-	183.70	0.70				
Age	20.33	0.49	25.33	0.60				
Level of Education	-17.59	-0.97	-18.66	-1.03				
Level of Education	-	-	-	-				
R^2	0.006		0.009					

Source: Own elaboration

Significant at the 0.001+; Significant at the 0.01***; Significant at the 0.05**; Significant at the 0.1*

Table 4. Statistical results of the models for Smart Living Apps

Variables	**Dependent Var: DOWNLOADS**				**Dependent Var: SCORE**			
	Coef.	**t**	**Coef.**	**t**	**Coef.**	**t**	**Coef.**	**t**
Gender	0.09	0.50	-	-	0.22	1.94*	-	-
Gender	-	-	0.13	0.52	-	-	-0.13	-0.92
Age	-0.01	-0.10	-0.01	-0.07	-0.07	-0.67	-0.02	-0.88

Level of Education	-0.03	-1.62*	-0.03	-1.73*	-	-	-	-
Level of Education	-	-	-	-	-0.21	-1.88*	-0.04	-1.67*
R^2		0.036	0.035		0.069*		0.050*	

Variables	Dependent Var: OPINIONS			
	Coef.	t	Coef.	t
Gender	-163.86	-0.42	-	-
Gender	-	-	551.30	1.04
Age	26.24	0.28	36.20	0.39
Level of Education	-36.87	-0.42	-39.76	-1.09
Level of Education	-	-	-	-
R^2	0.014		0.025	

Source: Own elaboration
Significant at the 0.001+; Significant at the 0.01***; Significant at the 0.05**; Significant at the 0.1*

In the case of Smart Living applications, we can observe (see Table 4) that that the education level has a negative and significant relation (β= -0.027 and β= -0.029; ρ <0.10) with the number of downloads' mobile applications, when we analysed women and men, but the coefficient is a little stronger in the case of men. So, we cannot reject the H.3.1, because the citizens with upper education level are less likely to downloads mobile apps. However, we did not find a significant relation between gender and age with downloads, so we reject H1.1 and H2.1.

Also, we found a positive and significant relation between women and score's apps (β= 0.215 ; ρ <0.10). However, there is not significant relation when we analysed men. So we cannot reject H1.2, because the women are more likely to value mobile applications. In addition, there is a negative and significant relation between high education level with score. So we cannot eject H3.2, because the citizens with High School education are less likely to value apps. This way, we did not find significant relation between age and score's apps (we reject H.2.2).

Finally, when we analysed the number of opinions, we can observe that age, gender and education has not a significant relationship, so we reject H1.3, H2.3 and H3.3.

4 Conclusions

The research of this paper is a first approach to identify factors that could explain the downloads, utility and use of urban apps. In this paper, we focus our efforts in the demographic profile of citizens' interest, score and opinions of local government apps in leading SCs, according to the IESE Business School project named "Cities in Motion", because In addition, demographical aspects can influence on the apps use (Gebresselassie & Sanchez, 2018).

Findings indicate that SCs in Spain, Italy and Germany provide more than the 46% of the urban apps in the SCs included into the sample selection of this research. It is also worthy of note that, except for SCs in Spain and Norway, the rest of sample SCs are usually focused on smart living apps. This finding seems to confirm recent research that indicates that smart living is the most significant dimension for influencing the citizen's perception of quality of life (Rodríguez Bolívar, 2019).

Besides, a recent research in Spain has indicated that the greatest interest of public administrations has been focused on the development of applications on tourism,

perhaps due to the tourist aspect of SCs (Ugarte et al., 2017) or to the fact that younger tourists and tourists with higher incomes tend to use e-services more intensively (Neuts et al., 2013). Indeed, most of sample SCs are highly visited cities by foreign young and highly income tourists (see Eurostat dataset).

Also, road congestion has reached extreme levels in the major cities in the world and it seriously affects the quality of life of the citizens (Pacheco et al., 2018). Indeed, the mobility problems into the cities is a relevant issue and are forcing local governments in SCs to adopt strategies to address city mobility problems (Chow, 2018), using smart mobility apps for avoiding these problems and making mobility management more efficient. Thus, our findings point out that the creation of smart mobility apps are also very relevant in sample SCs.

As for the hypothesis testing, based on the the capability theory (Heres et al., 2005), our findings show differences in the use of sample Apps by citizens. This way, only a negative and significant association has been found between the education level and app downloads (model 1) (see research methodology section). Therefore, even the most educated users, i.e., those arguably most aware of and equipped with skills to use apps effectively, express very serious concerns regarding the interest and utility of those apps, perhaps due to emerging security and privacy challenges, which are critical to gain the citizens' acceptance of smart city apps (Daneva & Lazarov, 2018).

On another hand, in the case of smart living apps, our findings indicate, again, a negative and significant association between the education level and the app downloads (model 1) and scoring (model 2), as well as a positive and significant association between women and the scoring of apps (model 2). Nonetheless, we have not found a demographic profile of the citizens and the opinions in the sample urban apps.

These findings seem to indicate that people more interested in using apps are both those in younger ages (millennials) and those that are not highly educated, perhaps because they are more prone to use smartphones to connect to internet (see http://www.pewinternet.org/fact-sheet/mobile/). Therefore, this result confirms current data of the use of smartphones in countries like Spain or USA and it is contrary to prior research that found that, in Germany, people that participated in apps were mostly male, middle-aged, politically and technically interested and already actively participating in society (Schröder, 2014). In this regard, the uncertainty of the owner of the data generated in the apps could be a reason for supporting our findings (Mainka et al., 2018).

In brief, a careful analysis of the citizens' profiles suggested that it is possible to divide the users of smart city apps into three groups: the advocates, the worried users and the apathetic users of smart city apps. The advocates are women linked to the use of smart living apps. The worried users are highly educated people for all smart dimensions apps. Finally, the apathetic users are those not included into the previous groups and include males of different ages. Future research should make a deeper analysis of these three groups and know the reasons why these urban apps have not got enough success.

In this regard, a recent research indicates that local governments should never assume that citizens will automatically use apps once they are launched. By contrast, continuing citizen marketing campaigns tailored to different age groups and communities are needed (Tang et al., 2019). Also, the involvement of users in the app devel-

opment process to provide feedback in different app development stage could be also very important in this issue (Tang et al., 2019). Therefore, future research could deep into these analyses in order to build models that explain the interest, use and collaboration of citizens in urban apps into SCs. In addition, it could be interesting a qualitative analysis of the opinions and perceptions expressed by the users about the use and usefulness of Apps using a survey or a questionnaire.

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