

Exploring Factors Influencing the Adoption of Smart Parking

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Abstract

In the digital era several smart technologies have disrupted several industries across the globe. This study explores the factors that influence the adoption of smart parking. A systematic literature review was adopted based on a quantitative content analysis on data that was collected from selected peer-reviewed published articles. The TOE theoretical framework was used as the lens for the study. The results of the study reveal that cost, maintenance of technology, institution size, complexity and technological support are the main factors influencing the adoption of smart parking. Previous studies suggest that smart parking improves safety of pedestrians and cars, conservation of nature, decreases land degradation, and improves convenience. The study contributes to knowledge on factors influencing the adoption of smart parking. The limitation of the study was that it was based on convenience sampling, therefore making it difficult to generalize the results.

Keywords

Smart, smart parking, technology, environment, organization, adoption, TOE framework

Introduction

Smart parking is a crucial smart infrastructural development and is viewed as a panacea to car parking problems within cities (Ahvenniemi et al., 2017). Smart parking involves the use of information and communication technologies (ICT) to assist drivers to find a vacant parking spot. Kharde et al., (2018) note that smart parking is predominantly being implemented and utilized by entities such as airports, shopping centres and city garages through the use of automated technologies. They assert that the adoption of smart parking curbs parking problems such as traffic congestion, car accidents, loss of time, air pollution, road rage and damage to property. The adoption of smart parking can be successful if properly implemented and unsuccessful if poorly planned. Uskov et al., (2016) argue that through the use of digital technologies, smart parking can be adopted efficiently regardless of the available parking spaces. A systematic literature search was adopted for the purpose of identifying the factors influencing smart parking from existing literature. The research question of the study was derived from the research problem, and is: What are the factors influencing the adoption of smart parking? The overall objective of the study was to identify factors influencing the adoption of smart parking. The rest of the paper is structured as follows:- The next section is a brief literature review and outline of the theoretical framework, section 3 discusses the research methodology, section 4, the results and finally section 5, the discussion and conclusion.

Literature Review

This section reviews literature on factors influencing the adoption of smart parking. The literature review provides a comprehensive background to the study. It further discusses the technology, organization and environment (TOE) framework used as the lenses for the study. A smart city is an urban area that controls

and manages environments of all its critical infrastructures to enhance optimization of its resources, plan its precautionary maintenance activities and monitor security facets while exploiting services to its citizens (Lin, 2015). However, they argue that smart cities are classified in different dimensions which are technology, human, and institutional dimensions. The term Smart cities can be used interchangeably with virtual city, intelligent city, learning city, ubiquitous, knowledge city, digital city, information city, smart community, wired city and sustainable city (Kharde et al., 2018). In general, a smart city constitutes of smart living, smart governance, smart environment, smart people, smart economy and smart mobility.

Smart Parking

Smart parking is the way in which drivers are helped to find a parking spot through ICTs (Shoup, 2014; Lin, 2015). This suggests that smart parking improves safety of pedestrians and cars, conservation of nature, decreases land degradation, and improves convenience. There have been debates concerning the success of implementing smart parking considering the limited space and the parking spots being dispersed. Geng and Cassandras (2012) discuss solving the dynamic problem of parking spaces at a limited environment. The authors formulated a framework which can aid smart parking system infrastructure at a limited space. The study demonstrates the success of the smart parking system which was deployed and tested in the garage of the Boston University.

The benefits of adopting smart parking at any environment include reduced traffic congestion, simple structure and operation, improved car security, real time data, enhanced user experience, increased safety and integrated payment (Sandhya et al., 2017). Despite the realization of these benefits there are factors which influence the adoption of smart parking at organizations which are, budget constraints, gaining stakeholder support, short-term mind-set, insufficient resources, expertise and to some extent, policy hurdles. A recent study reported that parking at the majority of institutions is associated with severe hitches and a broader array of unique challenges due to poor or no smart parking facilities (Meng et al., 2018). In addition, the key aspects that smart parking system architecture comprises include parking sensors with a durability and functionality which can be affected by meteorological conditions of the area, servers which involve sourcing of cloud storage and provision of real-time information, and mobile application, which is the touch point for the final user, which are the vehicle drivers (Shoup, 2014). Besides the high cost of procuring the sensors, factors such as institutional vision and goals, data storage capacity, computation power of the institution and communication resources tend to hinder the adoption and implementation of smart parking. An imbalance of these requirements could cause an organization to be reluctant to adopt smart parking.

Theoretical Framework

Baker (2012) defines the TOE framework as an organizational-level theory that explains three components (technology, organization and environment) that influence a firm's decision-making process in adopting or innovating technology. The framework gives a valuable tool that can be used for studying the adoption of various IT innovations. Figure 1 presents the TOE framework developed by Tornatzky and Fleischer (1990), which illustrates that technological innovation decision making is influenced by three components which are technology (availability, characteristics), organization (formal structures, communication processes, size) and external task environment (industry characteristics, technology support, government regulation). The TOE framework has been used extensively to understand the adoption of innovations in various industries (Baker, 2012).

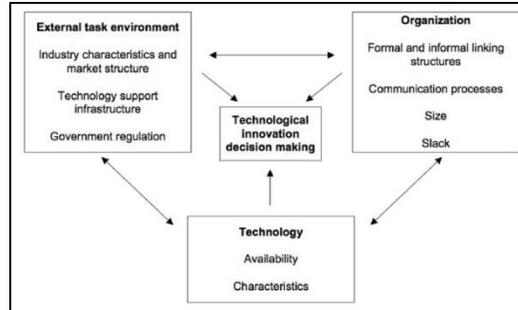


Figure 1: TOE framework (Source: Tornatzky & Fleischer, 1990)

Research Methodology

This section describes the research methodology of the study which includes the unit of analysis, research design and method. In this study, a systematic literature review approach was adopted to ensure that the research objectives are met. According to Durand, et al., (2011) a systematic literature review is a systematic method that collects secondary data or existing data, critically appraise research studies, and synthesizes studies. According to Babbie and Mouton (2001) there are two types of content analysis research; these include qualitative content analysis and quantitative content analysis. The author adds that qualitative content analysis is suitable for low volumes of research data and quantitative content analysis is useful for large volumes of research data. A quantitative content analysis research approach was used, as the study analyzed content from peer reviewed articles. An eight phase quantitative content analysis approach was adopted which included research questions, conceptualisation of the questions, sampling and unitizing, code scheme development, data collection, coding, reliability testing and analysis and finally, results and discussions (Rose et al., 2015; Jokonya, 2015). The target population was limited to existing literature from journals and conference papers published between the years 2013 to 2018. The inclusion and exclusion criteria process retrieved 71 relevant articles.

Study Results

This section presents the data collected from 71 articles published between the years 2013 to 2018 on factors influencing the adoption of smart parking. The objective of the study was to determine the factors influencing the adoption of smart parking.

Technological Factors

Figure 2 shows the study results of the frequencies of the technological factors influencing the adoption of smart parking.

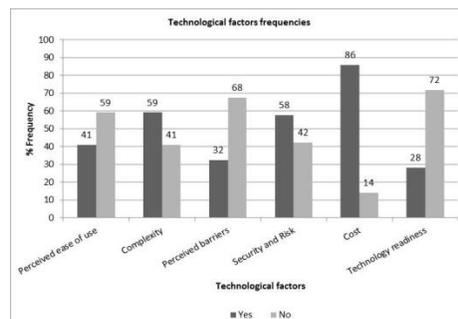


Figure 2: Technological Factors

The majority of the articles ranked cost (86%) as the primary technological factor, followed by complexity (59%), security and risk (58%), perceived ease of use (41%), perceived barriers (32%), and technology readiness (28%). The results suggest the adoption of smart parking is more influenced by cost and complexity of the technology. In addition, technology readiness and perceived barriers had the least influence on the adoption of smart parking.

Organizational Factors

Figure 3 presents the study results on the frequencies of the organizational factors influencing the adoption of smart parking. The study results show that IT infrastructure complexity (68%) was the highest ranked organizational factor, followed by institution size (51%), organization readiness (30%), financial resources (25%), and strategic planning (37%). The results suggest that the adoption of smart parking is less influenced by strategic planning and financial resources, which is primarily influenced by the top management.

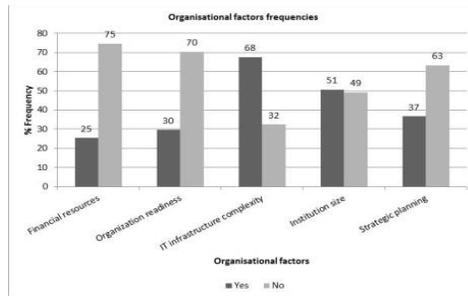


Figure 3: Organizational Factors

Environmental Factors

Figure 4 summarizes the frequencies of the environmental factors influencing the adoption of smart parking. As shown on figure 4, both technology support infrastructure (80%) and regulatory environment and support (79%) were highly supported as the most important environmental factors influencing the adoption of smart parking, followed by maintenance and support (63%). On the other hand, the results showed IT policy (31%), and government and industry pressure (24%) as the least important environmental factors influencing the adoption of smart parking. The results suggest that IT policy and government and industry pressure are not considered that much as factors that influence the adoption of smart parking. The government and industry pressure had the least frequency.

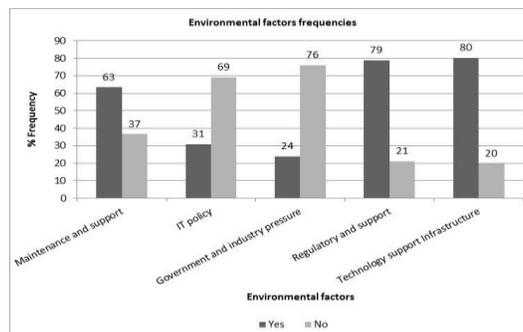


Figure 4: Environmental Factors

Discussion and Conclusion

The objective of the study was to identify the factors influencing the adoption of smart parking. Based on this objective the study was guided by the TOE framework to identify the factors. The study adopted a systematic literature review as the methodology and content analysis for the research design. The content analysis method involved formulating the research questions, conceptualisation of the questions, sampling and unitizing, code scheme development, data collection, coding, reliability testing and analysis and finally, results and discussions. The search strategy from the study population yielded a total of 71 articles which were used to identify the dominant factors that influence the adoption of smart parking. The study results showed that the main technological factors influencing the adoption of smart parking are cost, complexity and security; the main organizational factors are IT infrastructure complexity and institution size; and lastly the main environmental factors are maintenance and support, regulatory and support and technology support infrastructure. Previous studies suggest that smart parking improves safety of pedestrians and cars, conservation of nature, decreases land degradation, and improves convenience. The study contributes to knowledge on factors influencing the adoption of smart parking. However, the limitation of the study was that it was based on convenience sampling, therefore making it difficult to generalize the results. Conversely, this limitation can be used as opportunity for further research in smart parking.

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