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Determinants of multi-service smartcard success for smart cities development: A study based on citizens' privacy and security perceptions

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ABSTRACT

Smart cities aim to increase their efficiency and quality-of-life thanks to technology-based services and collective intelligence. In this environment smartcards represent a strategic instrument to link citizens to public administration and local infrastructure to further advance on smart city plans. This research proposes a theoretical model and present privacy and security as key drivers of citizens' intentions to continue using smartcards. The functional benefits (i.e. usefulness and ease-of-use), the level of personal interaction with local services, and the direct and moderating effects of socio-demographic variables complete our framework. The findings of an empirical study with smartcard users in Zaragoza (Spain) show usefulness and security as the main antecedents of continuance intentions. In turn, the influence of socio-demographic variables is not significant, which suggests that smartcards should focus on a wide-range of users. These results offer interesting implications and recommendations for public managers such as the need to guarantee the security of the transaction system and to expand the number of services and initiatives relaying on the smartcard service in order to gradually develop the smart city transformation.

1. Introduction

The continuous increase of urban population is motivating great changes in the management of cities. In this context, smart cities initiatives launched by local administrations make an intensive use of information to improve city infrastructures' integration, efficiency, quality of life, transparency and citizen participation (Aldama-Nalda et al., 2012). Smart cities not only aim to better fulfill citizens' needs and demands in the local level but also to achieve the latest stages of e-government development such as services' integration, citizens' interactivity and city transformation (Nograšek and Vintar, 2014). Smartcards represent an initial stage of smart cities implementation and a crucial innovation to advance on local services' integration and citizen interaction with the surrounding infrastructures (Deakin & Al Waer, 2011). From a functional perspective, smartcards allow user's identification, access to local facilities, and payment of small fees in basic services such as public transport with shorter transaction times and greater convenience (Bunduchi, Weisshaar, & Smart, 2011; Chan et al., 2010; Truman, Sandoe, & Rifkin, 2003). Nevertheless, smartcards are not always well accepted by citizens (Loo, Yeow, & Chong, 2009; Smith, 2005), because of privacy and security concerns (e.g. Bailey & Caidi, 2005; Truman et al., 2003). Certainly, the use of smartcard services deals with citizens' private information such as name, age and records of its uses, that needs to be secure since it is also a payment system connected to a user's bank account. Therefore, there is a managerial need to understand the factors that may affect the continued use of smartcards by citizens in order to attain efficiency (Gunawong & Gao, 2010) and to consolidate the smartcards' contribution to the transformation of cities into smart cities.

Consequently, the purpose of this work is to expand the knowledge on the smart cities phenomenon by analyzing the consolidation of smartcard initiatives. More precisely, our work presents the following contributions to this emerging body of literature: (a) our research deals with the development of smart cities and focuses on the continuance intentions to use smartcards as one of its strategic drivers; (b) the research model integrates citizens' privacy and security concerns related to smartcards, their personal interaction with local services, and their perceptions about smartcard functionality; and (c) we deepen on public policies related to smartcard consolidation and suggest implications for the management of smart cities transformation. To do that, we focus on the smartcard service of Zaragoza (a north-eastern city in Spain), which was introduced as an essential element to evolve in a broader smart city plan. This scenario provides an appropriate context for analyzing the continued use of the smartcard that may be generalizable to a great number of cities in the near future.

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Taking into account the previous considerations, this work is structured as follows. First, we briefly describe the main characteristics of the smart city plan in Zaragoza and the strategic role of the smartcard service. Second, we explain privacy and security as the main citizens' concerns that endanger the success of smartcard initiatives. Next, we develop a research model to explain continuance intentions of smartcard use and formulate the hypotheses of the study. Then, we describe the methodology employed and the processes of data collection and measures validation. After that, we present the results obtained in the empirical analysis. Finally, we discuss the main conclusions and implications for public policy management, and expose the limitations of the study that open new avenues for future research.

2. Theoretical development

2.1. Smart city plan: The case of Zaragoza

More than half of the world's population lives in bigger and bigger cities, which complicate citizens' daily life in urban areas but also the public management of local infrastructures and services (Chourabi et al., 2012). Smart city projects make an intensive use of IT as a mean to improve the city quality of life and its social, health, economic and environmental welfares (Aldama-Nalda et al., 2012), presenting e-government as an interactive model integrating technology, people, structures, processes and culture (Nograšek and Vintar, 2014). In this way, smart city plans usually involve the integration of services, the interaction and participation of citizens and the transformation of both the city and its local government. Thus, in the last ten years, local e-government has moved from city web sites as a services' catalogue to carry out transactions (Welch, Hinnant, & Moon, 2005) to smart cities which represent the latest and most advanced level of e-government development models (Coursey & Norris, 2008). A distinctive characteristic of smart cities is that these initiatives aim to perfectly combine the best of both the physical and virtual worlds to achieve smartness by means of a collective intelligence based on information sharing (Deakin & Al Waer, 2011).

In the last years, like many cities around the world (Chourabi et al., 2012), the City Council of Zaragoza is implementing a plan to gradually transform to a smart city. This strategy involves four strategic lines closely related to the new era of e-government development (Nograšek and Vintar, 2014). Table 1 presents and explains such strategic lines in detail.

2.2. The role of smartcards in smart cities implementation: the case of Zaragoza

As an essential step to evolve in the development of smart cities, smartcards technology integrates previous local services technologies to facilitate citizens' interaction with city infrastructures (Deakin & Al Waer, 2011). As a valuable instrument to join citizens to the smart city plan and in order to better satisfy citizens' daily needs, Zaragoza public managers launched a smartcard service in 2009. Fig. 1 presents the personal smartcard specimen publicized by the city council.

Similar to other smartcards worldwide (Chan et al., 2010; Truman et al., 2003), the Zaragoza smartcard accomplishes three purposes: (1) Identification by means of the name and a picture of the cardholder appearing on the front of the card, (2) access to public facilities as a member card by mean of contactless RFID technology, and (3) payment of small fees to access public services. This multiple function card can be employed in a long list of public and private services linked to the urban area.

In addition to citizens' oriented advantages, the city council also relies on the smartcard as an instrument to develop specific public policies. First, the introduction of the smartcard involved a technical integration and modernization of the multiple services technologies offered in the urban area; specifically, it needed the cooperation of all public agencies and those private partners collaborating in the project. Second, given that the smartcard is associated to the identity of the holder, some public policies are already implemented in this way (e.g. a discount in the urban transport is applied for the elderly or unemployed collectives). After four years from launching, 190,000 inhabitants (which represent around 30% of the population) hold a personal smartcard to interact with Zaragoza local services.

2.3. Citizens' concerns regarding the use of e-government smartcards

Previous literature clearly support that users may perceive e-government innovations as a threat, specifically in uncertain or risky contexts such as public management of citizens information (e.g. Martin & Rice, 2010). Because smartcards deals with users' personal identity and records of service use, the private and secure use of this information may worry some citizens (Bailey & Caidi, 2005; Loo et al., 2009), as they are users' concerns commonly identified in e-government literature (Welch et al., 2005). Nevertheless, little effort has been done by previous literature to analyse and empirically confirm to what extent privacy and security concerns are relevant for smartcard users' post-adoption behaviours.

In prior research, perceived privacy is defined as the extent to which a potential user believes that his or her personal information is protected and will not be used without authorization (Casaló, Flavián, & Guinalíu, 2007). Privacy worries for internet users are related to the transfer of personal data to others without express consent, or hacker's theft of personal information (e.g. Harris Interactive, 2002). Also, several authors have noted the possible perception of privacy related risks associated to smartcard technology (e.g., Kerilis, Kolias, & Nikita, 2013). Since smartcards include personal information about the card-holder that is recorded and managed by public administration (Bailey & Caidi, 2005), we expect that citizens' perceived privacy of the technology might be a critical concern to determine the continuance of citizens as users of smartcards (Kerilis et al., 2013).

On the other hand, perceived security is the extent to which a potential customer believes that a system has the technical guarantees for completing transactions and transmitting sensitive information in a secure manner (Casaló et al., 2007). Security of payment systems is the aspect that usually most worry e-government users (e.g., Dunkerley & Tejay, 2012). A lack of perceived security represents a barrier to use innovations because users are afraid that transactions might not be secure (e.g. Casaló et al., 2007). Since smartcards are employed as a payment and information exchange system to interact with many public services, we expect that the perceived security of the smartcard may be a critical concern for many citizens (Gunawong & Gao, 2010). Indeed, security concerns have been a common issue when providing public services (Loo et al., 2009), as previous studies suggest that many e-government systems were vulnerable to security attacks (e.g. Bertot, Jaeger, & Hansen, 2012).

2.4. Traditional determinants of e-government smartcards consolidation

In the last decade there has been an increasing interest in launching smartcards by many different public organizations. Therefore, most research related to this issue has focused on smartcard adoption (e.g.; Chan et al., 2010; Lee, Cheng, & Depickere, 2003; Loo et al., 2009). In this respect, previous research recognizes that the level of complexity of this e-government service diminishes smartcard acceptance (Truman et al., 2003). Thus, to facilitate the use of smartcards to a wide range of citizens, ease-of-use must be a priority (Plouffe, Hulland, & Vandenbosch, 2001). Based on Davis (1989), we define perceived ease-of-use as the belief that using the smartcard will be free of effort. Because ease-of-use is one of the most clearly observable characteristics of smartcard technology, we consider it as an initial relevant factor that affects other variables in our framework. We also consider perceived usefulness as the principal factor determining the continued use of smartcards. Perceived usefulness