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Factors Affecting the Adoption of Smart Waste Management

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Abstract
In recent years, there has been minimal research on the adoption of smart waste management in organizations. The study objective, therefore, is to explore factors affecting the adoption of smart waste management in organizations. The study adopted a systematic review based on quantitative content analysis to explore factors affecting the adoption of smart waste management in organizations using the TOE (Technological, Organizational, and Environmental) Framework as a theoretical lens. The quantitative content analysis helped examine literature using qualitative data quantitatively using a statistical package. The study results indicate the technological factors affect smart waste management more in organizations than organizational and environmental factors. The study contributes to the body of knowledge of factors affecting the adoption of smart waste in an organization.

Keywords: technological factors, organizational factors, environmental factors, TOE framework, smart waste management, Internet of Things, NFC

Introduction

Comprehensive organizations globally have increased the adoption of smart waste management as a means of improving waste collection processes (Mavropoulos, 2017). Environmental challenges faced by local and national municipalities have also led to an acceleration in the development of smart waste management. The study on smart waste management has gained momentum in recent years due to the influence that technology has over industries as we are heading towards the fourth industrial revolution (Zygiaris, 2013). The introduction of sensors and automation is anticipated to revolutionize waste collection and recycling, to direct and allow this influence, development, and investment in big data and artificial intelligence is necessary (Mavropoulos, 2017).

Although technology has been a leading factor in the direction of smart waste management, more focus is now on other factors such as organizational factors and environmental factors (Zygiaris, 2013). The study objective, therefore, is to explore

factors affecting the adoption of smart waste management in organizations. The structure of the paper is as follows: section 2 provides a detailed literature review on smart waste management organizations. Section 3 focuses on the research methodology used for the study. Section 4 presents the study results. Finally, chapter 5 provides a discussion and the conclusion of the study.

Literature Review

A smart university is understood as a certain intellectual ability that addresses several innovative socio-technical and socio-economic aspects of growth (Zygiaris, 2013). Marsal et al. (2014) stated that smart organization initiatives try to improve urban performance by using data, information, and information technologies (IT) to provide efficient services to residencies and optimize existing infrastructure, to increase collaboration among different economic actors, and to encourage innovative business models in both the private and public sectors. Furthermore, Lombardi et al., (2012) evaluate smart organization as ambitiousness of Carbon Dioxide (CO2) emission reduction strategy, efficient use of electricity, efficient use of water, area in green space, greenhouse gas emission, intensity of energy consumption, policies to contain urban sprawl, the proportion of recycled waste.

Smart Waste Management.

Smart waste management entails all the activities and actions essential to managing waste from its inception to its final disposal (United Nations, 1997). This process includes the collection, transportation, treatment, and removal of waste alongside monitoring and regulating the process. Waste collection procedures vary widely among various countries and provinces. Zygiaris, (2013) note that smart technologies have the foremost effect on the collection, processing, energy recovery, and dumping stages of traditional waste management. Therefore, the implementation of technology improves the collection process of waste in the organization. The adoption of smart technologies will improve efficiencies in waste management. Some of the technologies that can improve waste collection and management are The Internet of Things, Near Field Communication, Big Data, and Cloud Computing.

Internet of Things (IoT)

The Internet of Things (IoT) has a promising potential application in the domain of smart organizations (Nagalingeswari & Satamraju, 2017). Patel, (2016) defines the Internet of Things (IoT) as the general idea of things, especially everyday objects that are understandable, identifiable, locatable, addressable through information sensing device and/or controllable via the Internet, irrespective of the communication means (whether via RFID, wireless LAN, wide area networks, or other means). The Internet of Things (IoT can provide valuable service in organizations in smart waste management.

Near Field Communications (NFC)

NFC is a new type of technology that allows the collaboration of devices to send and receive information without physical contact in a similar manner as the Internet of Things. The Central Bank of Jordan, (2015), note that NFC technology facilitates a

simple and safe two-way communication between electronic devices, allowing users to implement contactless transactions, gain access to digital content, and connect electronic devices with a single touch. The implementation of NFC in waste management can ease the actual waste collection process in organizations. The collection process can use big data to make the process efficient.

Big Data

Khan, Uddin, Gupta & Seven (2014) defined Big Data as a large set of data that is much unstructured and disorganized (Khan, Uddin, Gupta & Seven, 2014). The main strength of the big data concept is the influence it has on numerous aspects of a smart organization and consequently on people's lives. One tool that can assist in recognizing areas of potential improvement and making informed decisions is data analytics. Data analytics involves the collection and analysis of data to better identify inefficiencies and decision-making (Celaj, Desmond, Shah, & Shirai, 2017). Therefore, the use of big data plays an important role in smart waste management in organizations as collected dated is analyzed into information useful for strategic decisions.

Cloud Computing

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction (Jadeja & Modi, 2012). Hans, Bahli, Heier & Schewski, (2013) add that cloud computing makes it easier for firms or individual business functions to establish new services without managing or owning computer resources. Cloud computing links platforms together and allows them to work as a union as it offers online servers as a service. Cloud computing works well with big data that also link with the Internet of Things to reach smart waste management.

Theoretical Framework

This study adopted the TOE Framework as a lens of understanding the technology-organization-environment (TOE) framework (Tornatzky and Fleischer, 1990). The framework utilizes elements that influence technological adaptation in the environmental context and the organizational context. Baker (2011) suggests that successful adoption is not just a function of appropriate technology, but also technological, organizational, and environmental contexts of the organization.

Technology Context

The technological context includes both internal and external technologies that are relevant to the organization, technologies that are already in use at the organization as well as those that are available in the industry but not currently in use (Baker, 2011). This includes current practices and equipment internal to the firm (Tornatzky and Fleischer, 1990), as well as the set of available technologies external to the firm. Technology is the backbone of smart waste management and the adoption of technology improves efficiency.

Organization Context

Baker, (2011) said, "The organization context characteristics and resources of a firm include linking structures between employees, internal organizational communication processes, organizational size, and the number of slack resources". In many cases, the organizational context includes management structure and the extent of centralization. For an organization to remain competitive, it must have an innovative structure to implement smart waste management.

Environment Context

The environmental context is the arena surrounding the organization, which consists of multiple stakeholders such as the industry members, competitors, suppliers, customers, the government, the community (Angeles, 2014). The stakeholders can influence how a firm interprets the need for innovation, its ability to acquire the resources for pursuing innovation, and its capability for actually deploying it. In many instances, the introduction of technological innovation is highly dependent on the influence that the stakeholders have over the environment. Angeles, (2014) further states that government regulations are also another influential factor affecting the adoption of technologies in organizations.

Research Methodology

Research design describes the method followed for conducting the research, which includes the when from whom, and conditions for data collection (Vosloo, 2014). The researcher adds that a research design provides an outline of the research, as well as how the researcher goes about attaining the research objectives. It is therefore important to have a design before one collects and analyses data. The study adopted a content analysis to collect and analyze peer-reviewed published articles. Content analysis is a systematic and objective research method for describing and quantifying a phenomenon based on concepts (Schreier, 2012; Jokonya, 2015). The research design is suitable for the study because it provides a structured method for quantifying the contents of the qualitative text in a simpler approach. The unit analysis type for the study is the organization. The primary question seeks to identify factors that affect the adoption of technologies in waste management using the TOE framework.

Data Sources and Sampling

The study adopted convenient or opportunity sampling to explore factors affecting smart waste adoption in organizations. Etikan, Musa, and Alkassim (2015) defined convenience sampling as a type of non-probability or non-random sampling where members of the target population that meet certain practical criteria, such as easy accessibility, geographical proximity, availability at a given time, or the willingness to participate are included for the study. The sampling method was most suitable for the study because it allows the researcher to search and use what is available and convenient. Data sourcing involved searching and manipulating scientific databases using relevant keywords on the factors that affect the adoption of smart waste management. The following keywords were used: Smart waste, smart universities TOE framework, Internet of Things (IoT), Cloud computing, Big data, Near Field

Communications. The selected articles were peer-reviewed and published from 2015 - 2018.

Research methods

There are two main research methods namely qualitative and quantitative research methods. The study used the quantitative method to explore factors affecting the adoption of smart waste management. Quantitative research, according to Van der Merwe (1996), is a research approach aimed at testing theories, determining facts, demonstrating relationships between variables, and predicting outcomes. The study used content analysis to analyze qualitative data (text) quantitatively and presented the results in the form of graphs, charts, and frequencies.

Data analysis

In a review of the literature is important for the researcher to explain the process, different opinions on the use of concepts, procedures, and interpretation of the content analysis (Bengtsson, 2016). The analysis involved identifying themes and variables that were most common in the published articles. The analysis was guided by predefined groups and coding procedures as part of transforming qualitative data into quantitative data. According to Jokonya (2015), the transformation of qualitative text to quantitative data is important to generate quantitative statistics with the use of the PSPP statistical package. The statistical package helped to present a better view of the information on factors affecting the adoption of smart waste management.

Study Results

This section presents and discusses the results of the study on smart waste management. The data collected helped to answer the main research question and achieved the research objectives. The study collected data from articles published between 2013 and 2018 on the adoption of smart waste management at universities. The objective of this research was to investigate the factors that are affecting the adaptation of smart waste management for universities. The study objectives were to explore factors that affect the adoption of smart waste management in organizations The structure of the section is as follows: the first section presents the demographic results and the second section discusses the TOE framework constructs results.

Demographic Data

The demographic data section provides the results collected from articles dating from the year 2013 - 2018. The section presents demographic results on the year of publication, region, and the research method used in the articles. The data was analyzed from articles collected from different databases.

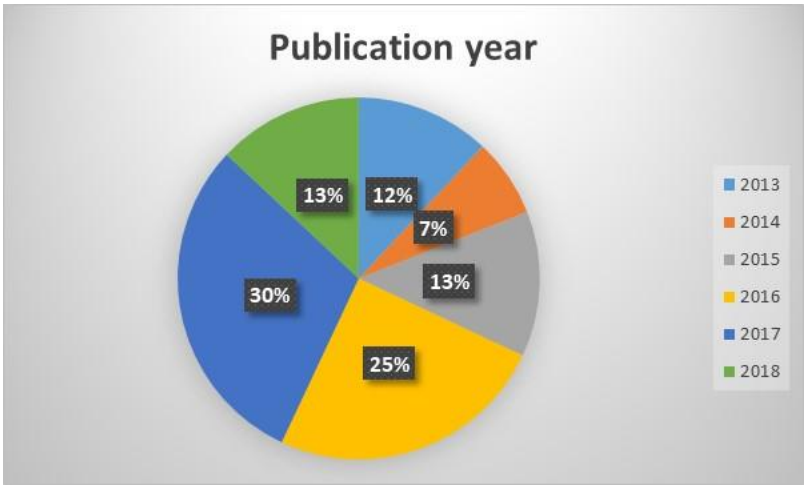

Figure 1: Article by Year.

Figure 1 above presents the frequencies of the published year of articles from the 40 articles published between the years 2013 to 2018 respectively. By far the most frequent year of publication was 2017 with (30%), followed by 2016 (25%), 2015 (13%), and the year 2014 having the least at (7%). The research suggests that there was an increase in the output of research on smart waste management. When comparing the two years we see a huge increase of 27% in 2017 from the year 2013 as our base year.

Article Distribution by Region.

Figure 2 below presents the results of published articles by region on smart waste management from the articles published between the years 2013 to 2018 respectively. South America had the lowest percentage of published articles at only (3%). Europe had the highest number of published articles at 42%, followed by Asia at (32%), then Africa (13%), finally North America at (10%). The study results suggest the there was more research studies in Europe on smart waste management than in other regions.

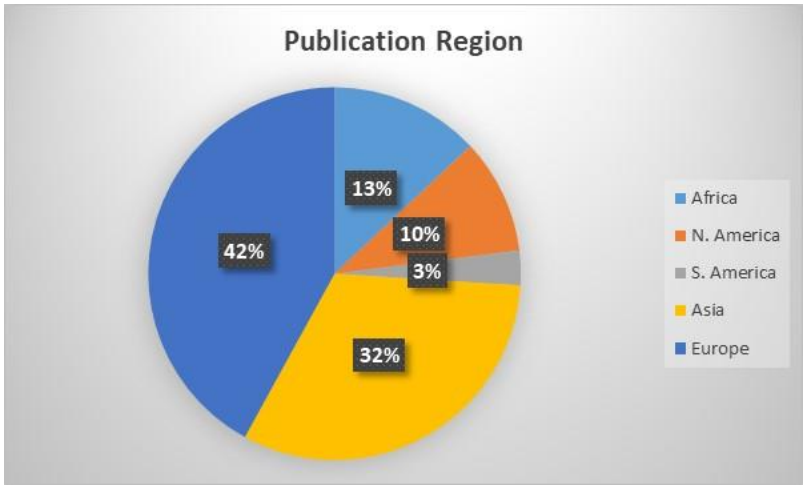

Figure 2: Article by Region

Research Methods

The results below show the research method used for research articles published on smart waste management from 2013 - 2018. The results show that majority of the published articles used qualitative research at (72%) followed by mixed-methods

(20%) and finally quantitative (8%). The study results suggest that the most popular research method was qualitative research.

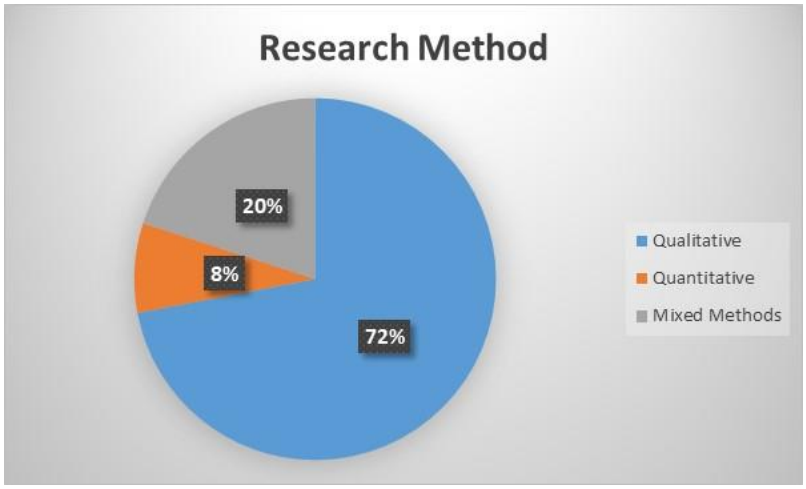

Figure 3: Research Methods

TOE Framework Results

The sub-sections be presents results on the TOE framework constructs (technological, organizational and environmental) factors variables affecting smart waste management adoption in organizations.

Technological Factors

The figure below shows technological factors affecting the adoption of smart waste management in organizations. The results show that all technological factors security (75%), access (93%), support (92%), and standards (57%) had high frequencies. The results suggest these technological factors affect the adoption of smart waste management in organizations.

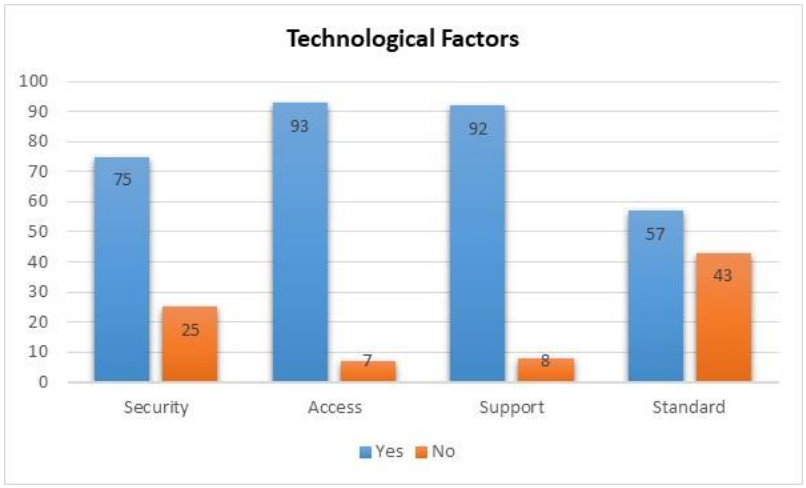

Figure 4: Technological Factors

Organizational Factors

The figure below shows organizational factors affecting the adoption of smart waste management in organizations. The results show that organizational factors management (87%), HR skills (60%), and resources (57%) had high frequencies. The

results suggest these organizational factors affect the adoption of smart waste management in organizations. The other organizational factors such as firm size (38%), centralization (38%), and formalization (20%) had lower frequencies, which suggest that they are not factors in smart waste adoption based on the articles published from 2013-2018.

Figure 5: Organisational Factors

Environmental Factors

The figure below shows the environmental factors affecting the adoption of smart waste management in organizations. The results show that environmental factors community (87%), customers (62%), stakeholders (82%), and regulations (82%) had high frequencies. The results suggest these environmental factors affect the adoption of smart waste management in organizations. The other environmental factors such as suppliers (40%), and competitors (33%) had lower frequencies, which suggest that they are not popular factors in smart waste adoption based on the articles published from 2013-2018.

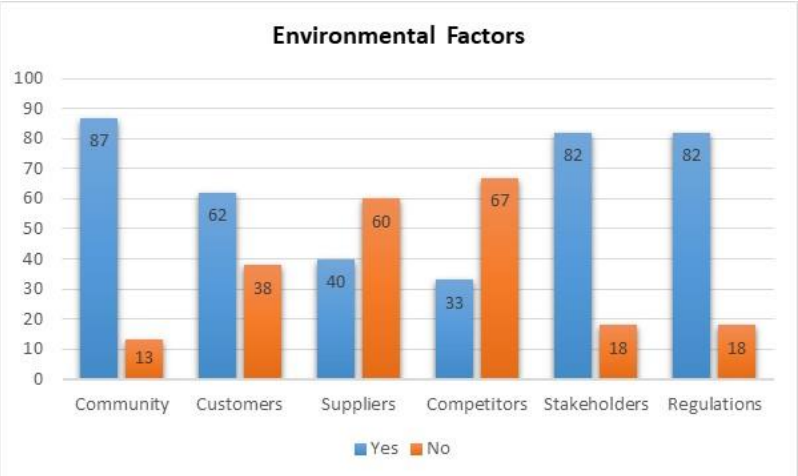

Figure 6: Environmental Factors

Discussion and Conclusion

The study explored factors affecting the adoption of smart waste management in organizations. The study results suggest that there was an increase in research output on factors affecting the adoption of smart waste management in organizations. Shaalan, (2017) supports the results stating that the effect of ICT has caused increased pressure on traditional infrastructures; hence, many organizations are embarking on smart waste management. Besides, the study shows that Europe had most research on the adoption of smart waste management in organizations and South America had the least. The study also showed that qualitative research was the most dominant research method applied in most studies.

The results showed that all technological factors security, access, support, and standards had high frequencies, which suggest that these technological factors important in the adoption of smart waste management in organizations. Literature supports that security has a great influence on technological factors. Shaalan, (2017) highlighted that security precautions and privacy concerns can work as an incentive and can increase trust in the dependability of the information shared.

The study results indicate that technological factors management, HR skills, and resources are important factors that affect the adoption of smart waste management in organizations compared to firm size, centralization, and formalization based on the articles published from 2013-2018. The results show that environmental factors community, customers, stakeholders, and regulations affect the adoption of smart waste management in organizations than suppliers, and competitors based on the articles published from 2013-2018.

In a conclusion, the study suggests that technological factors affect more important in the adoption of smart waste in organizations compared to organizational and environmental factors based on the articles published from 2013-2018. The study contributes to the body of knowledge of factors affecting the adoption of smart waste in organizations. Despite the contribution, the study has some limitations worth mentioning. The study was based on convenience sampling which makes it difficult to generalize the results. However, the limitation is an opportunity for further research in smart waste management using other research strategies and methods. Therefore, the study can act as a stimulus for further research in smart waste management.

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