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A systematic literature review of factors affecting the adoption of technologies in food waste management

Robyn-Lee Joubert, Osden Jokonya*

University of the Western Cape, Bellville, Cape Town 7535, South Africa

Abstract

Food waste has become a growing topic in many disciplines. The study explore factors affecting the adoption of technologies in food waste management. There are limited studies in literature on factors that affect the adoption technologies in in food waste management. The understanding of the factors is important for the success of the adoption technologies in food waste management. Therefore, this study aims to fill that gap. The study adopted a systematic literature review to explore the factors that affect the adoption technologies in managing in food waste in supply chain. The Technological, Organizational and Environmental (TOE) framework was used explore the factors that affect the adoption of technologies in food waste management. The study used quantitative content analysis to analyse data collected from published articles. The study results suggest that the technological factors and environmental factors were the most factors affecting the adoption of technologies chain in food waste management. The paper contributes to the body of knowledge on factors affecting the adoption of technologies in food waste management. The use of different research methods may also be important for future research in food waste management.

* Corresponding author. Tel.: +27-74-619-3605.
E-mail address: ojokonya@uwc.ac.za

1.   Introduction

Souza [1] defined supply chain management as the supplying or supply network of a product between businesses and wholesalers involved in the transformation process of raw material to customer. In short, it is the process and link between raw material and product to customer [1]. Sustainable supply chain management, which focuses on incorporating environmental, social and economic objectives as the organisation's main supply chain processes, has prompted improvement of sustainability in organisations [2]. This issue is also one of public concern reported in the general media. One article challenges the 'all you can eat' buffet, describing how this model contributes to food waste as individuals order dishes, they cannot finish [3]. BBC News [3] highlighted that food wasted may be useful in providing a meal to the poor.

Food loss occurs when food is misplaced or thrown away in the supply chain process because of pre-harvest complications, for example, pesticides, packing, transporting or storage issues [2]. An example is, fresh fruits being of squashed or damaged during transportation due to poor packaging. On the other hand, food waste is the throwing away of perfectly edible food. Reasons for this are quality standards or food nearing expiration. Whether it be not meeting quality standards, expiration dates or transportation, tons of food are wasted on an annual basis. Food waste concerns have increased due to the increased demand on the state to manage waste [4]. Urban growth has drastically affected city waste disposal, with an aligned increase in food waste [5]. Approximately one third of food manufactured or intended for human consumption, equivalent to "1.3 billion tons" is disposed in landfills [9]. In developing and under developed countries, where poverty is high, and food waste is prevalent in the beginning phases of the supply chain. In developed countries, due to supermarket practices or consumer waste, the greatest waste is evident in the later stages of the supply chain [6]. The problem identified is food waste and how organisations discard and waste food on a daily basis due to poor infrastructure and supply chain processes. There is no way to measure expiration dates or monitor goods on the shelf. The primary research question of the study: What are the factors affecting the adoption of technologies in supply chain to reduce food waste? The objectives of this research were to explore the impact of the fourth industrial revolution on food waste.

2.   Overview of Supply Chain Management

Kasza et al. [7] defined supply chain as a network between businesses connected through backward and forward integration, often in the various parts of the manufacturing process and delivery activities that ensure a product and service reach the consumer. Mentzer et al [8] added that a supply chain is an agreement between organisations or individuals who have a direct involvement in the upstream and downstream link of product, service between customer and business [8]. Supply chain management is based on the development of a value-chain linkage which comprises of individual organisations who are dedicated to providing product or service and information to obtain goals of efficient flow of the chain of supplier management [9]. Supply chain management involves the movement of resources and products, from start to end product [10]. With technology and the use of information systems it has become easier to create an effortless supply chain link between suppliers, manufacturers and consumers, eliminating poor performance from suppliers and erratic customer demands. It also assists in improving business and supplier relationship and the unpredictability in the business environment [11]. As businesses move towards more integrated business information system and with the advancement in technologies, business processes became efficient and accurate through the implementation of a more collaborative approach supported by online data access [11].

The current industrial revolution, known as the fourth industrial revolution (4IR) or 4.0, includes the emergence of artificial intelligence in the manufacturing industry. An example of this is Radio Frequency Identification (RFI). Radio Frequency Identification comprises three sections, namely a chip that has an antenna that emits signals to and from the chip, connected on the product, which then connects to hardware enabling organisation functions. Technology such as RFI makes use of radio frequencies to communicate immediately with multiple objects which are far from each other. Technology will aid in product traceability among supply chains and thus improve demand forecasting, flexibility and agility [12]. Supply chain actions have moved to focusing on satisfying demand, as it occurs, as opposed to holding onto heaps of inventory. This flexibility provides a for a more efficient and effective supply chain [13].

2.1. Food Waste

Each year large amounts of food intended for human consumption is lost or wasted during various supply chain phases or steps [14]. Food loss often occurs in the production phase or manufacturing phase, whereas food waste is at the consumer, or final phase [14]. In developed countries the largest impact of food waste is at the customer stage, while in the under-developed and developing countries it is at the agricultural and manufacturing stages where the most food is wasted [14]. According to Schanes et al. [15] during the food production and manufacturing stage, often-environmental impacts affect food loss and wastage. Some of the other factors that affect food waste management are storage, transportation and managerial challenges. Consumers focus on the aesthetic defects of food and thus in the supply chain food that is spoiled does not make it to the consumer. It is vital to note that when food is wasted in the final consumer phase of the supply chain this undermines the efforts at the beginning phases of the supply chain to facilitate efficiency [15].

2.2. TOE Framework and Related Studies

The technological, organizational, environmental (TOE) framework focuses on three aspects of an organization that impact the process of each context [16]. The technological aspect focuses on both internal and external technologies which are related to the organization. Organisational aspect places emphasis on the aspects which describe the organization such as size, scope and management structure. Environmental aspect is the overarching area in which the organization operates and functions, whether micro or macro, competitors, suppliers and government [16]. The TOE framework (figure 1), provides a solid foundation and support for organisations to focus on the specific factors identified. Organisations use the TOE model to improve process efficiency by understanding RFID adoption in supply chain of manufacturing firms [17].
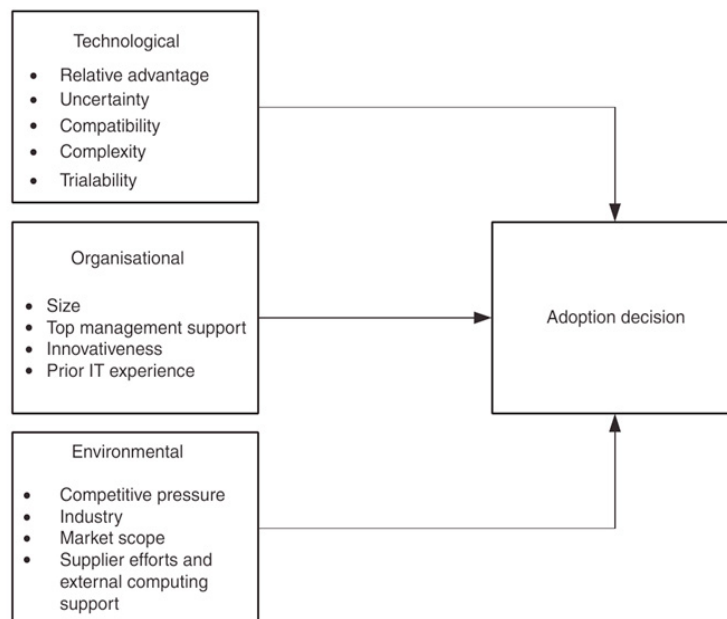

Figure 1: TOE Framework

A study by Girotto et al. [18] noted that the increase in food waste, which is discarded or lost, was found to be the prime driver of increased waste [18]. Their study attempted to identify sustainable solutions in both agricultural and industrial supply chain sectors [18]. Another study by Oh et al. [5] suggested how to convert food waste into a sustainable energy resource by the means of natural occurrence of the degrading process of the food, using the microorganisms. The consideration of the life cycle assessment of food waste and the management options are being made available [19]. Stancu et al [14] conducted surveys to measure consumer perception on food waste. Their focus on moral norms and attitudes towards wasting food which can be consumed by humans, showed how norms and behaviour impact food waste [14].

3. Research Design and Methodology

This section discuss the research methodology used for the study. The systematic literature review was to explore factors affecting the adoption of technologies in supply chain to reduce food waste. Systematic literature reviews provide a researcher with unending amounts of literature, which can be analysed by a pre-defined tool. The study used content analysis research design. The study collected only credible literature to ensure accuracy of information [20]. Babbie et al. [21] defined content analysis as a research tool used to determine the appearance or occurrence of certain words or concepts within journal articles or texts. Content analysis seeks to show the underlying meaning of written sources by making use of categories. Content analysis provides for different perspectives and thus makes use of credible sources to support my topic of study [20]. Content analysis uses written texts by categorizing the content of the text into factors, which assists with the study. Research method consists of three types of research, quantitative, qualitative and multi-method data collection [20]. The study adopted a quantitative content analysis method to explore factors affecting the adoption of technology to reduce food waste. Based on this the unit of analysis is studying or analysing articles, journal articles.

3.1. Data sources and sampling

As secondary data, non-empirical data was used in the research, the data sources were journal articles, comprising published peer reviewed journal articles from multiple databases, including Science Direct, Elsevier to name a few. 67 journal articles were reviewed. The data collection method used comprised key words searches related to the topic done via Google Scholar [22]. Convenience sampling was used to obtain the various articles. Convenience sampling is determined using characteristics of the unit of analysis which is convenient to access. Sampling was done by typing in key words or phrases of articles into credible databases to obtain the journal articles. The instrument used is a table which utilizes a TOE framework. The framework is made up of technological, environmental and organisational themes which serve as the main categories. These are then supported by sub categories. For example under technology will be RFID, IoT. All the articles are listed on one side of the table and headings and factors affecting the research topic listed on the top of the table. These categories were then applied to articles.

Table 1: TOE Factors that influence technological adoption on food waste

Technology Factors	Organisational Factors	Environmental Factors
Complexity	Size	Government
Compatibility	Centralization	Competitors
Security	Formalization	Consumers
Access	Management	Community
Support	Human Resources	
Standards	Resources	
	Quality	

3.2. Research methods

Focus was on quantifying and analysing the presence of certain words and phrases and recording the information gathered, drawing inferences from words and phrases used by various authors. Categories were allocated to identify the articles and indicate which category appears most or less in the article. A quantitative methodology for structure was used to identify patterns and regularities in the articles. One of the advantages of content analysis is that it provides for a rigid method of quantifying data of a more qualitative text. A simple, clear and easy format can be used to identify the phrases and texts.

3.3. Data analysis

Inferences were drawn from the table analysis of the TOE framework. Various statistical approaches were used to find the results and outcomes of the research. The data analysis made use of excel calculations to assist in reaching conclusions, and providing adequate support and findings. In this study, data analysis consisted of organising the pre-determined context into a framework with aspects and factors. Using demographics to analyse the articles publications. The 67 articles were manually entered into an excel spreadsheet based on the researcher's subjective perception and interpretation. The excel data was then exported to an application called SPSS which assisted with the statistical analysis of the data.

4. Study Results

The section below provides graphical illustration of the 65-70 articles in the study published between the periods 2008-2019 based on factors that affect the adoption in food waste management. This section is broken up into three sub-sections: demographic data of the study and TOE factor that affect technological adoption in food waste management.

4.1. Demographic Data

The study results show that 23% of related articles published during 2008 to 2013 and 76% related articles published during 2014 to 2019. These results show a gradual increase from 2013 to 2015. The lowest number of related articles were published around 2008-2009 and to the highest number of related articles during 2018 to 2019.The results show that Europe had the highest recorded number of related articles 51% which were articles studied, followed by Asia 24%s, and North America at 15%. The lower side of the spectrum was South America only having 2% of the articles, followed by Africa with 3 % of the articles. The results indicate that Europe had nearly half of the research, published around 2008-2019. The results show that the qualitative research was the most used research method to conduct research at 40 percent, followed by quantitative at 37 percent and lastly multi-methods with 23 percent. Most of the published articles 57 percent used systematic literature review design to conduct research. The other design types were surveys at three percent and case studies at six percent.

4.2. Factors affecting technological adoption

The section below provides graphical illustration of the technology, organizational and environmental factors that affect the adoption of technology in food waste management.

4.2.1. Technology Factors

Six technology factors were analysed that affect the adoption of technology in food waste management (figure 2). The factors include complexity, compatibility, security, support and standards. The results show that technology support (76%) had the highest percentage technological factor that affect the adoption of technology in food waste management. The other variables of the technological factors were as follows complexity (70%), compatibility (19%), security (37%), standards (57%) and access (51%). The result suggest that support was the most popular and security the least popular of the factors.
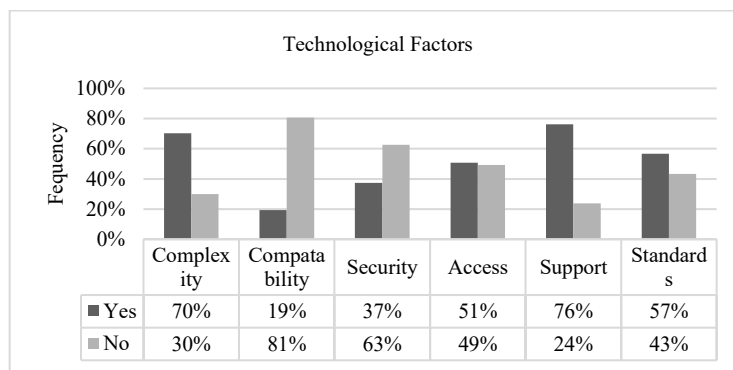

Technological Factors	Complexity	Compatability	Security	Access	Support	Standards
■ Yes	70%	19%	37%	51%	76%	57%
■ No	30%	81%	63%	49%	24%	43%

Figure 2: Technological Factors

4.2.2. Factors affecting the organisation

Seven organizational factors were analysed that affect the adoption of technology in food waste management. Organisational factors studied include: the size of the organisation, centralization of the organisation, formalization, management, human resources, resources and quality. Figure 3 below presents the graphical illustration of the organizational factors based on the 67 articles published during the period 2008-2019. The results show that

management factor had (94%), followed by quality (88%). The lowest being formalisation of the organization with 6%. The organizational size had a frequency of 64% of the published articles.
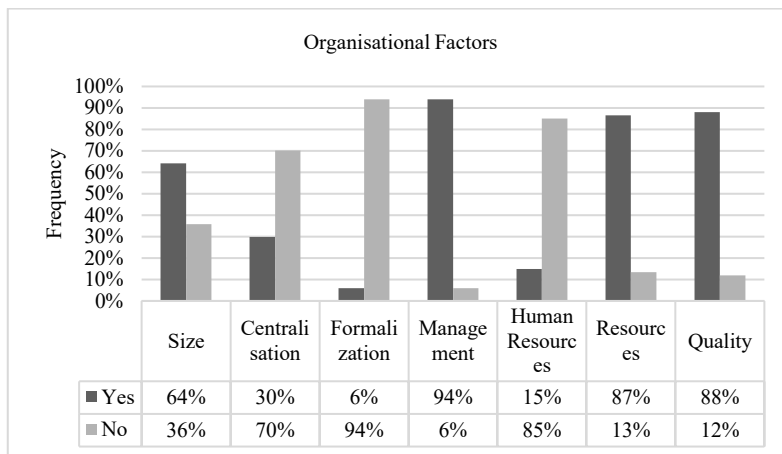

Figure 3: Organisational Factors

4.2.3. Factors affecting Environment

In this research study, six environmental factors were analysed that affect the adoption of technology in the food waste management. These factors included: government, management, competitors, suppliers, consumers and the community. Figure 4 below depicts that consumers play a big role in the environmental factors of the adoption of technology in food waste management, at 96%. Consumers are those using the products and thus make up the environment in which organisations operate. Community had the lowest percentage at 45% in the articles published during the period 2008-2019.
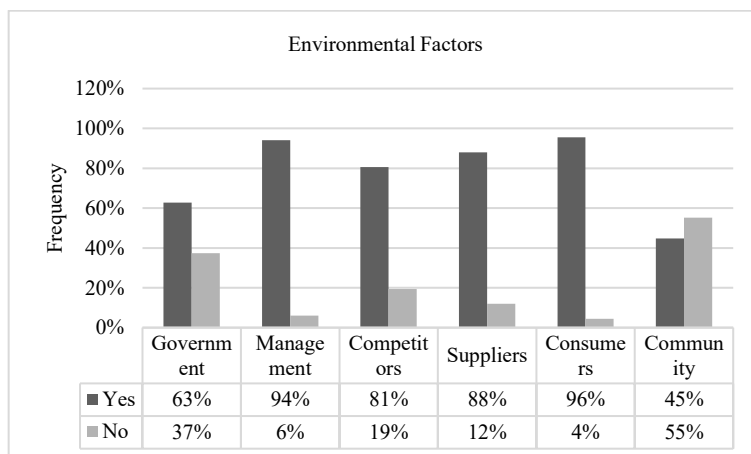

Figure 4: Environmental Factors

5. Discussion and Conclusion

The study conducted a systematic literature review on the factors that affect the adoption of technology in food waste. A total of 67 articles were selected within the period 2008-2019. The study results suggest that there was an increase in the articles published on topic of the adoption of technology in food waste from 2014 to 2019. The results indicated that authors preferred qualitative research method and most articles were published in Europe, followed by

Asia. Africa and South America had least published articles on the adoption of technology in food waste. The results indicate that the technological factors such as support, access, complexity and standards were more common in published articles. The most common organisational factors in publishes articles were size, management, resources and quality. The environmental factors most common were government regulation, competitors, consumer demand and suppliers. The environmental factors such as consumers considered important in the adoption of technology in food waste.

As a conclusion, the study explored some of the factors the affect the adoption of technology in food waste. The study indicate the support, access, complexity and standards were the technological factors most common in the published articles. In addition to that, size, management, resources and quality were also common organisational factors. Finally yet importantly government regulation, competitors, consumer demand and suppliers were the most common environmental factors in the published articles. The study results may be useful to organisation that want to adoption of technologies to reduce food waste. The study contributes to the body of knowledge on the adoption of technology in food waste management in the supply chain. Despite the study's contribution, it had also some limitation. The study based on secondary data not empirical data. Future research may therefore focus on empirical studies using other research methods.

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