IIAI Open Conference Publication Series
IIAI Letters on Business and Decision Science
Vol. 001, LBDS002
DOI: https://doi.org/10.52731/lbds.001.002

Citizen Perceptions of Intention to Live in a Smart Cities Based on its Characteristics

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Abstract

In smart city, the challenge is to bridge business-centric and citizen-centric views by engaging citizens and business stakeholders. This paper is to identify the intention of living in a smart city as from its characteristics in the individual perception by citizens based on the proposal model. The empirical research carried out herein was based on a survey, consisting of a sample of 812 valid questionnaires. A quantitative survey approach was applied and results were analyzed using Confirmatory Factor Analysis (CFA). In addition, Structural Equation Modeling (SEM) was employed for examining the relationships between various constructs in the proposed conceptual model. From the structural model, couple of hypotheses were supported, and this research discusses the relationship between perceived usefulness and citizen's intention to live in a smart city.

Keywords: Smart city, Quality of life, Service, Perceived usefulness, SEM

1 Introduction

In smart cities, the challenge is to bridge business-centric and citizen-centric views by engaging citizens and business stakeholders [1]. Smart cities are a new technology-based vision for improving many aspects of urban life [2]. In particular, there is a need for a cross-sectoral and more collaborative approach that can support the transition to "smart mobility" for improved quality of life and vibrant urban development [3]. Mobility is recognized as a general indicator of a smart city [4], noting that a business ecosystem of multiple companies, organizations, and stakeholders work together to achieve or improve urban mobility [5]. Understanding the evolutionary process of the mobility business ecosystem will help in the formulation of public policy, the implementation of strategic decisions regarding business and technology partnerships, or the identification of gaps in services provided to citizens and businesses as service customers [6]. On the other hand, aspects of smart cities, such as mobility services, are often excluded by technology-centric definitions [7]. In fact, it has been conceptualized that smart cities are predominantly a top-bottom approach, and it has been argued that they should evolve toward a more bottom-up approach [8]. A shift to a more inclusive, citizen-centered view is required to balance ICT-driven urban innovation with citizen cultural considerations [9].

In this study, we aim to clarify the intention to live in a smart cities based on the characteristics of citizen in their individual perceptions, based on the proposed models in smart cities by Giffinger [10] and Khatoun and Zeadally [11] and "Smart City Reference Architecture" by the Cabinet Office in Japanese government [12]. The reason for choosing citizen as the target of the survey is that in a smart city, citizens are the creators and users of services and technologies, and they play an important role in smart city development because they provide ideas and feedback about the city [13]. Already, cities around the world are introducing opportunities to make

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citizens a key asset, especially in order to better understand the realities of their citizens [14].

The following sections are organized as follows. Section 2 describes the literature review on smart city services according to previous studies and presents the hypotheses and conceptual model. Section 3 presents the results of the analysis based on confirmatory factor analysis (CFA) and structural equation modeling (SEM). Section 4 provides a discussion, and finally, Section 5 details the conclusions, limitations of this study, and implications for future research.

2 Literature Review

A. Smart City Indicators

As aspects that influence the improvement of citizen's quality of life (QoL), the characteristics of smart cities are presented according to the model proposed by Giffinger et al. [10], with six categories (mobility, economy, governance, living, people, and environment). These continue to be updated with European city information in European smart cities 4.0 [15]. Other smart city evaluation indicators widely used around the world for policymaking reference for multiple cities include ISO37120, ITU-T Y.4903, SMART CITIES INDEX, Smart cities Ranking of European medium-sized cities, with the main categories being economy, mobility services, research and development, and community culture [16] [17] [18] [19]. On the other hand, in Japan, the Cabinet Office's "Smart City Reference Architecture White Paper" [12] consists of four basic principles, and in particular, the user-centered principle that all those involved in smart cities must always promote smart city initiatives with the users of smart city services. Therefore, in this study, we focus on "local economy", "local mobility services" and "local community culture" as common items between the evaluation indicators of European countries and Japan.

B. Characteristics of a smart city

(1) Local economy

Smart cities encourage and recognize the importance of a knowledge-based economy and promote economic growth by encouraging creativity and technological development in industry [20]. Through public-private partnerships, international linkages between economies, and the exchange of research and technology, smart cities aim to increase productivity and expand opportunities for citizens, and have a positive impact on reducing unemployment [21]. Similarly, the smart economy seeks to create innovative capacities in an environment that stimulates competitiveness and entrepreneurship, presenting flexibility in all situations, not just labor relations, and the interconnectivity enabled by the use of ICT tools as key challenges [22][23].

(2) Local mobility service

It integrates transportation resources and urban infrastructure, allowing people to manage the flow of demand [24]. In addition, a wide range of options should be explored, such as having multiple modes of transportation, including buses, trains, individual transportation services, and bicycles. This should be done in order to integrate all areas of the city, taking into account different types of special need [25]. ICT tools can be used to optimize public transportation, making it faster, safer, and more sustainable. A broad technological base to support this system is essential. In addition, accessibility, providing real-time information to all citizens, not only in the transportation system but also in a range of information and technology systems throughout the region, is an essential element of a smart city [20]. Logistics in smart cities should be designed to prioritize public, ecological, and efficiency, to meet internal as well as external demands, to be connected to other neighborhoods in the vicinity, and to promote greater social inclusion [26].

(3) Local community culture

Local governments are focusing on the regional scale to design urban spaces and solve problems in order to adapt to regional specificities. For example, they adapt to regional specificities through regionally based smartphone applications [27], the use of participatory design in urban projects [28], the improvement of regional information systems [29], and social innovation-based initiatives at local scales [30]. In addition, they support the networking of citizens and the revitalization of local communities by working with volunteer citizens as community coordinators who serve as intermediaries between city officials and local citizens, and by encouraging local participatory groups [31]. This allows citizens to thrive and become actors in the communities and the urban spaces in which they interact [32].

C. Perceived usefulness and intention to live in a smart city

Perceived usefulness positively influences behavioral intentions [33][34]. In this study, this construct is adapted to "intention to live in a smart city". Similarly, "perceived usefulness" may be affected by the antecedent variables which is smart city characteristics in this case. The dependent variable in this study, intention to live in a smart city, measures the degree to which individuals are interested in the perceived usefulness [35] and are willing to use it or recommend to friends to live there. The hypotheses are constructed as follows. And Figure 1 shows the conceptual model of this study.

H1(+) : Perceived usefulness positively influences the intention to live in a smart city.

H2(+) : Smart city characteristics positively affect perceived usefulness.

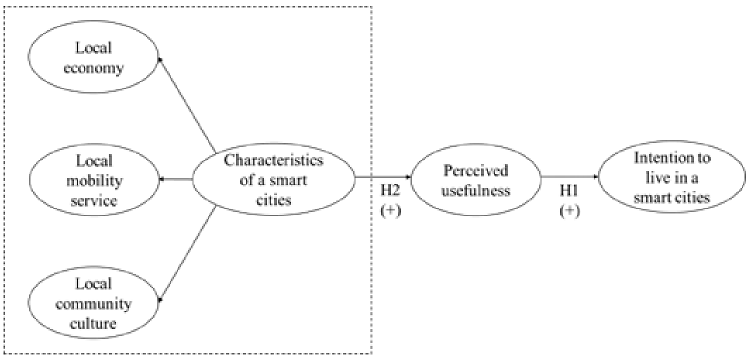

Figure 1: Conceptual Model

3 Analysis and Results

A. Measurements and Questionnaire

The measurement items were created by adopting most of the established measurement scales, with some modifications to further adapt them to this research area. The measurement scale is based on the model of Giffinger et al. [10], taken from the literature (e.g., [20], [26]) and further refined to fit the relevant research field. We empirically test each hypothesis through the items of these measurement scales. Prior to conducting this survey, we commissioned a research firm to conduct a questionnaire survey of citizens living in seven prefectures (Tokyo, Kanagawa, Osaka, Aichi, Chiba, Saitama, and Hyogo). Attribute items consisted of gender, age, annual income, type of residence, and other factors. Items on the measurement scale were described on a 7-point Likert scale ranging from 1 (not at all agree) to 7 (very much agree).

B. Data collection and demographics

A total of 858 questionnaires were completed online in January 2022, and 812 were deemed useful for analysis because 46 of the excluded questionnaires had inappropriate responses (e.g., the same answer to all questions). The survey data revealed that 80.2% of the respondents were male. Middle-aged respondents (40-59 years old) accounted for 59.7% of all respondents, followed by those in their 60s, 30s, and 20s. Since this was an open survey covering seven prefectures, the largest number of respondents were company employees, followed by non-regular employees. The demographics of the survey subjects are shown in Table 1.

C. Nonresponse Bias and Sample Validity

In order to assess non-response bias, we selected the first 10% of respondents and the last 10% of respondents to compare early and late respondents [36]. T-test was used for these two samples and concluded that no significant differences existed. There is no non-response bias in this study.

The Kaiser-Meyer-Olkin (KMO) was applied to examine normality and outliers. The KMO measures sampling accuracy and the Bartlett sphericity test. For sampling accuracy, a KMO value close to 1 represents a more accurate sample size [37]. In Barlett's sphericity test, the p-value was used as a measure of the significance of the correlation between factors. Note that varimax rotation was considered in this study. The results of the factor analysis showed that the KMO value was 0.975 and the chi-square value of Bartlett's test was 20903.454 with a p-value <0.05. Thus, there was little concern for multicollinearity, and all measurement scale items were very appropriate for analysis by factor analysis.

D. Scale reliability and construct validity validation

Reliability refers to the overall consistency of a test that yields a given measurement result. Table 2 shows the results in this section. The reliability of each factor was measured using Cronbach's alpha test. Factors with an alpha of 0.7 or greater were deemed reliable [38], indicating that the items on each measurement scale were appropriate for the survey. CFA was then conducted to verify construct validity. After examining the measurement model with confirmatory factor analysis, several measurement scales were identified in this study that did not directly measure the factor and were therefore excluded from subsequent analyses. Thus, the 22 scale items included in the goodness-of-fit measurement model are local economy (6 items), local mobility service (5 items), local community culture (6 items), perceived usefulness (2 items), and smart city residential intention (3 items). Construct validity consists of convergent and discriminant validity. The average variance extracted (AVE) is the value of the variance introduced by the factor for measurement error [39]. The standardized factor loadings for each factor were all greater than 0.7, directly explaining the high AVE and construct reliability (CR) and adequate convergent validity. The criteria for AVE is 0.5 and the CR is 0.7 [40][41]. In this study, the AVE ranged from 0.539 to 0.825 and the CR from 0.894 to 0.950 as shown in Table 3. Hair et al. [42] proposed to use the square root values of the AVEs to compare them with the square correlations between factors, and in this study, we organized them in the same way.

E. Structual equation modeling

SEM was applied to evaluate the proposed conceptual model. Figure 2 shows the SEM model. A large sample size is necessary for a comprehensive analysis, and in this study, the minimum sample size of 200 was exceeded by using 812 samples, which are reliable data (e.g., [43]). As with the measurement model, goodness-of-fit indices were also evaluated to prove the goodness of fit of the structural model. The results for all goodness-of-fit indices were CFI = 0.961, AGFI = 0.879, GFI = 0.902, and RMSEA = 0.063. Since the fit indices values were within the cut-off point [44], the structural model was statistically significant at a p-value of 0.01.

F. Verification of Hypothese and Implications

SPSS version 23 and AMOS software version 23 were used to test the hypotheses. Table 4 presents a summary of the results of the analysis, suggesting that all the positive causal relationships assumed in H1 and H2 are correct. It is suggested that all the positive causal relationships assumed in H1 and H2 are correct. Specifically, the higher the degree of perceived usefulness, the higher the intention to live in a smart city. (H1, 5% significant) Furthermore, smart city characteristics positively affect perceived usefulness. (H2, 5% significant) These results suggest that smart city characteristics influence perceived usefulness and that perceived usefulness leads to the intention to live in a smart city.

4 Discussion and Implication

This study found that smart city characteristics are important for perceived convenience and for residential intention. While previous studies have been based on the European Smart City model, this study provides new findings with the addition of community culture. Hypothesis testing results show that local community culture has a strong impact on smart city characteristics (standardized coefficient = 0.89, p-value < 0.01). This may be due to citizen's perception of community life in the local community. Among the questionnaire items, citizen's sense of belonging (standardized coefficient = 0.813, p-value < 0.01) and official workshops (standardized coefficient = 0.806, p-value < 0.01) were the most influential. This is thought to be because citizen is more likely to perceive this as a characteristic of a smart city since it is something they are familiar with in their daily lives. Local economy also has a strong influence as a characteristic of a smart city (standardized coefficient = 0.85, p-value < 0.01). Of the questions asked, the most significant impact was on awareness of the new business environment and new ideas. We believe this is due to citizen expectations for collaborative creation using new technologies that will be fostered in smart cities. Local mobility services likewise have a strong impact on smart city characteristics (standardized coefficient = 0.85, p-value < 0.01). In particular, citizen is interested in the development of transportation networks up to automated driving and bicycle paths. In both cases, items directly related to citizen's daily lives had a high impact on the results.

5 Conclusion

This study investigated the impact of citizen's perceived usefulness of smart city features on their intention to live in a smart city. The two research hypotheses showed a strong positive relationship (p-value <0.01). Therefore, it was found that for citizens, the perceived usefulness of a smart city to the characteristics it possesses makes them want to live there and recommend it.

The study also has its limitations. Due to the limitation that smart cities are currently under development in our country, this study analyzed citizens' intentions based on perceived usefulness. In the future, it is necessary to focus on the structure of service quality experienced by citizens living in the area, such as local mobility services and local community culture, to explore important factors that influence loyalty [45].

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Table1: Demographic Data

	n=812
Residential areas	*Percent*
Tokyo	30.1
Kanagawa	20.4
Chiba	11.1
Saitama	11.2
Aichi	8.9
Osaka	11.4
Hyogo	7.0
Total	100.0
Gender	*Percent*
Male	80.2
Female	19.8
Total	100.0
Age	*Percent*
60 years old or older	19.8
50 to 59 years old	33..4
40 to 49 years old	26.3
30 to 39 years old	14.8
20 to 29 years old	5.6
Total	100.0
Academic background	*Percent*
Junior high school graduates	1.0
High school graduates	16.9
Junior college and vocational school graduates	13.8
Under graduate of university degree	59.8
Master of university degree	8.0
Doctor of university degree	0.5
Total	100.0
Profession	*Percent*
Employee	72.1
Non-regular employee	15.5
Civil servant	0.7
Faculty	0.2
Medical doctor	0.5
Lawyers / Accountants	0.2
Agriculture / Forestry & Fisheries	0.2
Company Management / Directors	2.2
Sole proprietor	7.3
Housewife	0.7
Others	0.2
Total	100.0
Residence information	*Percent*
Detached residence (One's own)	42.2
Apartment house (One's own)	24.0
Rented house	1.0
Rented apartment house	27.7
Company owned house / Domitory	1.6
Parent's home	3.1
Others	0.2
Total	100.0

Table 2: Results of Reliability Analysis and CFA

	Factor loading	*Reliability coefficient (alpha)*	*CR*	*AVE*
Factor1. Local economy		0.934	0.935	0.705
I think there is high capacity and production efficiency from the positive effects of the market economy.	0.778			
I think there is creativity in society where new content and ideas are invented.	0.789			
I believe in the ability to adapt to new scenarios, unpredictable events and opportunities.	0.778			
New services will increase employment opportunities, which will lead to the development of the community.	0.743			
I think it will create a new business environment.	0.819			
I think smart cities are attractive as tourist hubs to attract people.	0.721			
Factor2. Local mobility service		0.926	0.927	0.716
Safe and effective public transportation (trains and buses) and good connectivity.	0.779			
I believe that alternative means of travel that would improve travel efficiency.	0.744			
Efficient public transportation, highways, and bike paths would be developed and optimally utilized.	0.794			
I think it is a city where people can get around comfortably using automated mobility.	0.793			
the transportation network would be optimized to allow congestion-free travel.	0.735			
Factor3. Local community culture		0.938	0.938	0.717
I believe it will strengthen the role and support system of local citizens in their communities.	0.724			
I think smart cities will promote initiatives (initiatives) that encourage local cooperation among citizens.	0.771			
I believe that smart cities will promote new ideas and utilization of devices (electronic devices) among citizens.	0.718			
I believe that in a smart city, people living in the city will have a greater sense of community belonging.	0.813			
I believe a joint workshop will be held between citizens and smart city officials.	0.806			
I believe that in a smart city, citizens are placed in a culture of openness and a stronger sense of belonging.	0.791			
Factor4. Perceived usefulness		0.930	0.894	0.808
I think a smart city would be an improvement against current city quality standards.	0.775			
I think the idea and value of a smart city is conducive to a positive aspect to the city.	0.792			
Factor5. Intention to live in a smart cities		0.949	0.830	0.826
I would like to participate in (and support) the residential opportunities offered by smart cities.	0.810			
I would like to support the conversion of the city I live in to a smart city.	0.858			
I would recommend residing in a smart city.	0.865			

Table 3: Results of Discriminant Validity

	Variables	*E*	*MS*	*CC*	*PU*	*IL*
1	Local economy (E)	0.839				
2	Local mobility service (MS)	0.744	0.846			
3	Local community culure (CC)	0.759	0.750	0.847		
4	Perceived usefulness (PU)	0.793	0.833	0.842	0.899	
5	Intention to live in a smart cities (IL)	0.738	0.695	0.733	0.884	0.909

Table 4: Summary of Hypotheses Test Results for Structual Model

Hypotheses	*Path*	*Standardized coefficient*	*Hypotheses Supported?*
H1	Perceived usefulness (PU) -> Intention to live in a smart city (IL)	0.883***	Yes
H2	Characteristics of a smart city(C) -> Perceived usefulness (PU)	0.941***	Yes

Path significant at: **p<0.05; ***p<0.01,

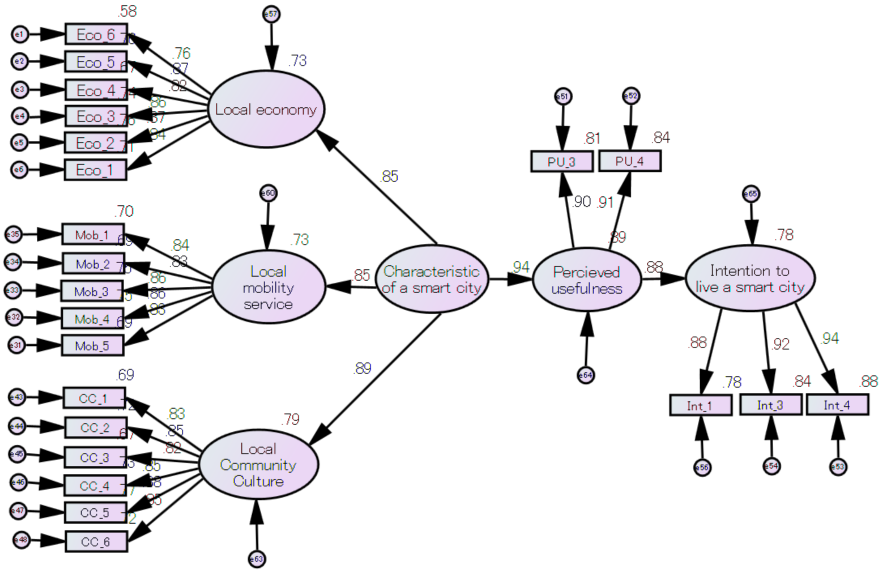

Figure 2: Structual Model