

# **Factors Influencing the Adoption of Digital Technologies to Reduce Food Waste in Retail Supply Chain.**

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## Plagiarism Declaration

### Declaration

Hereby I, Kagiso Elton Mpa, declare that *Factors Influencing the Adoption of Digital Technologies to Reduce Food Waste in Retail Supply Chain* is my own original work and that all sources have been accurately reported and acknowledged, and that this document has not previously in its entirety or in part been submitted at any university in order to obtain an academic qualification.

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## Abstract

Digital technologies are anticipated to revolutionize various work sectors and industries, including the retail supply chain. The adoption of these technologies offers numerous advantages, such as enhanced efficiency, cost reduction, better insights into production issues, and improved customer experiences. This research aims to identify the key factors influencing the adoption of digital technologies within the retail supply chain, with a particular focus on addressing food waste. The study employs the technology, organization, and environment (TOE) framework to construct an alternative conceptual model by examining thirteen contextual factors. A positivist paradigm approach was adopted to test the conceptual framework's hypotheses against observations gathered using a survey questionnaire, of which the analysis followed a quantitative and deductive approach. The study results show that complexity, compatibility, cost, size, expertise, and competitive pressure positively influence the adoption, appropriation, and use of digital technologies in the retail supply chain. This study adds to a deeper understanding of factors influencing the use of digital technologies in retail supply chain operations.

Keywords: digital technologies, retail supply chain, adoption, big data, logistics, data analytics, adoption, technological factors, industry 4.0, and perishable produce.

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## **Chapter 1: Introduction and background**

### **1. Introduction**

Some researchers define a supply chain as a series of activities and the flow of resources involved in delivering fresh products from the supplier to a consumer without compromising quality (Tijsskens, 2001). Retail supply chains lose profits due to food turning to waste owing to the perishable nature of some food products. Haass, Dittmer, Veigt, & Lütjen (2015) state that almost “one-third of all the food produced in the world is wasted”. Food waste depends on factors like the efficiency of refrigeration systems, the efficiency of the logistics network (Haass et al., 2015), and changes in consumption patterns (European Commission, 2011).

At every point of the supply chain, food is wasted (Irani & Sharif, 2016) as a result of ongoing changes in product quality as they flow from the origin to the final destination, which also affects the final cost of the product as well as influence consumer perceptions (Dabbene, Gay, & Sacco, 2008). Some losses are avoidable, while some are unavoidable (San-Epifanio & Scheifler, 2015). Nonetheless, supply chain managers must prepare for these uncertainties despite the complexity (Dabbene, Gay, & Sacco, 2008), as the benefits will directly improve efficiency (Irani & Sharif, 2016), safety within the supply chains, as well as consumer confidence (Kher, Frewer & De Jonge, 2010).

Supply chains are working to reduce food waste and make the best use of their limited resources. Jedermann, Nicometo, and Uysal (2014) blame resource inefficiency on the “lack of effective monitoring of resource usage, food losses, and wastage”, which could be improved by implementing data tracking technologies. Matopoulos, Barros, & van der Vorst (2015) also suggest that to efficiently optimize resources within the supply chains, it is important to be resource-aware. This means collecting and monitoring real-time resource consumption data, which benefits include improved efficiency, cut costs, legal compliance, and improved customer satisfaction (Haight & Park, 2015; Abderahman Rejeb, 2019).

In the era of wireless technologies, the Internet of Things (IoT) capabilities enable tracking and monitoring resource usage (Jagtap & Rahimifard, 2017). The IoT is an integrated architecture that consists of sensors that allow the exchange of data between different platforms with different functionalities such as monitoring products (Amendola, Lodato, Manzari, Occhiuzzi, & Marrocco, 2014), as well as data exchange within the supply chain stakeholders (Abderahman Rejeb, 2019). This means everyday devices which are more intelligent owing to

improved communication (Ray, 2018), and their ability to gather large volumes of data in real-time could be used to monitor and reduce food waste (Combaneyre, 2015). The Internet of Things (IoT) technologies have been adopted within the supply chain domain for process optimization (Jagtap & Rahimifard, 2017), and the benefits are already significant enough to place IoT as a universal solution (Ray, 2018). For example, the implementation of IoT concepts to manage and monitor inventories like expired stock (Satyavolu, Setlur, Thomas, & Iyer, 2015) and shelf-life predictions which can minimize food waste (Nukala, Shields, McCarthy, & Ward, 2015). However, the slow pace of IT adoption could be a result of challenges associated with the increased operating costs (Wen, Hu & De Clercq, 2018), poor organizational culture, and poor leadership styles (Mogogole & Jokonya, 2018).

The use of digital technologies like IoT is transforming the traditional supply chain into a smart technologies-driven supply chain (Nukala, Shields, McCarthy, & Ward, 2015). Even with the increase in adoption of these technologies, and the significant concerns for resource insufficiency, food wastage, and inconsistent productivity (Jagtap & Rahimifard, 2017), currently, there is little research exploring digital technology applications in reducing food waste, especially in the retail supply chain. Therefore, this study aims to explore the elements that affect retail supply chains' deployment of digital technologies to reduce food waste.

### **1.1 Statement of the research problem**

Of all the food produced globally, nearly one-third is wasted (Haass, Dittmer, Veigt, & Lütjen, 2015), and reducing such waste will directly have a positive impact on securing food supply chains (Irani & Sharif, 2016). For a more effective approach to food waste reduction; advanced technologies such as cloud computing and IoT could be considered, as have been leveraged in Financial Supply Chain Management (FSCM) (Yu, Yan, & Cheng, 2001; Kelepouris, Pramataris, & Doukidis, 2007; Manzini & Accorsi, 2013; Yu & Nagurney, 2013). This means the use of data-driven systems to monitor processes for better decision-making and a more sustainable food supply chain (Zhong, Xu, & Wang, 2017). Hence this research is motivated by considerations to adopt digital technologies to reduce food waste in the retail supply chain, for many good reasons — food security, economic gains, environmental sustainability and quality supplies.

### **1.2 Primary research question**

What are the factors influencing the adoption of digital technologies to reduce food waste in the retail supply chain?

### **1.3 Aim of the study**

The study aims to investigate the technological, organizational, and environmental factors influencing the adoption of digital technologies in retail supply chains to minimize food waste.

### **1.4 Research objectives**

Firestone (1987) maintains that “quantitative methods express the assumptions of a positivist paradigm, which claims that behaviour can be explained through objective facts”. The specific objectives of this study are:

- To investigate technological factors that influence retailers to adopt digital technologies to reduce food waste in the retail supply chain.
- To investigate organisational factors that influence traders to adopt digital technologies to reduce food waste in the retail supply chain.
- To investigate environmental factors that influence retailers to adopt digital technologies to reduce food waste in the retail supply chain.
- To propose a framework to assist retailers with the adoption of digital technologies to reduce food waste in the retail supply chain.

### **1.5 Conceptual model and hypothesizes**

This study incorporates and investigates three categories of contextual factors; technological factors, organisational factors, and environmental factors. “Past research has shown a range of independent variables from these three contexts, while adopter or non-adopter firms can be thought of as a binary dependent variable” (Gutierrez, Boukrami, & Lumsden, 2015). In this study, thirteen predictors from the three factors that are believed to be important were statistically tested against the dependent output, to measure the significance of each variable in determining the decision to adopt digital technologies to cut down on food waste in the retail supply chain. The predictors formed a proposed conceptual model or framework. The dependent variable is the retailer’s behaviour towards adoption, measured in their intent. Behaviour is usually difficult to measure; hence intent is used (Ajzen, 1991).

*H1:* Compatibility does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.

*H2:* Complexity does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.

*H3*: Relative advantage does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.

*H4*: Cost does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.

*H5*: Organization's top management does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.

*H6*: Organizational size does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.

*H7*: I.T. expertise does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.

*H8*: Technological readiness does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.

*H9*: Organizational innovativeness does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.

*H10*: Competitive pressure does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.

*H11*: Customers do not influence the adoption of digital technologies to reduce food waste in the retail supply chain.

*H12*: Technology vendor support does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.

*H13*: The social community does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.

## **1.6 Location of the study**

This will be conducted in selected retail stores around Gaborone, Botswana.

## **1.7 Limitations**

Some of the drawbacks encountered were that the data was collected during the COVID-19 pandemic, which made it difficult to reach and make follow-ups with the respondents. Due to the restrictions that came with the pandemic, not many retails were sampled and thus the study

only focused on Gaborone, resulting in a low response rate and adoption of biased convenience and purposive sampling approaches.

### **1.8 Chapter summary**

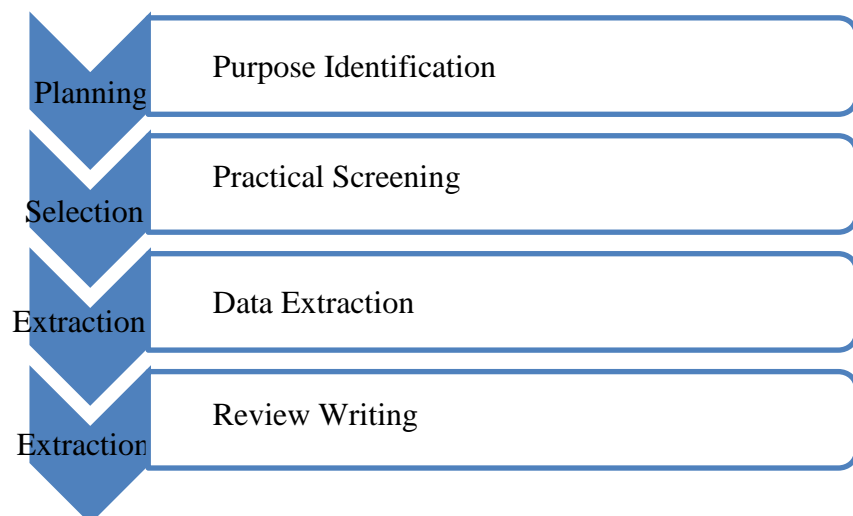
This chapter introduced the issue of food waste in retail supply chains, highlighting that nearly one-third of global food production was wasted due to factors like inefficient refrigeration, logistics, and changing consumption patterns. It emphasized the importance of adopting digital technologies, such as the Internet of Things (IoT), to monitor and reduce food waste by improving resource tracking and management. Despite the potential of these technologies, their deployment in food supply chains was still limited. The study aimed to investigate the technological, organizational, and environmental factors influencing the adoption of digital technologies in retail supply chains to minimize food waste, with a focus on retail stores in Gaborone, Botswana. Additionally, the conceptual model and hypotheses developed in this chapter will serve as the basis for empirical investigation in subsequent chapters.

## Chapter 2: Literature review

### 2.1 Introduction

The digital technologies framework discussed in this study is rooted in a literature review that was carried out. The literature review is an excellent research methodology to the extent that it can synthesise research findings and identify areas where more research is needed, thus providing the basis for a conceptual model, and informing policy and practice (Snyder, H. 2024). The literature review can be narrowed down, for example, “to investigate the association between two specific variables, or can be broader, such as compiling evidence in a certain research area” (Snyder, 2019, p. 333). The literature review covered research on topics relevant to the study, like the Fourth Industrial Revolution, supply chain 4.0, additive manufacturing, food waste in the retail supply chain, theoretical framework, and related studies.

The literature review selection process was based on factors such as the author, technology revised (digital), year of publication, relevancy to the retail supply chain, and context of the study. This study applies a content-analysis literature review based on studies identified from mainstream academic databases in digital technologies adoption within the FSC, with explicit procedures and guidelines in place to minimize bias. Content-analysis technique is a semi-systematic review that can be defined as a method for analysing themes, patterns, theoretical perspectives, or common factors within a specific topic (Braun & Clarke, 2006; Ward, House, & Hamer, 2009). Even though a semi-systematic review was considered, a systematic approach presented in Figure 1 was rather adopted, as it provided a better guide to a scientifically rigorous literature review (Okoli, 2015).

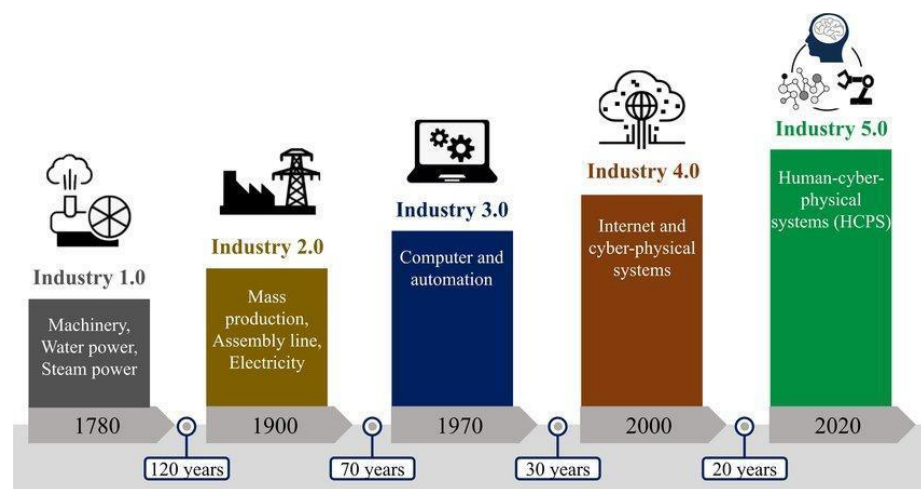


**Source:** (Okoli, 2015)

Figure 1. Literature Review Approach.

## 2.2 The 4<sup>th</sup> Industrial Revolution

The fourth industrial revolution (4IR) is described as “a world where individuals move between digital spaces and reality with the use of interconnected technologies to empower and manage their lives” (Xu, David, & Kim, 2018), for improved operational efficiency and productivity (Lu, 2017). The five major drivers of 4IR, as pointed out by Roblek, Meško, and Krapež (2016) and Posada, Toro, & Barandiaran (2015), are “digitization, optimization and customization of production; automation and adaptation; human-machine interaction (HMI); value-added services and businesses, and automatic data exchange and communication”.



**Source:** (Chen, 2021)

Figure 2 Main characteristics of industrial revolutions.

Figure 2 shows the main features of the industrial revolutions in the period 1780 to 2020, as illustrated by Chen (2021). As supported by the illustration, the phenomenon of 4IR is characterised by cyber-physical and internet systems like “additive manufacturing, advanced robotics, artificial intelligence, autonomous vehicles, blockchain, drones, the internet of things, etc”. (Tang & Veelenturf, 2019). Some of the biggest advantages of 4IR are value creation through efficiency and new business models (Roblek, Meško, & Krapež, 2016). However, to take full advantage of such technologies and the transformation that comes with their implementation does not only require technological systems and solutions, but the solutions must also be innovative and sustainable (Morrar, Arman, & Mousa, 2017).

Figure 3 shows the mind map which is a summary of the frequently discussed technologies and methods of Industry 4.0 as allocated into clusters, according to Li, Yao, Shao, and Wang (2014).

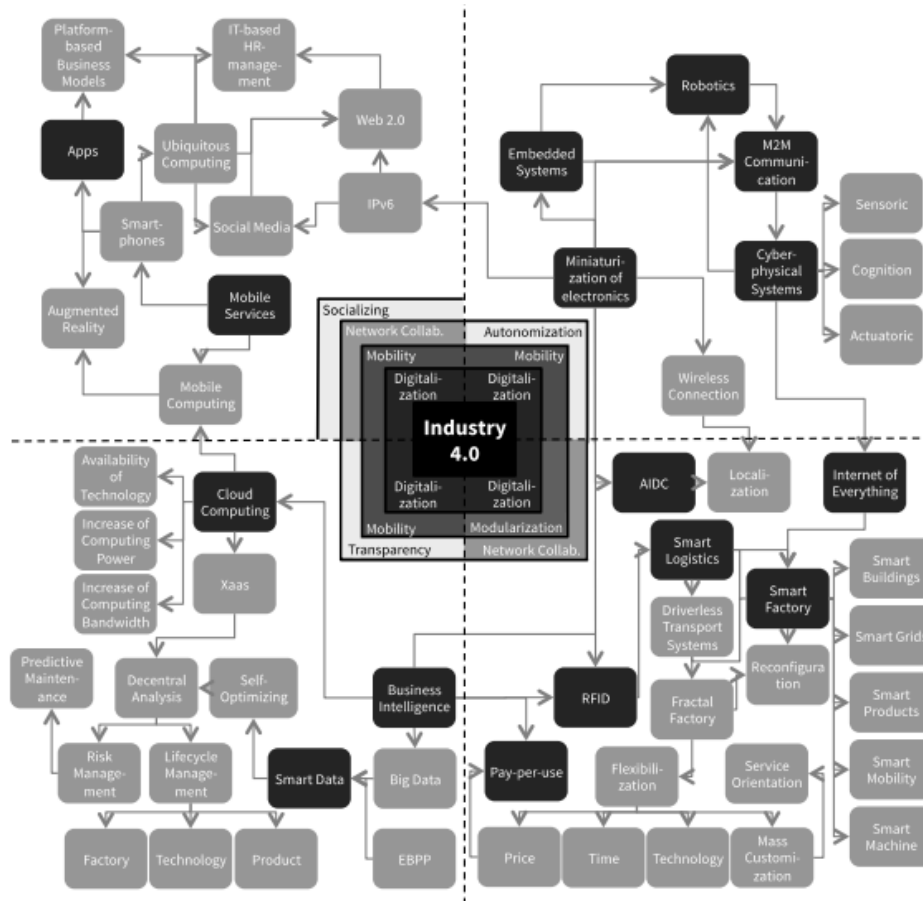


Figure 3: Industry 4.0 Technological Mind-map (Source: Li, Yao, Shao, & Wang, 2014)

The significant impact of the drivers of the 4<sup>th</sup> Industrial Revolution era will be as a result of digitization and automation processes, the impact of which will be felt even by enterprises, whether big or small (Sommer, 2015). Some of the implications include upskilling of employees and job losses (Weber, 2015). The uncertainties and effects have since ignited debates around the most ideal approach to greatly exploit rapid technological breakthroughs. For example, there are still questions about big data and cyber security issues. Furthermore, technologies like IoT mean having everything connected and thus imply increased vulnerabilities in networks and systems (Xu, David, & Kim, 2018). Other 4IR technologies adoption challenges include organizational mindset (Roblek, Meško, & Krapež, 2016), employees' expectations (Scheer, 2012), and lack of proper regulations (Duan, Zhang, Gong, Brown, & Li, 2020).

### 2.3 Artificial Intelligence

Artificial intelligence (AI) has significant potential to revolutionize food waste management by analyzing vast datasets and improving processes within the food supply chain. However, many organizations and consumers are unaware of AI's capabilities and the innovative methods

it offers to effectively address food waste (Wafi & Tumiran, 2024). In their review to explore strategies for sustainable consumption using AI to mitigate food waste, they further highlighted key innovations such as smart inventory management, recipe generation based on available ingredients, automated waste tracking, predictive meal preparation analytics, and consumer behavior insights. The study concluded that AI presents a practical approach to promoting sustainable consumption practices across the food supply chain.

In their study, Elgalb & Gerges (2024) explored the use of AI and Big Data within the food supply chain, emphasizing their applications in demand forecasting, inventory control, and optimizing delivery routes. Through examples from prominent industry players, they demonstrated how these technologies can significantly reduce food waste and enhance sustainability efforts. The research also addresses key obstacles, including issues related to data integration, scalability, and the financial burden of implementation, while proposing actionable strategies to tackle these challenges.

#### **2.4 Additive Manufacturing**

Guo & Leu (2013) define additive manufacturing as processes that “make three-dimensional parts directly from CAD models by adding materials layer by layer, offering the beneficial ability to build parts with geometric and material complexities that could not be produced by subtractive manufacturing techniques”. Limitations of the traditional methods of manufacturing result in high cost of the final product, hence additive manufacturing techniques are seen as sustainable alternatives due to their high accuracy levels, and rapid production cycles, thus resulting in cost reductions and increased efficiency (Jiménez Calzado, Romero, Dominguez Espinosa, Espinosa, & Domínguez Somonte, 2019).

3D printing technology forms a rapidly evolving industry (Rogers, Baricz, & Pawar, 2016), and as it disrupts established systems like global supply chain. The sectors in which additive manufacturing is used are shown in Figure 4 with their respective usage degrees.

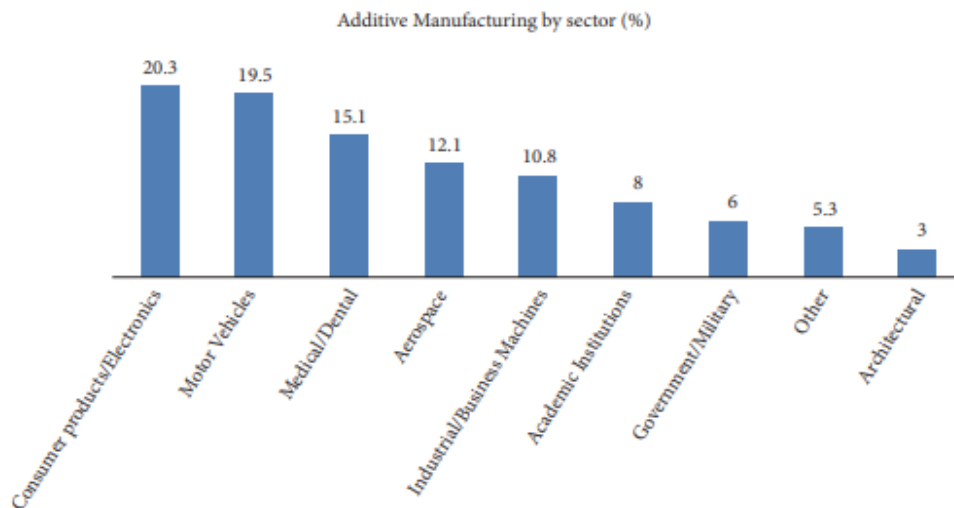


Figure 4. Additive Manufacturing by sector (Jiménez Calzado, Romero & Dominguez Espinosa, 2019)

Jiménez Calzado et al. (2019) points out that in the food industry, where additive manufacturing technologies are already adopted, there are significant benefits being realised.

## 2.5 Supply Chain 4.0

The supply chain, as per Beamon, (1999) definition, is defined as an “integrated manufacturing process in which raw resources are transformed into finished goods before being distributed to customers”. Hence due to developments in technology, the modern supply chain foundation is big data and AI (Tjahjono, Esplugues, Ares, & Pelaez, 2017), and leverages Industry 4.0 drivers such as Block Chain, the Internet of Things, big data, analytics and advanced robotics - for operational efficiency purposes (Alicke, Rexhausen, & Seyfert, 2017), sustainability, reduce costs and increase product quality (Dossou, 2018). For instance, Radio Frequency Identification tags are extensively integrated to sense and monitor products and things (Amendola, Lodato, & Manzari, 2014), to improve resource efficiency (Jagtap & Rahimifard, 2017).

The Industry 4.0 environment is characterised by interconnected smart machines, automated production lines, and analytics that allow the analysis and understanding of production problems and solving them with the least amount of human intervention (Tjahjono, et al. 2017). These disruptive technologies will also change the interactions between supply chain players and machines, resulting in the total transformation of the global supply chain (Tang & Veelenturf, 2019). Some of the food supply chain companies that adopted IoT technologies in their processes and operations include Rova, Siemens, Martec and 2 Sisters (Jagtap &

Rahimifard, 2017). Table 1 highlights existing IoT-based supply chain solutions as captured by Khan, Byun, & Park (2020).

Table 1. Comparison of supply chain solutions. IoT: Internet of Things.

Author	Objective
Accorsi, Ferrari, & Gamberi (2016).	Monitoring environmental stress throughout the dairy product supply chain.
Wang, Yue, & Zhou (2017)	Monitoring environmental factors throughout the dairy product supply chain.
Tsang, Choy, & Wu (2019).	A cost-effective tracking system for perishable food.
Borah, Naik, & Patgiri (2020).	IoT and Blockchain in farm supply chain.
Khan, et al., (2020)	Industry 4.0 technologies in food provenance systems.

The Global System for Mobile Communications Association (GSMA) defines IoT as “the utilisation of intelligently connected devices and systems to leverage data collected by embedded sensors and actuators in machines and other physical objects”. A typical IoT architecture that could be used to solve the resource efficiency problems in FSC consists of “the sensing, network and service, and application layers” as outlined by Ray (2018) and Figure 5 below.

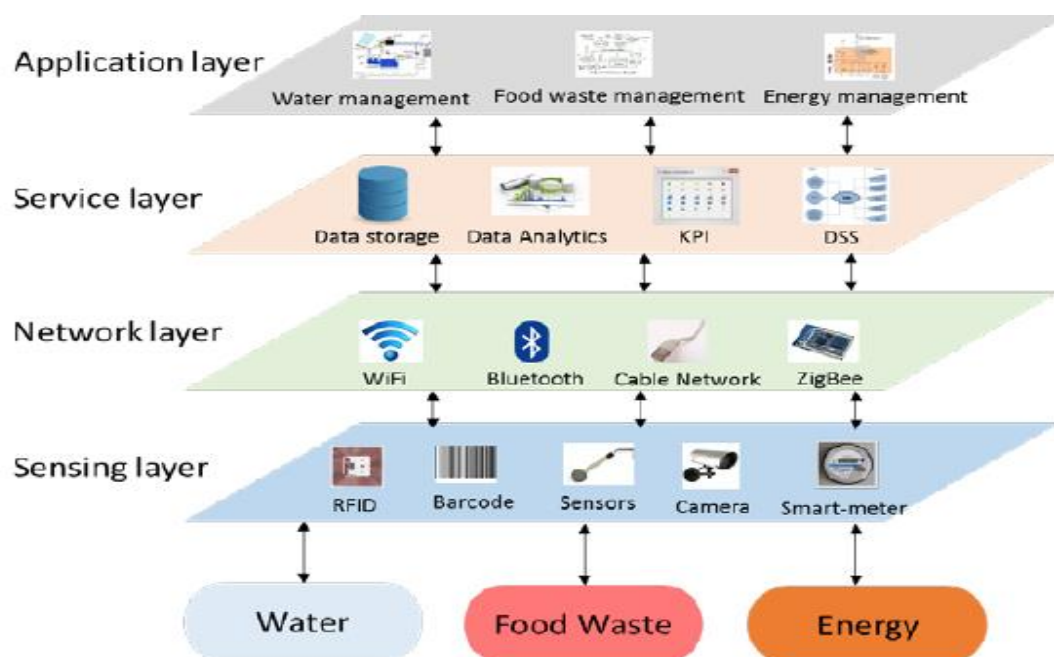


Figure 5. An Example of Resource-Efficient Internet of Things Infrastructure for FSCs (Source: Jagtap & Rahimifard, 2017).

According to Gunawan Witjaksono et al (2018), the technical setup of the IoT network system is as below:

- Sensing layer – this consists of a variety of sensing devices, including RFID tags, cameras, and smart sensors.
- Network layer - this refers to modern connectivity technologies such as WiFi, Bluetooth, Raspberry Pi's, etc used as a data-sharing link between the sensors and the service layer.
- Service layer – this is where data is stored and pre-processed for analysis.
- Application layer – the layer provides user interface services where stakeholders can easily access the information.

Tjahjono, et al. (2017) observe that supply chain 4.0 technologies like “big data analytics, cloud technology, cybersecurity, the IoT, miniaturization of electronics, robotics, drones and nanotechnology and Business Intelligence”, could also have negative implications if there are no clear boundaries. Hence there is a need for a clear adoption strategy, a more transparent understanding of the concepts and a holistic management approach to adoption (Pfohl, Yahsi, & Kurnaz, 2015). This is because the implementation of supply chain 4.0 means the managing of advanced technologies, the environmental and the human resources factors concerned, to effectively handle the disruption of business operations (Dossou, 2018).

Barriers to supply chain 4.0 adoption can be grouped into external, inter-organisational, intra-organisational, and technical barriers (Saber, Kouhizadeh, Sarkis, & Shen, 2019). Other researchers categorised major barriers into institutional, strategic, technological and legal constraints (Luthra & Mangla, 2018).

The applications of smart logistics (Logistics 4.0) and smart factories are also anticipated to have the greatest impact on Industry 4.0, for example, smart factories will include driverless-transporting-systems, autonomous systems, and processes (Pfohl, Yahsi, & Kurnaz, 2015). For easier explanation, Logistics 4.0 can be defined from two perspectives: “regarding the short-term definition, Logistics 4.0 is characterized by the exchange of large volumes of data between associated processes. While the medium-term definition of Logistics 4.0 is characterised by

independent and self-organizing systems within an ecosystem”. (Szymańska, Adamczak, & Cyplik, 2017).

The IoT framework that combines digital and physical systems into logistics promises to deliver but is not limited to, improved fleet management, real-time monitoring of material flows as well as precise risk prediction and mitigation (Hofmann & Rüscher, 2017). For example, the business could rely on an algorithm that predicts traffic and weather conditions, then inform on the right transportation system and route (Li, Yao, Shao, & Wang, 2014). In a broader context, GPS, RFID, and other connected sensors enhance in-transit visibility by monitoring conditions like temperature and humidity, as well as accurately tracking the location of vehicles on public roads or at shipping terminals Rejeb, Keogh, & Treiblmaier (2019). Furthermore, Affia, Yani, & Aamer (2019), and Mohamed, Elkafi, & Bahroun (2020) recognised that the FSG is complex and thus forces companies to be innovative to stay ahead of the competition.

Implementation of Industry 4.0 technologies in the supply chain and logistics continue to prove value addition for both suppliers and customers, who are looking for fast delivery services, and high-individualized products and services (Barreto, Amaral, & Pereira, 2017). For instance, Davenport and Harris (2007) identified firms such as Procter and Gamble, as organizations that enjoyed a competitive advantage as a result of data-driven decisions. Additionally, smart logistics will cut production and storage costs while increasing output levels, customer satisfaction, and customer service (Barreto, Amaral, & Pereira, 2017). Despite the huge potential for implementation, some of the disadvantages include high investment costs and technical requirements (Szymańska, Adamczak, & Cyplik, 2017). IoT-related technical challenges include ensuring security, authenticity, confidentiality, and privacy Rejeb et al., (2019).

## **2.6 Food waste in the retail supply chain**

According to Mohamed Ben-Daya et al., (2020), FSCs are more complex because they experience heightened concerns regarding food safety and from production to the final retail stores and final consumer, there is the risk of food quality being compromised due to exposure to different environments, leading to food waste (Affia, et al., 2019; Gustavsson, Cederberg, & Sonesson, 2011). Thus, the most crucial indicator of food supply chain performance, is the maintenance of high food quality (Rong, Akkerman, & Grunow, 2011). For example, some products could become spoiled and lose their freshness, the consequences of which have a

detrimental impact on the environment, the economy, and food security. (Mena, Adenso-Diaz, & Yurt, 2011).

Retailers contribute to the food waste problem since their business models have an impact on consumer demands and the supply chain as a whole (Cicatiello & Franco 2020). According to Buzby, Bentley, Padera, Ammon, & Campuzano (2015), the biggest contributing factors of food waste at retail establishments include over-stocking and over-preparing, both as a result of the lack of insightful forecasting of store visits or walk-ins. In their study, Cicatiello and Franco (2020) found that in retail, food products had the highest food waste rates in terms of value (about 16.3% of turnover), pastries at about 5.9%, then seafood at about 4.3% and fruit and vegetables at around 2.5% of turnover. Last but not least, the rates of food waste for frozen goods, groceries and unpackaged cold cuts were negligible (Figure 6).

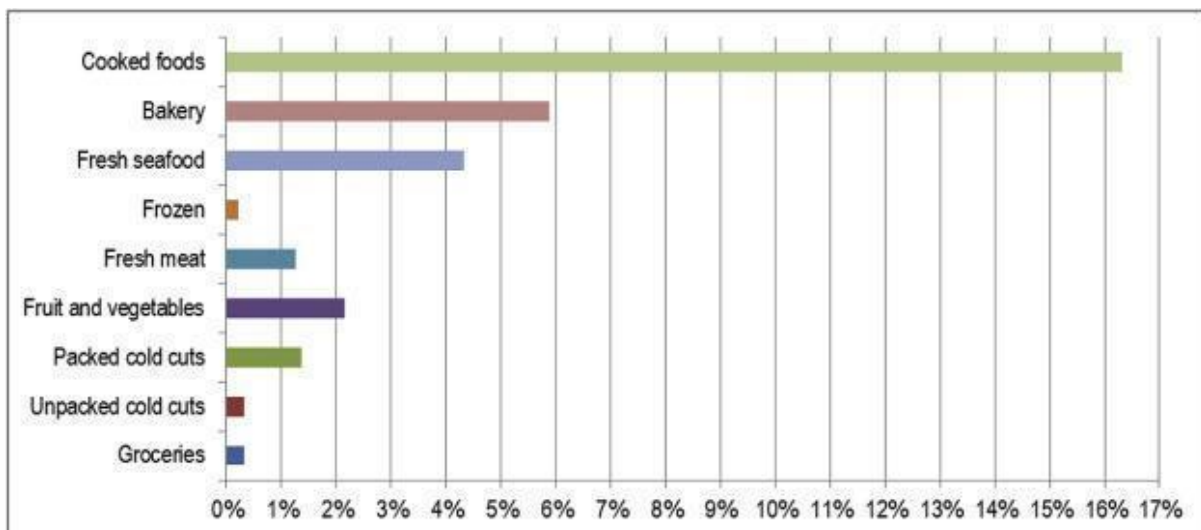


Figure 6. Value of food waste by category (Source: Cicatiello & Franco, 2020)

There is therefore a need for extra attention and higher efficiency over the handling processes such as storing and shelf-life monitoring to cut food waste. Most literature on retail food waste puts much emphasis on quantification, the basis of continuous measurement with data collected at the store (Cicatiello & Franco, 2020). Concerning this food waste problem, Duan, Zhang, Gong, Brown, & Li (2020) suggest that many technologies have been investigated with the hopes of tackling food recalls efficiently. The need for the retail supply chain to adopt technologies like intelligent containers (Haass, Dittmer, Veigt, & Lütjen, 2015), RFID technology (Bhattacharya & Wamba, 2018), IoT (Lin, Lee, & Lin, 2016), and Blockchain (Kamath, 2018) to reduce food waste is further fuelled by consumers' growing demand to know the authenticity and knowledge of the products before purchasing (Duan, Zhang, Gong, Brown,

& Li, 2020). Consequently, there is a need for thorough studies on the diffusion and adoption of innovation to food waste reduction in the retail supply chain.

## **2.7 Related studies**

Studies using the TOE framework to measure the diffusion of digital innovation in the retail space were visited. From the studies visited, results show that depending on the industrial context, the impact of technological, organizational, and environmental elements at play differ, for example, technological costs, environmental changes, organizational culture, and management's appetite for transformation have shown to play different roles in determining technological implementation across various industries (Bhattacharya & Wamba, 2018).

Although further research still needs to be done, the implementation of efficient IoT-based applications to the food waste management and supply chain is gaining more consideration (Wen, et al., 2018). In a study to “analyse the drivers of IoT technology adoption in the Chinese agricultural supply chain”, Lin, Lee, & Lin (2016) found that technical variables (perceived benefit, complexity, cost, and compatibility) have a complex influence on the technology adoption of IoT. Additionally, organizational variables (talent, size of the enterprise, trust, and management support) and environmental variables such as government support and external pressure, all have a positive impact on the adoption of IoT technologies. On the other hand, Kamble, Gunasekaran, Parekh, & Joshi (2019) found that internal and external factors like government regulations and internet infrastructure are significant drivers for IoT adoption in food retail supply chains. Furthermore, under the topic of IoT adoption in food supply chain management, Affia, Yani, and Aamer (2019) identified key factors such as perceived performance benefits, cost considerations, data complexity, compatibility, technical expertise, hardware and infrastructure requirements, peer and government support, security and privacy concerns, and willingness to adopt.

To examine determinants of the implementation of human resource information systems in the hospital industry of Bangladesh, based on the TOE framework, Alam, Masum, Beh, & Hong (2016) opine that “the 5 most important considerations are IT infrastructure, top management support, IT capabilities of staff, perceived cost and competitive pressure”. In the study on HRIS adoption by small-to-medium firms, perceived benefits, organizational Human Resources Information System (HRIS) expertise, and top management backing were shown to be important decision-driving factors (Scupola & Pollich, 2019).

Bhattacharya & Wamba (2018) proposed a TOE framework predicting the intention to adopt RFID in retail. According to the study's findings, relative advantage, competitive pressure, catalyst agents, and value chain complexity are important factors influencing the adoption of RFID in the retail sector. However, Brown & Russell (2007), and Wang et. al. (2010) concluded that technological variables also play a role in the adoption of RFI in the supply chain. In other adoption studies; Awa, Ukoha, & Emecheta (2016) concluded that “organizational and environmental factors are less important when compared to technological ones in SMEs' adoption of enterprise resource planning (ERP)”.

In their efforts to determine the determinants of the adoption of cloud computing with the TOE framework, Gutierrez et. al., (2015) concluded that out of the eight factors they have examined; “technology readiness, complexity, competitive pressure, and trading partner pressure have a big impact on whether or if cloud computing services are adopted in the UK”. Another study identified training and education, relative advantage, organizational readiness, complexity, compatibility, trading partner, top management commitment, and competitive pressure as factors that directly influence plans to adopt cloud computing (Gangwar, Date, & Ramaswamy, 2015).

## **2.8 TOE theoretical framework**

Researchers have proposed many conceptual frameworks for technological adoption. Frameworks such as the theory of reasoned action (Ajzen & Fishbein, 1980), innovation diffusion theory (Rogers E., 2003), the technology acceptance model (Davis, 1989), the theory of planned behaviour (Ajzen, 1991), the resource-based view (Caldeira & Ward, 2003), technology-environment-organization (Tornatzky & Fleischer, 1990) and stage model (Poon & Swatman, 1999). These frameworks all seek to support different theories on the most significant factors that influence technological adoption. The theories of TOE and TAM target to clearly describe end-user adoption and technology acceptability at the institutional level (Awa, Ukoha, & Emecheta, 2016); consequently, the TOE of Tornatzky and Fleishcher has been a major source of inspiration for many studies on organizational adoption of technology (Bhattacharya & Wamba, 2018). Tornatzky and Fleischer (1990) developed a framework for technology adoption that is based on the company's appetite towards internal and external elements like the organization size, environment, and organizational strategy.

The work presented uses the TOE theoretical framework to investigate selected factors and their influence on firm-level adoption of digital technologies to reduce food waste in the retail

supply chain. The study also constitutes the merge of two research perspectives, digital technology, and supply chain. The assessment tools used are the technological-organizational-environmental (TOE) framework because the assessment is at an organisational level and on the basis that the framework is widely accepted by innovation adoption studies (Cooper & Zmud, 1990; Thong, 1999). Kuan & Chau (2001) also recommends the framework as “a practical method for looking at elements influencing adoption”. The framework considers the three contexts of technology, organisation, and environment (Bhattacharya & Wamba, 2018), that could affect the implementation of digital technologies.

The TOE framework has been applied to assess how different technologies are being adopted in different industries, for instance, Bhattacharya & Wamba (2018) considered a TOE framework in determining key indicators to distinguish RFID adopters from non-adopters in the retail supply chain. As opposed to that, Hwang, Huang, & Wu (2016) analyzed the factors influencing the adoption of a green supply chain using the TOE framework. Other information systems topics where the TOE framework was tested include but are not limited to e-commerce (Martins & Oliveira, 2009) and knowledge management systems (Lee, Kim, Choi, & Lee, 2009). Despite different researchers like Oliveira and Martins (2011) also asserting that the TOE framework is better at explaining intra-firm innovation adoption because it considers the environmental context, Gangwar, Date, & Raoot (2014) argue that the framework does not offer clear constructors compared to the technology acceptance model (TAM), even though acknowledging its significance in explaining technology adoption.

Figure 7 below depicts elements of the study’s TOE framework, purposefully selected from a group of comparable hypotheses.

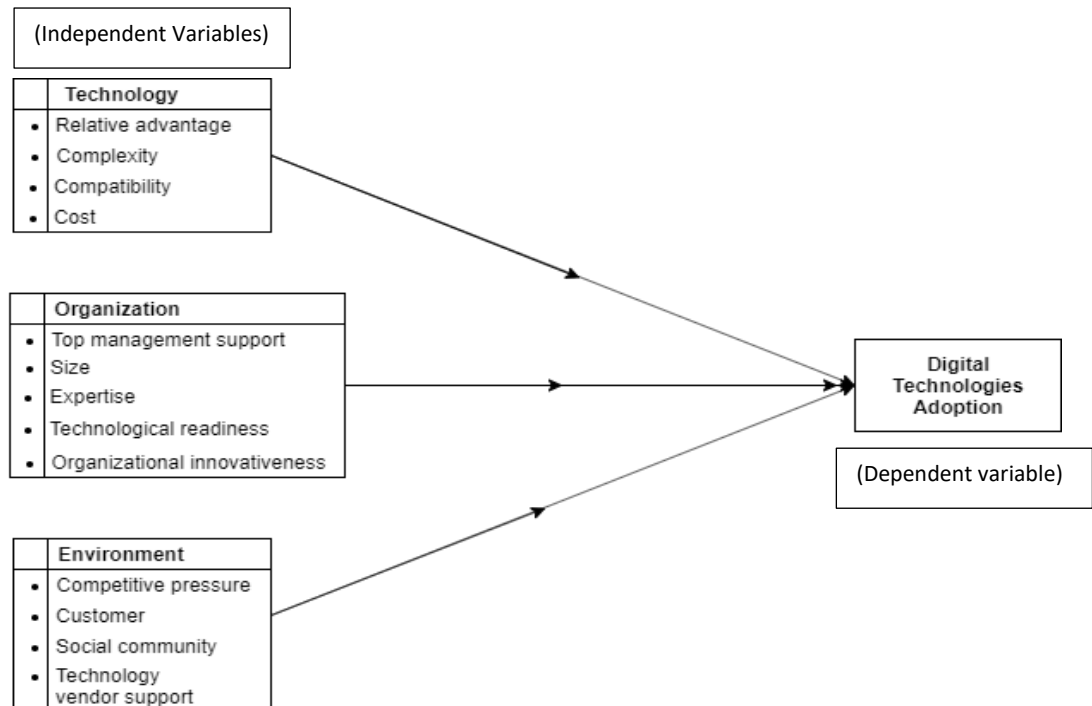


Fig. 7 Proposed technology-organization-environment framework, (adapted from Hwang, Huang, & Wu, 2016; Bhattacharya & Wamba, 2018).

### 2.8.1 Technology

The technological aspect considers all of the technologies already adopted within an organisation as well as those that are available to the organisation externally but not yet considered by the business (Baker, 2012). Through these technologies, a set of innovation attributes are studied as “potential determinants of the adoption decision in organizations” (Hameed, 2020). The attributes to be considered are the cost of adoption, relative advantage, complexity, and compatibility.

### 2.8.2 Organization

“The organizational context characterizes a firm's features, including its size, degree of formalization, degree of centralization, the complexity of its organisational structure, level of human asset quality, and quantity of internal spare resources” (Arpaci, Yardimci, Ozkan, & Turetken, 2012). Size, top management, expertise, organizational innovativeness, and technological readiness are examined in this study.

### 2.8.3 Environment

The environmental context may have an impact on how organizations adopt technology, based on the TOE framework. The environmental construct considers the structure of the industry, the availability of technology vendors, and the culture cultivated within the organisation (Baker, 2012; Awa, Ukoha, & Emecheta, 2016). The environmental attributes help in

measuring the impact of environmental pressures emanating from outside on adoption (Gutierrez, Boukrami, & Lumsden, 2015). This study looks at four environmental context-related factors to explain why digital technologies are being used to cut down on food waste in the retail supply chain: competitive pressure, customer, social community, and technology vendor support.

## **2.9 Chapter summary**

The literature review has provided a comprehensive exploration of the key themes relevant to this study, including the transformative potential of digital technologies within the retail supply chain and their role in addressing food waste. The chapter outlined the broader context of the Fourth Industrial Revolution, emphasizing technologies such as IoT, additive manufacturing, and AI, which are pivotal in Supply Chain 4.0. It highlighted the challenges posed by food waste in the retail sector and the potential of data-driven solutions to mitigate these inefficiencies.

Through the Technology-Organization-Environment (TOE) framework, this chapter established a robust theoretical foundation for examining factors influencing the adoption of digital technologies. Previous studies have demonstrated that technological, organizational, and environmental factors interact in complex ways, influencing the decision-making processes of retail organizations.

In conclusion, the literature demonstrates a pressing need for retail supply chains to adopt digital technologies to enhance efficiency, reduce waste, and meet consumer expectations. However, the slow pace of adoption due to factors like cost, complexity, and organizational readiness underscores the importance of understanding these influences more deeply. The insights gained from this review provide the necessary context and framework for the research methodology and analysis presented in the following chapters.

## **Chapter 3: Research methodology**

### **3.1 Introduction**

Methodology explains the philosophical assumptions supporting the research study (Thomas, 2010). In this section, the research strategy, research philosophy, research method, research approach, data collection and analysis methods, instruments, and ethical considerations are discussed. Furthermore, the justification for the methodologies employed in the study was discussed.

### **3.2 Research Philosophy**

Positivist and interpretive paradigms are paradigms commonly used by researchers, even though other paradigms can be used such as pragmatism (Alharahsheh & Pius, 2019). The main objective of the interpretive methodology is to comprehend phenomena, or the subjective experiences of how subjects under study think, feel, and act in their natural context (Hudson and Ozanne, 1988). This study adopted a positivist paradigm in an attempt to test hypotheses against what was observed. One perspective on how knowledge is produced holds that cause-and-effect correlations are explicit and prevalent, and that behaviour can be foreseen. (Burrell & Morgan, 1979). Positivism is usually referred to as a “science that uses quantitative measurement to standardize the knowledge generating process to improve the accuracy of the model that links and defines the association between the parameters” (Thomas, 2010, p. 294), that is, “its focus is on finding the truth and backing it up with evidence,” says Henning, Van Rensburg and Smit (2004, p. 17).

### **3.3 Research strategy**

A survey research strategy is used in this study instead of other research methods like case studies, archival research, ethnography, grounded theory, narrative inquiry, action research, and experiments. Yin (2017) acknowledges that case studies are best suited for exploratory research or when the context is critical, but they lack the scalability needed for studying broad trends like technology adoption. The deductive approach is typically linked with the survey research approach (Li & Li, 2015), and additionally examines a sample of a group to provide a statistical summary of the trends, thoughts, or sentiments of that group (Creswell J. W., 2017). Bryman (2012) emphasizes that surveys are ideal for capturing broad trends and patterns across populations, which is critical for understanding widespread phenomena like technology adoption. Furthermore, Wright (2005) highlights the advantages of online surveys, including

their ability to reach diverse populations efficiently, which is crucial for studying technology adoption in a digital context.

### **3.4 Research approach**

Deductive and inductive research approaches are the two primary types that are typically applied to the analysis, and the two approaches have different perspectives on the essence of actuality (Soiferman, 2010). “Assertions based on observations or empirical evidence are best presented inductively, while claims that are derived from legal frameworks, regulations, or other generally recognized standards are best expressed using deductive reasoning”, as explained by Trochim (2006). For this study, the deductive approach is adopted, because the investigation contrasts the consequences of existing ideas about the subject of the study with the data collected (Graneheim, Lindgren, & Lundman, 2017).

### **3.5 Research method**

Qualitative research is founded based on subjectivity, whereas the objectivity principle is the foundation of quantitative research (Abusabha, 2003). In this study, quantitative research was used to analyse data that reveal an individual’s experience. The methodology tries to compare and contrast how different communities and groups of people have adopted digital technologies to cut down on food waste in the retail supply chain (Thomas, 2010). The measured constructs and their relationships are then expressed using effect metrics, including correlations, ANOVA, frequency distributions, and other statistical tests. Hittleman and Simon (1997, p. 31) opine that “utilizing experiments, surveys and questionnaires, quantitative research collects data that is updated, tabulated, and quantifiable through the use of statistics”. The study follows a positivist paradigm and a deductive approach, which is more reason to adopt a quantitative method over the qualitative method.

### **3.6 Data collection**

Data were collected using a questionnaire instrument. In many studies, like Alshamaila, Papagiannidis, & Li (2013) and Alam, et al. (2016), the questionnaire instrument was utilized to research the uptake of technology. Thomas (2010) concluded that “compared to interviews, the questionnaire has the benefit of reaching a larger audience”. For this study, the questionnaire (Appendix B) was designed to comply with the TOE framework, consisting of closed questions. The first part covers respondents’ demographics and basic information about the firm. The questions in the final section are used to assess the firm's current implementation of digital technologies for reducing food waste, and the assumed thirteen factors for adopting

digital technologies. The responses were gathered using a 5-point Likert scale, where a score of 1 indicates "strongly disagree," a score of 5 indicates "strongly agree," and a score of 3 indicates "neither agree nor disagree".

According to Bell, Bryman & Harley (2022), the unit of analysis is "the level of social life about which conclusions are drawn and generalizations are made" (p. 61). In this research, the unit of analysis is mid- to senior-level professionals working in the retail supply chain sector, specifically those with expertise in Information Technology (IT) and retail business operations. These individuals were selected as the target audience for the survey because they possess firsthand industry knowledge and domain expertise, making them well-suited to provide meaningful data on the applications of Big Data in retail supply chains. Their roles involve decision-making and strategic planning, which are critical to understanding the challenges and opportunities in implementing these technologies. By focusing on this group, the study aims to capture informed perspectives that reflect real-world practices and experiences within the retail and IT domains.

A nonprobability sampling approach was considered due to limited time and resources. Two non-probability sampling approaches usually used in research to select a sample from a population are purposive and convenience sampling. Convenience sampling is "a type of nonprobability sampling in which individuals from the population of interest are included for the study if they satisfy certain requirements, such as accessibility and availability, proximity to the study site" (Etikan, 2016, p. 2). For this study, both purposive sampling and convenience sampling were considered because of the accessibility and availability of the sample elements, which was also deliberate looking at the participants' knowledge and experience for the most proper utilization of available resources. The other advantage of using this sampling technique is that it is affordable and an easier way to collect data from a larger population size. However, to reduce bias, candidates from different departments and backgrounds were obtained for the final sample list.

### **3.7 Data analysis**

A pilot experiment was carried out with the questionnaire to evaluate, validate, and improve its standard. The data was examined using the Statistical Package for the Social Sciences (SPSS). In this study, quantitative analysis of both quantitative and qualitative data is conducted (Li & Li, 2015). "To find patterns, important trends, and meanings that exist in the data, the organization and categorization of the data is the first step in the data analysis process"

(Thomas, 2010, p. 317). The survey results include frequency tables of responses and demographic information presented as graphs or pie charts. Additionally, it includes descriptive analysis, correlation analysis, and regression analysis. Intent to adopt digital technologies is the only dependent variable of the study, which has thirteen (13) independent variables. The dependent variable class respondents into adopters and non-adopters. In this analysis, useful information that may be used to answer the research questions can emerge. Moreover, a reliability test was run on the response data as per the literature (Thomas, 2010).

### **3.8 Ethical Considerations**

Creswell (1998) stresses that “researchers should always take into account the informants' liberties, rights, values, and preferences”. Ethics consideration also entails trust, protection of the information, anonymity, and trust between the researcher and the respondents (Žukauskas, 2018). Notably, several ethical concerns should be resolved both during and following the research. The study adhered to ethical considerations (reference: HS20/4/32), in line with what the University of the Western Cape ethical council has prescribed as a measure to prevent any potential abuse of the respondents.

Participants in the study were made aware of the goals of the research, their right to privacy, and their right to opt out of the research at any time if they felt uneasy for any reason. Written in the format outlined in Appendix A, the researcher also acquired their informed consent.

The researcher upheld the responsibility to behave with integrity and observed the rights of people directly involved in the research. Data will be disposed of and deleted once the final dissertation is marked and graded.

### **3.9 Chapter summary**

This chapter outlined the methodology of the study, which examined the adoption of digital technologies to reduce food waste in retail supply chains. It covered the research philosophy, strategy, approach, methods, data collection, analysis, and ethical considerations. Adopting a positivist paradigm and deductive approach, the study utilized a quantitative method to gather data via a structured questionnaire, targeting mid- to senior-level IT and retail business specialists in Gaborone, Botswana. The data were analyzed using SPSS to identify trends and relationships, while ethical considerations ensured participant rights and data integrity. The chapter emphasized the rationale behind the chosen methodologies and the importance of ethical research practices.

## **Chapter 4: Research findings and discussion**

### **4.1 Introduction**

This chapter analyses and presents results on the factors that affect the use of digital technology to reduce food waste in the retail supply chain. The findings are primarily based on information gathered from various Gaborone retail supply chain employees. After the presentation of demographic results, the data is analysed and contrasted with the objectives and hypotheses stated in the previous chapters. Statistical analysis like tests of the hypotheses, correlation of the factors and the dependent variable intent, and regression analysis of the conceptual framework were carried out.

### **4.2 Rate of Response**

There were 60 distributed questionnaires altogether and 55 questionnaires were filled and returned. Only five questionnaires were not returned. This is because some of the respondents were out of the offices due to COVID-19, as the fact that data gathering took place while the pandemic was at its worst. The constant lockdowns delayed the process, also causing a decline in the response rate. Nonetheless, a response rate of ninety-two percent (92%) was achieved. This high response rate is due to subsequently reminding the respondents to answer the questionnaires.

However, the study acknowledges certain limitations that may have influenced the findings. First, the sampling process may have introduced bias, as the respondents were primarily mid- to senior-level professionals, potentially excluding perspectives from other levels of the organizational hierarchy. Second, the reliance on self-reported data may affect the reliability of the results, as respondents' answers could be influenced by social desirability bias or subjective interpretations. Additionally, the use of a Likert scale, while useful for measuring attitudes and perceptions, may limit the depth of insights, as it restricts responses to predefined categories and may not fully capture the complexity of participants' views. These limitations highlight the need for caution when generalizing the findings and suggest areas for improvement in future research.

### **4.3 Likert Scale Transformations**

Responses were derived from a five-point Likert scale where Strongly Agree = 5, Agree = 4, More-or-less Agree = 3, Disagree = 2, and Strongly Disagree = 1 was used to rate each item on the questionnaire. For ease of interpretation and analysis of results, a mean transformation

was done to create new variables by merging the variables through the mean function for each respondent. The mean scoring criterion was developed to ascertain the degree to which the factors suggested affect retailers' decision to adopt digital technologies to reduce food waste. Appendix B shows the transformed constructs used for analysis.

#### 4.4 Reliability Test

Cronbach's alpha was used to measure the reliability or internal consistency of the set of questions. The reliability or internal consistency of the series of questions from the questionnaire instrument was evaluated using Cronbach's alpha. The test was designed to see whether the items accurately measured the relevant factors.

Table 2. Reliability Test Statistics

	Cronbach's Alpha	N of Items
Technological	.868	9
Organisational	.927	15
Environmental	.854	9

As a general principle, Cronbach's alpha of 0.70 and higher is considered good, and above 0.80 is considered exceptional. For the technological factor, 9 items revealed Cronbach's alpha = .868, and for organisational factor  $\alpha = .927$  while for environmental factor  $\alpha = .854$ . All of the Cronbach's alphas for the three attributes under consideration are higher than .80, which is regarded as a reliable indicator of the tool's dependability.

#### 4.5 Demographic Profile

The discussion that follows describes the demographic attributes of the survey respondents. General information like the department they work in and prior retail experience were among the features.

Table 3. Distribution of Departments

Department	Valid percentage
Retail	14,55%
Manager	10,91%
Supply Chain	9,09%

Operations	7,27%
Buying	7,27%
FMCG WHOLESAL	5,45%
Purchasing	5,45%
Commercial	3,64%
External candidate	3,64%
Food Retailer	3,64%
Fresh Foods Department	3,64%
General Merchandise	3,64%
Hospitality	3,64%
Human Resources	3,64%
IT	3,64%
Planning	3,64%
Student	3,64%
Sustainability	3,64%
<b>Grand Total</b>	<b>100,00%</b>

It was revealed that for department distribution, the retail department was 14.55 percent, followed by managers with 10.91 percent of the respondents. The supply chain was the third most represented with 9.09 percent of respondents. Buying and operations departments were both at 7.2 percent of the participants. FMCG Wholesale had participants that made up 5.45 percent of the respondents, while the lowest numbers of participants were spread across departments such as Information Technology, Planning, Human Resources, General merchandise, and many more.

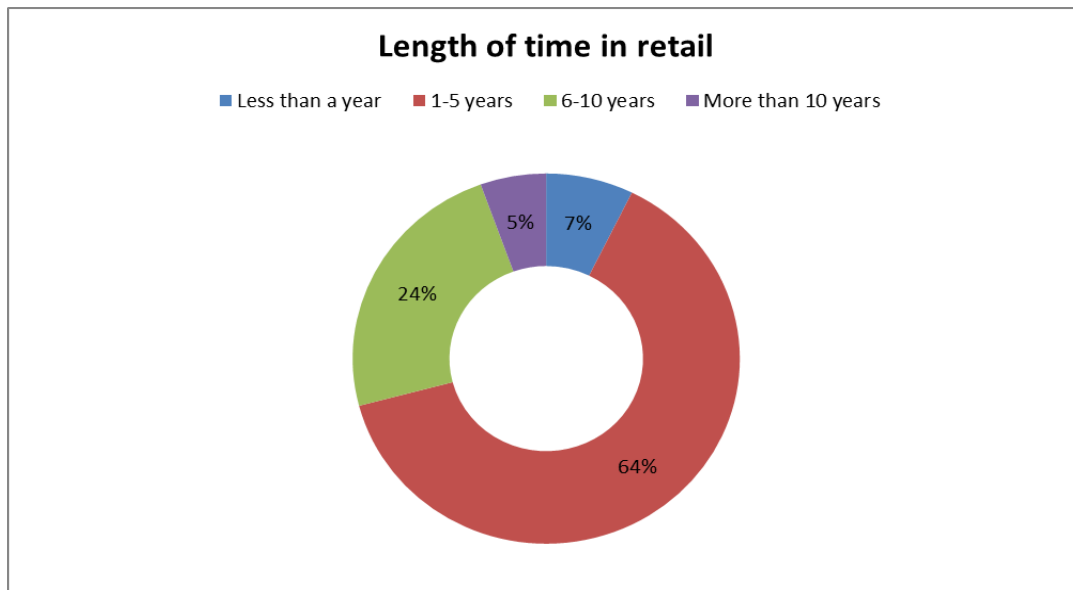


Figure 6. Length of time in retail

According to the findings, the majority of respondents, 64 percent, were people who have been working in retail for a period of 1 to 5 years. This is followed by the 6 to 10 years bracket with 24 percent of the respondents. The lowest groups are people who have been working in retail for less than a year and those with more than 10 years of experience, represented by 7 percent and 5 percent of respondents, respectively.

#### 4.6 TOE Framework Constructs

The TOE Framework was to investigate determinants of retail use of digital technologies to cut down on food waste in the retail supply chain. The respondents were questioned on how they believed environmental, organizational, and technological variables affected retailers' adoption of digital technology to cut down on food waste in the retail supply chain. Respondents had to order the factors on a five-point Likert scale.

##### 4.6.1 Technological factors

The figures below present summaries of the results as per the sub-constructs; technological compatibility, technological complexity, relative advantage and cost. The majority of respondents agreed that technological compatibility, technological complexity, and relative advantage influence the adoption of digital technologies in their respective retail supply chains, while most respondents were neutral about the cost.

#### 4.6.1.1 Technological Compatibility

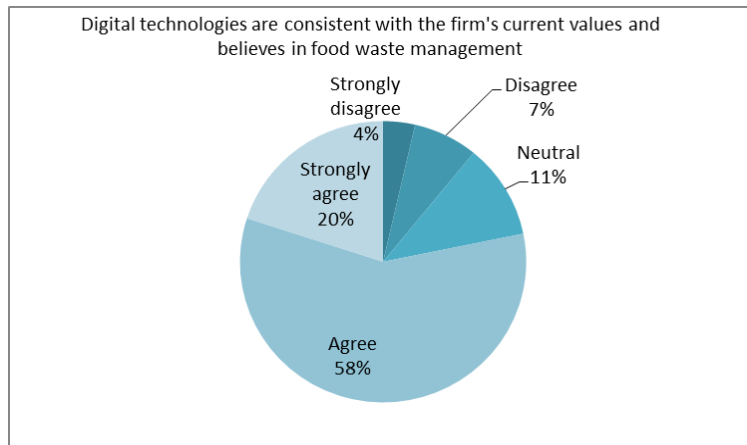


Figure 7. The firm's existing principles and ideals are aligned with digital technologies.

More than half of the responses to this question, or 58 percent, according to the findings, agreed that digital technologies are consistent with the firm's current values and beliefs in food waste management, 20 percent strongly agreed while 11 percent were neutral. Only 7% of respondents disagreed, while 4 percent strongly disagreed that digital technologies are consistent with the firm's current values and beliefs in food waste management.

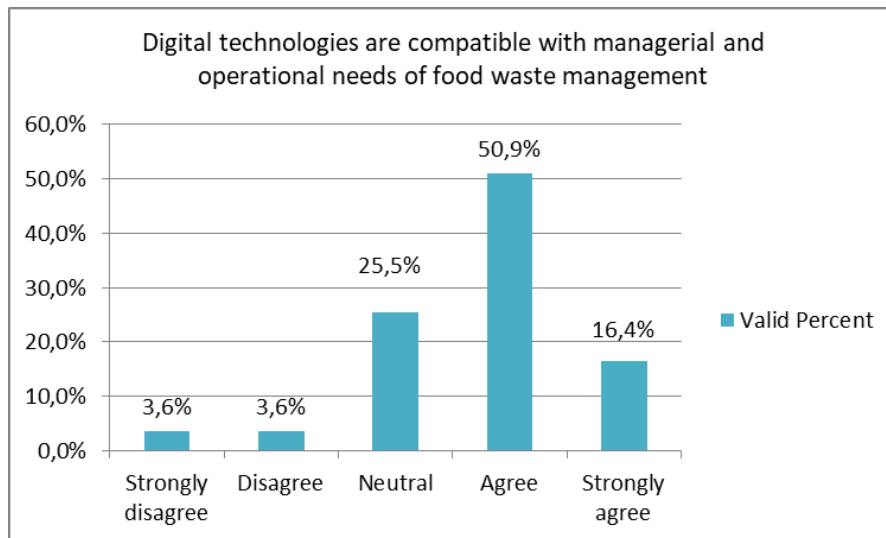


Figure 8. The managerial and operational requirements are compatible with digital technologies.

According to the respondents, digital technologies are compatible with the managerial and operational needs of food waste management as 16.4 percent of respondents strongly agreed, and 50.9 percent agreed. One-fourth of respondents expressed neutrality about whether digital

technologies are compatible with the managerial and operational needs of food waste management, while 7.2 percent of the respondents totally disagreed.

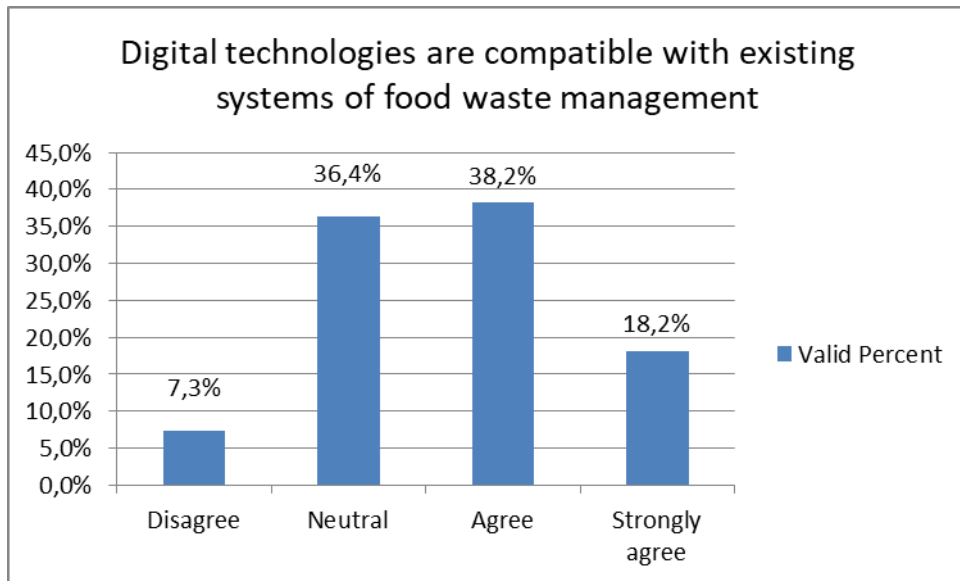


Figure 9. Digital technologies are compatible with existing systems.

The majority of respondents agreed that digital technologies are compatible with existing systems of food waste management within their firm's 38.2 percent agreed while 18.2 percent strongly agreed. About 36 percent of respondents were neutral on whether digital technologies are compatible with existing systems of food waste management within their organisations, while 7.3 percent disagreed with the statement.



Figure 10. Digital technology adoption is determined by previous adoption experience.

Still, under technological compatibility, 54.5 percent of respondents agreed that digital technology adoption is determined by how well other technologies have been adopted in the past. 20 percent of respondents strongly agreed with the statement, while 21.8 percent were neutral. Only 3.6 percent of the respondents disagreed, concluding that previous adoption experience does not influence digital technologies.

**4.6.1.2 Technological Complexity.**

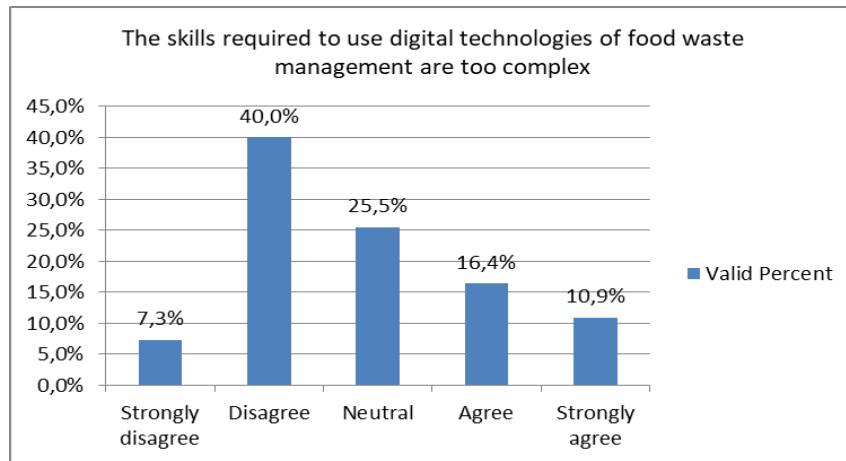


Figure 11. The knowledge needed to apply digital technologies for managing food waste is too complicated.

The statement that the skills necessary to employ digital technology for food waste management are too difficult was refuted by about 47% of the respondents, as 40 percent disagreed while 7.3 percent strongly disagreed. A total of 27.3 percent agree that the skills required to use digital technologies for food waste management are too complex, while 25.5 percent were neutral.

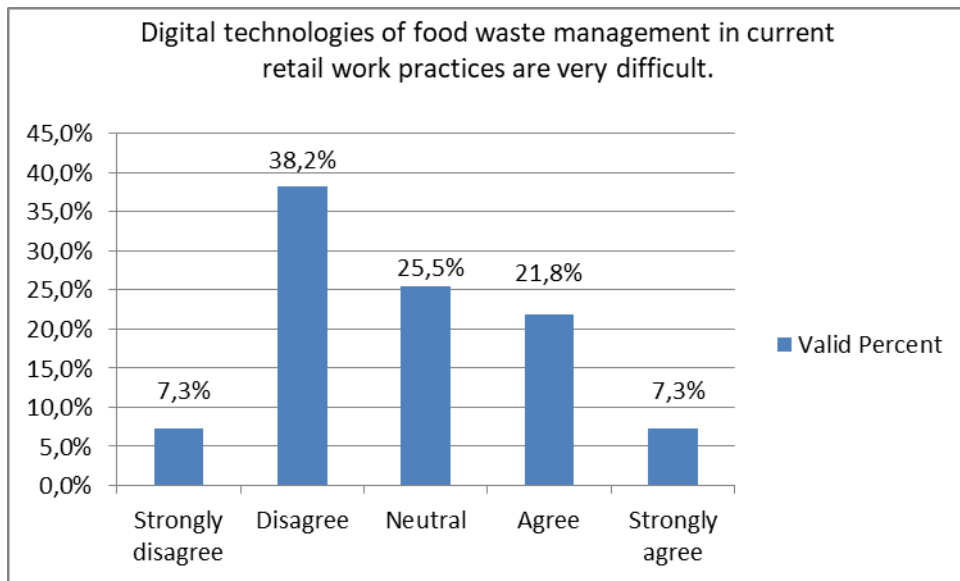


Figure 12. Integration of digital technologies into current retail work practices.

The majority of respondents did not see the complexity of the current digital technologies of food waste management as 38.2 percent disagreed that digital technologies of food waste management in current retail work practices are very difficult. A fair percentage of the respondents were not sure as 25.5 percent of them were neutral. A total of 29.1 percent agreed that digital technologies of food waste management in current retail work practices are very difficult.

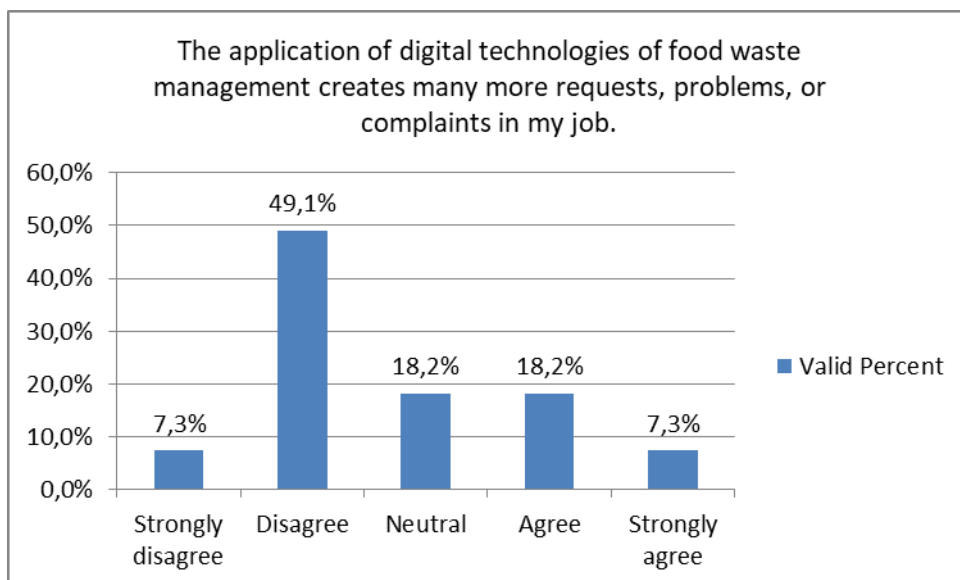


Figure 13. The employees' response to digital technologies adoption

A total of 56.4 percent disagreed with the statement that the application of digital technologies in food waste management creates many more requests, problems, or complaints in their job, while a total of those surveyed concurred. Significantly more respondents (18.2%) expressed neutrality on whether digital technologies of food waste management would complicate their jobs.

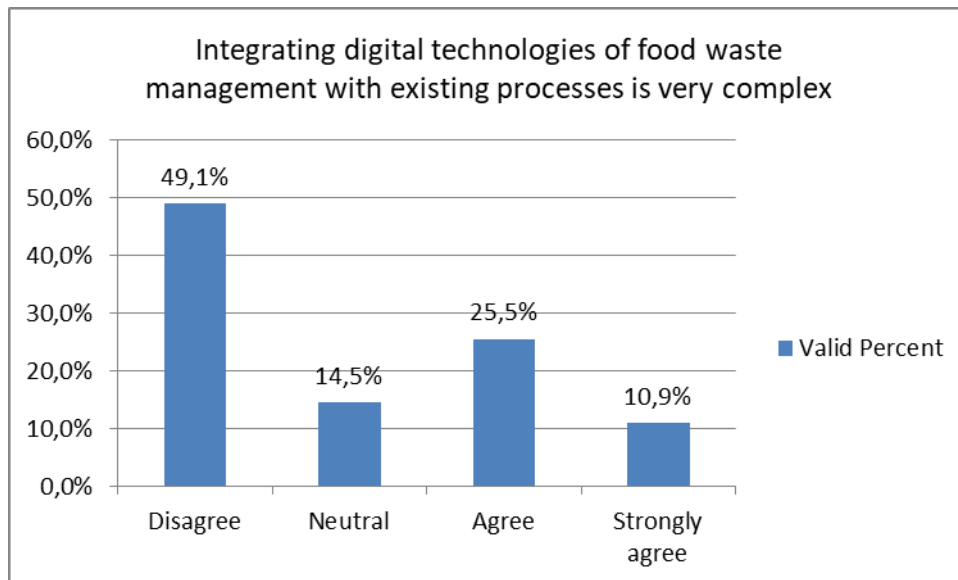


Figure 14. Integrating digital technologies with existing processes.

The majority of respondents disagreed that integrating digital technologies of food waste management with existing processes is a very complex process, as 49.1 percent disagreed. A total of 36.4 percent agreed that integrating digital technologies of food waste management with existing processes is very complex, while 14.5 percent were neutral.



Figure 15. Usability and management of digital technologies.

A total of 41.8 percent agreed that digital technologies of food waste management are easy to use and manage, while 14.5 percent disagreed. The majority, 43.6 percent, were neutral on whether digital technologies of food waste management are easy to use and manage or not.

#### 4.6.1.3 Relative Advantage

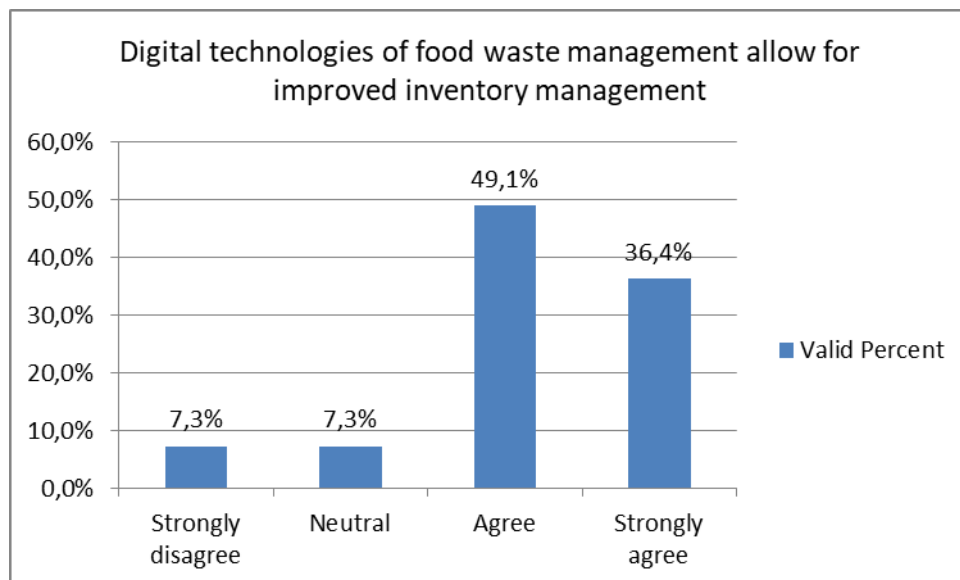


Figure 16. Digital technologies and inventory management.

The majority of respondents agreed that digital technologies of food waste management allow for improved inventory management, as a total of 85.5 percent agreed. Equal numbers of

respondents, at 7.3 percent respectively, were either neutral or strongly disagreed with the statement.

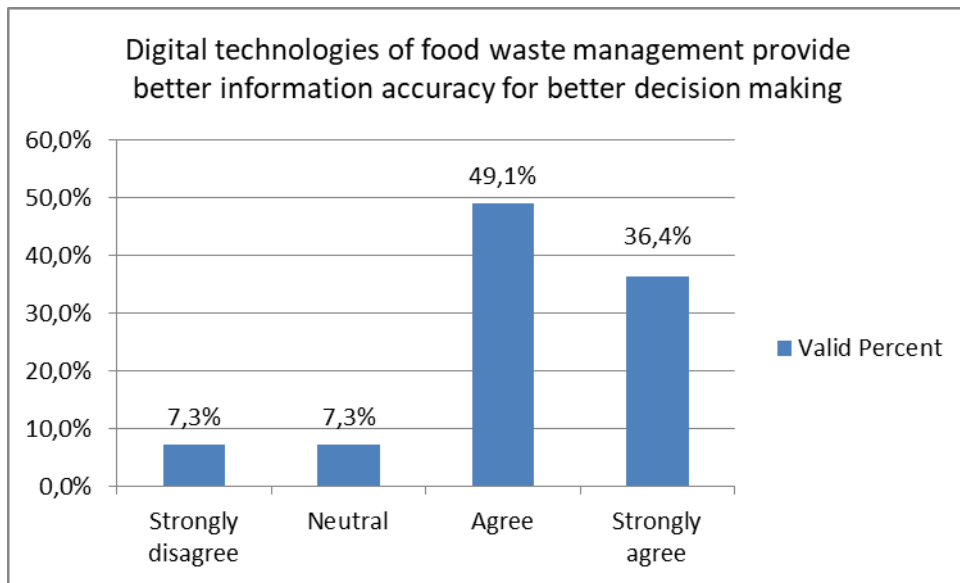


Figure 17. Digital technologies and decision-making.

The majority of respondents, or 85.5 percent, allude to the claim that digital technologies for managing food waste offer more accurate information for better decision-making. A total of 7.3 percent disagreed, while another 7.3 percent were neutral.

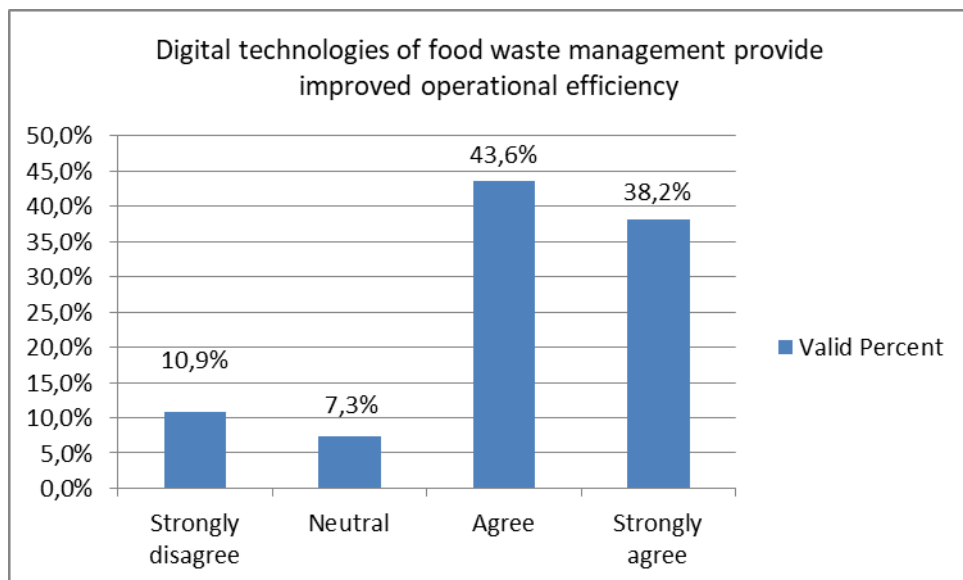


Figure 18. Digital technologies and operational efficiency.

A total of 81.8 percent agreed that digital technologies for food waste management provide improved operational efficiency, while 10.9 percent disagreed with the statement. Only 7.3 percent of respondents were neutral.

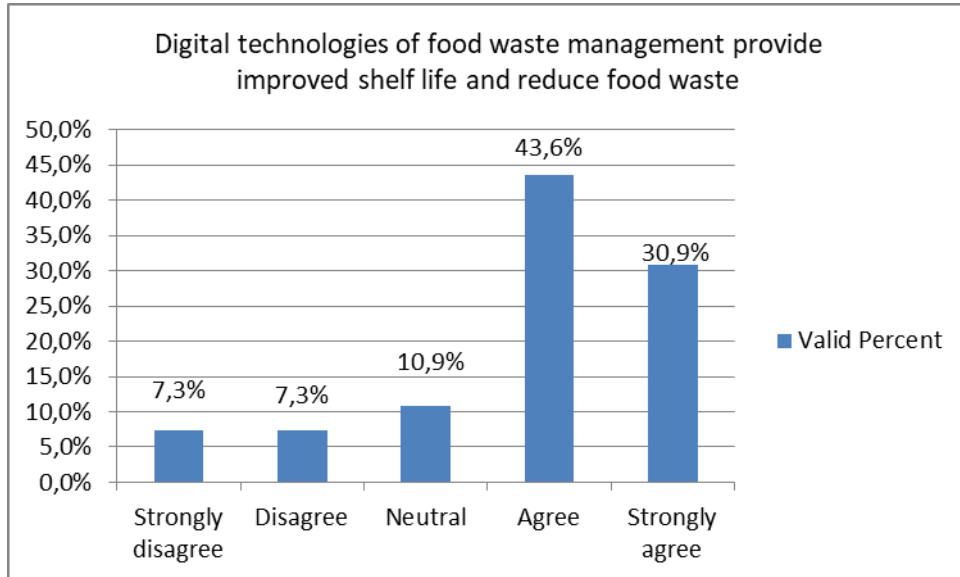


Figure 19. Digital technologies and shelf life.

A total of 74.5 percent of respondents agreed that digital technologies of food waste management provide improved shelf life and reduce food waste, whereas 14.6 percent disagreed. The remaining 10.9 percent were not sure.

**4.6.1.4 Cost**

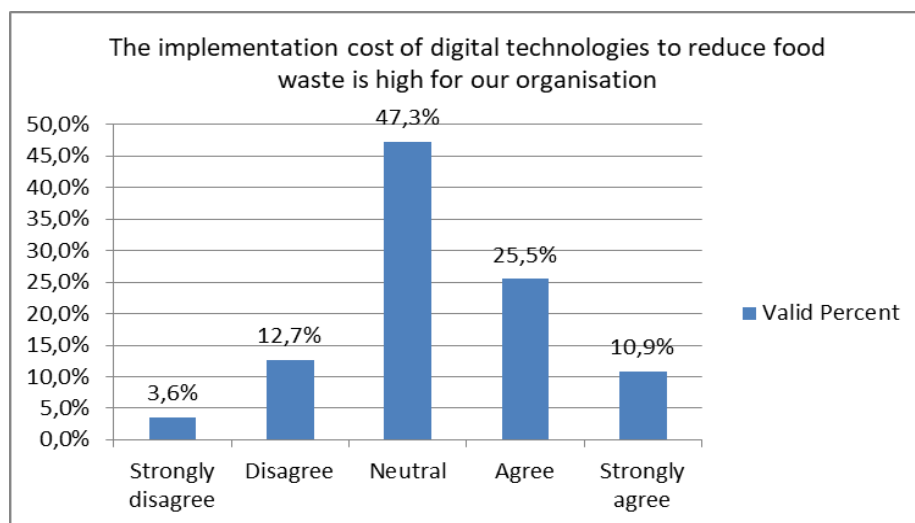


Figure 20. The implementation cost of digital technologies to reduce food waste is high for our organisation.

The survey's findings show that 47.3 percent of respondents, or the majority, were neutral regarding whether the implementation cost of digital technologies to reduce food waste in their organisation is high or not. However, a total of 36.4 percent of respondents agreed that the cost of implementation is high for their organisation, while 16.3 percent disagreed with the statement.

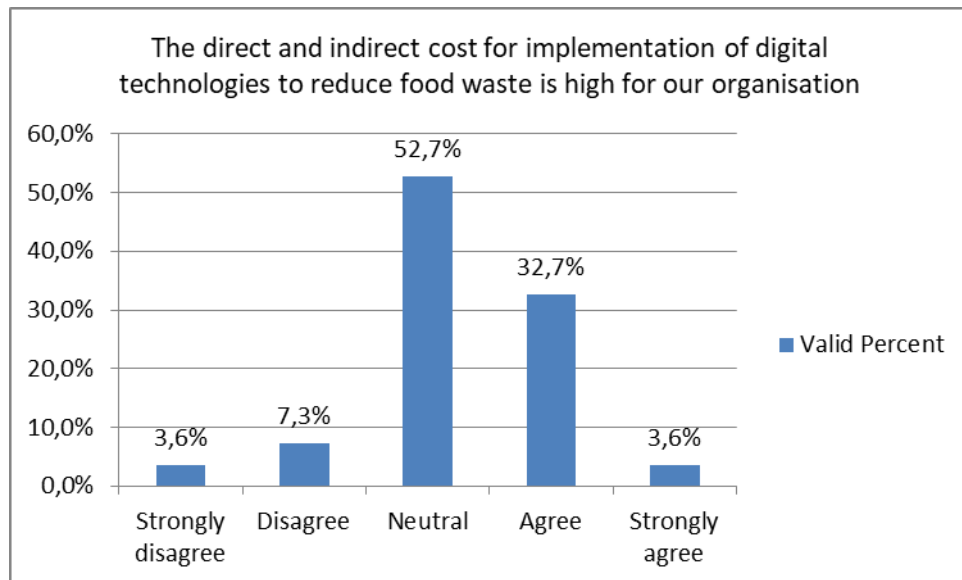


Figure 21. The direct and indirect cost of implementation of digital technologies.

Regarding the expenses associated with implementing digital technologies to decrease food waste, both direct and indirect, 36.3 percent of the respondents agreed that the costs are high for their organisation. Only 10.9 percent disagreed with the statement, while the majority, 52.7 percent, were neutral.

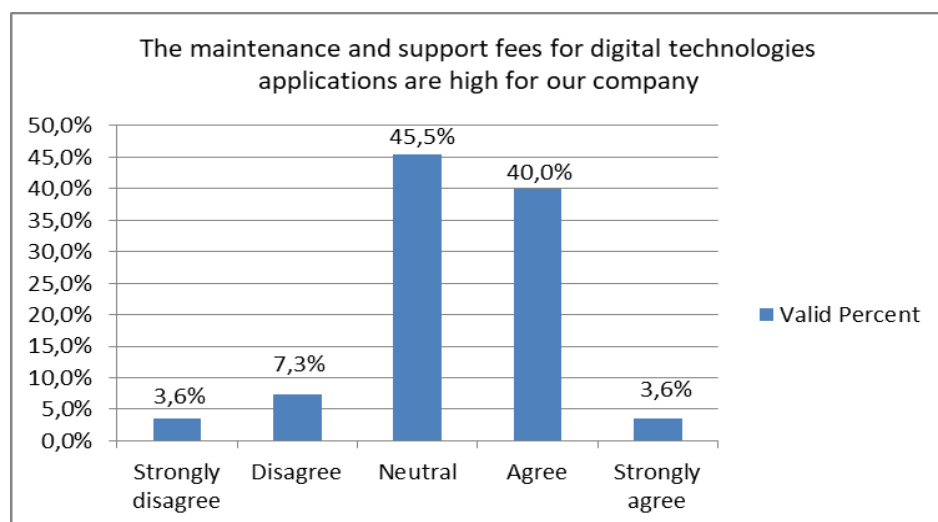


Figure 22. The maintenance and support fees for digital technologies applications.

The majority of respondents, 45.5 percent, had no opinion about how expensive it would be for their business to maintain and support applications using digital technologies. The maintenance and support fees are expensive, according to 43.6 percent of respondents, while 10.9 percent disagreed.

#### 4.6.2 Organisational factors

The second construct of organisational factors that influence retailers to adopt digital technologies to reduce food waste in the retail supply chain is presented below. The results have been summarised in the figure as per the constructs; size, top management support, expertise, organisational innovativeness and technological readiness. The majority of respondents agreed that in their respective organizations, top management support, size, expertise, technological readiness and organisational innovativeness influence digital technologies adoption.

##### 4.6.2.1 Support from Top management

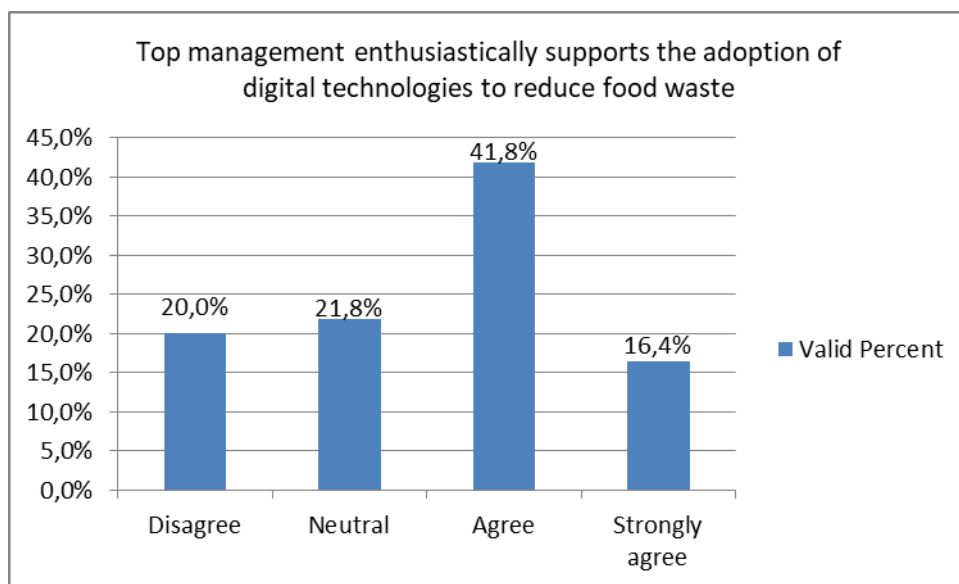


Figure 23. Top management is fervently in favour of using digital technologies to cut down on food waste.

The majority, a total of 58.2 percent of respondents, agreed that top management favours the adoption of digital technologies to cut down on food waste in their organisations, while 20 percent disagreed. About 21 percent of the respondents were neutral.

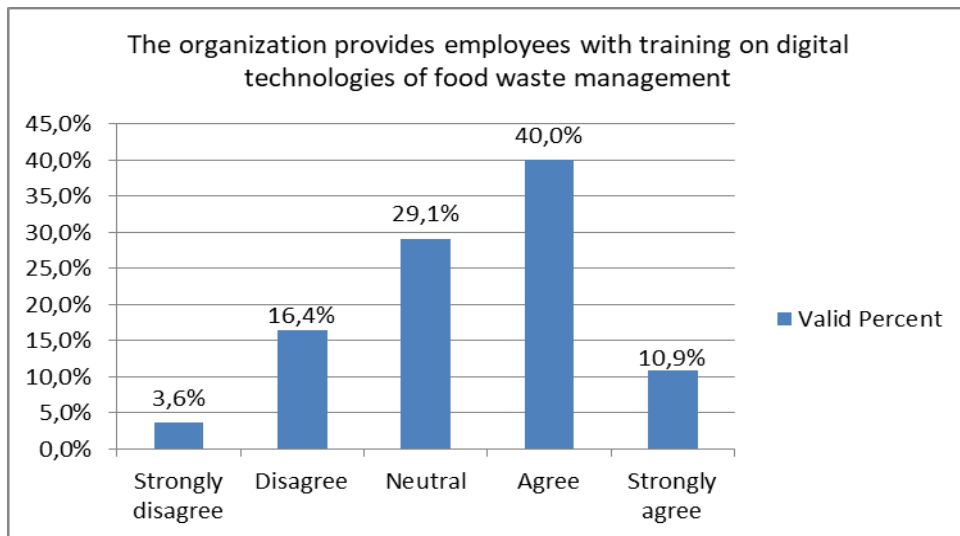


Figure 24. The organization provides employees with training on digital technologies for food waste management

The survey's findings demonstrate that the majority, 50.9 percent, concurred that their respective organisations provide employees with training on digital technologies of food waste management. This isn't the same for all respondents about 20 percent of them disagreed, and about 29 percent were neutral.

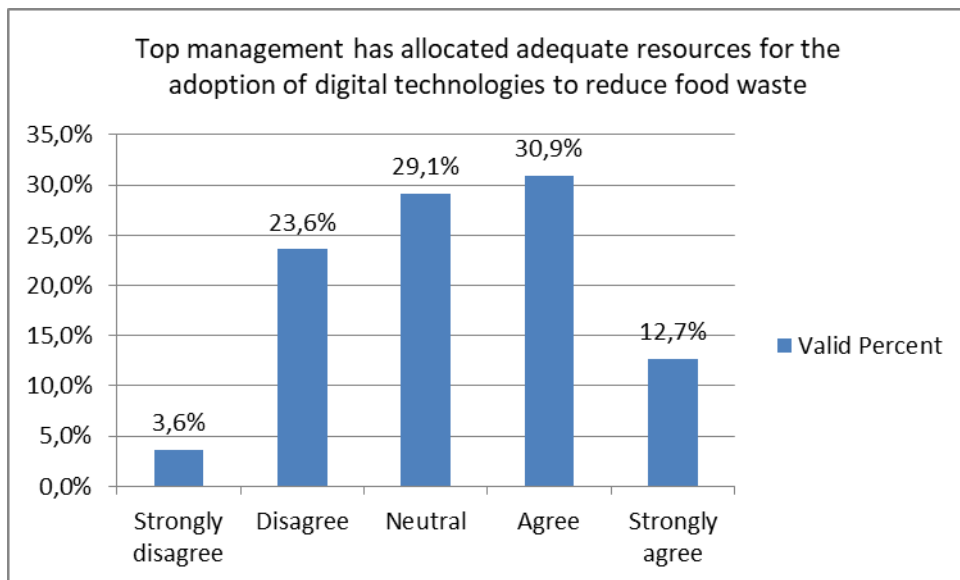


Figure 25. The senior management has allocated enough resources to support the implementation of digital technologies to cut down on food waste.

About 30 percent of the respondents agreed that top management has allocated adequate resources for the adoption of digital technologies to reduce food waste, while about 12

percent strongly agreed. Only 3.6 percent strongly disagreed while 23.6 percent disagreed with the statement. A significant percentage, 29.1 percent, were neutral.

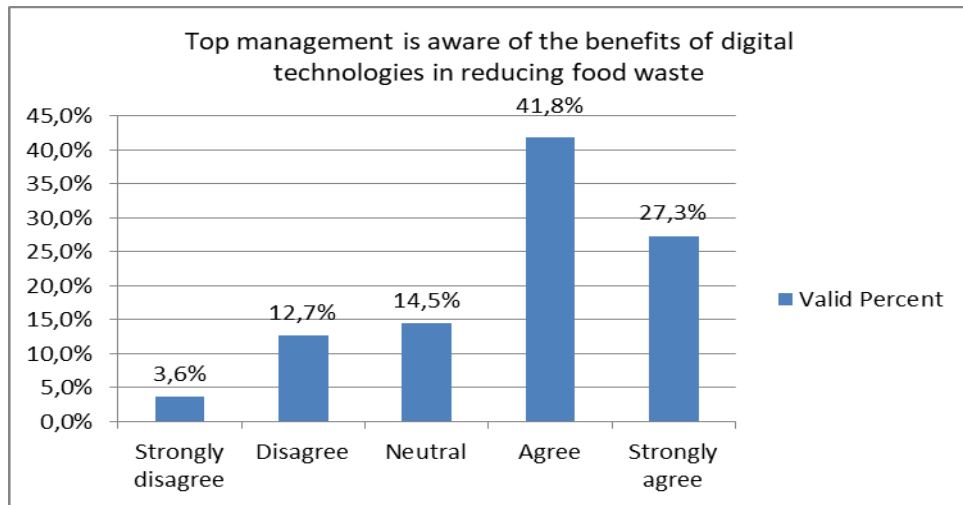


Figure 26. The highest levels of management are aware of how digital technologies may help reduce food waste.

The majority, a total of 69.1 percent of the respondents agreed that the highest levels of management are aware of how digital technologies may help reduce food waste, while 16.3 percent disagreed. Furthermore, 14.5 percent of the respondents were neutral.

#### 4.6.2.2 Size

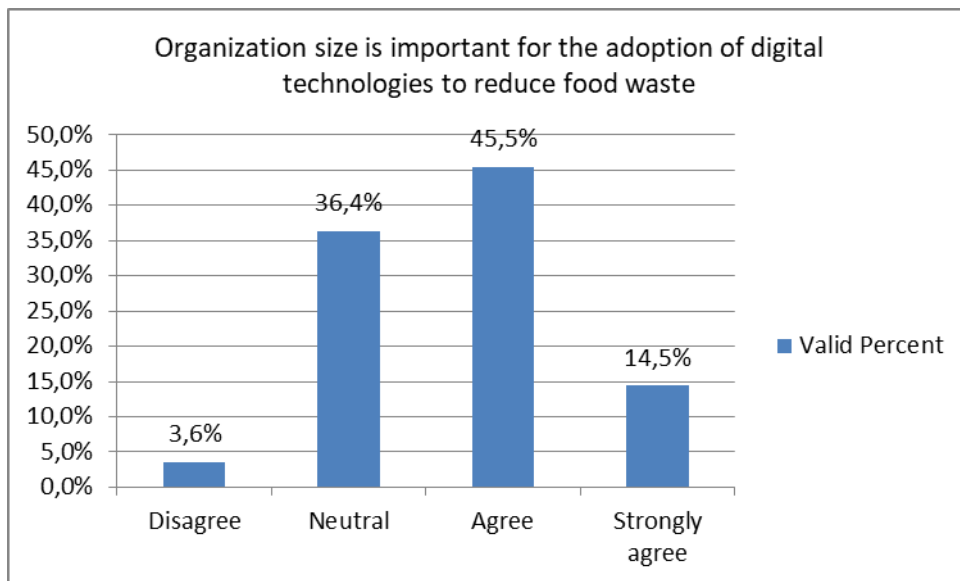


Figure 27. The importance of organizational size.

More than half of those surveyed, or 60%, concurred that the size of the firm matters when thinking about using digital technology to reduce food waste, while only 3.6 percent disagreed. A significant number of respondents, 36.4 percent, were neutral.

#### 4.6.2.3 Expertise

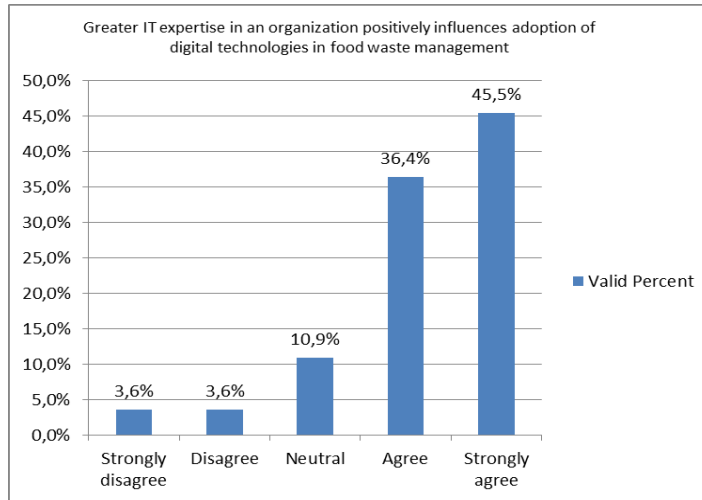


Figure 28. The use of digital technology for food waste management is positively influenced by an organization's level of IT knowledge.

The majority of respondents (81.9%) concurred that having more IT experience inside an organization influences the adoption of new digital technologies in food waste management, while only 7.2 percent disagreed. The remaining 10.9 percent were neutral.

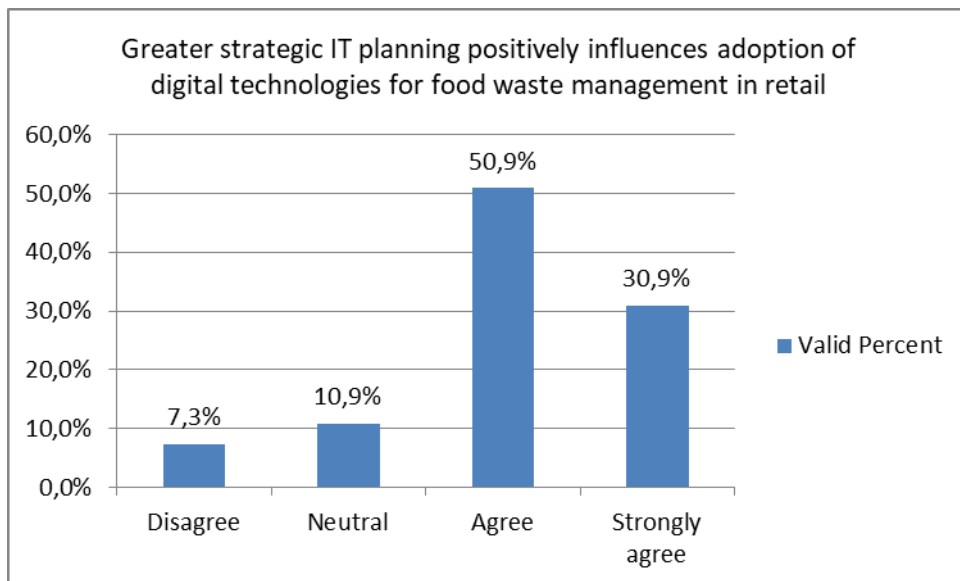


Figure 29. Digital technologies and Strategic IT planning.

The survey's findings demonstrate that 81.8 percent of respondents agreed, with only 7.3 percent disagreeing, that better strategic IT planning influences the use of digital technologies to minimize food waste in retail. 10.9 percent of respondents were neutral, which is a significant percentage.

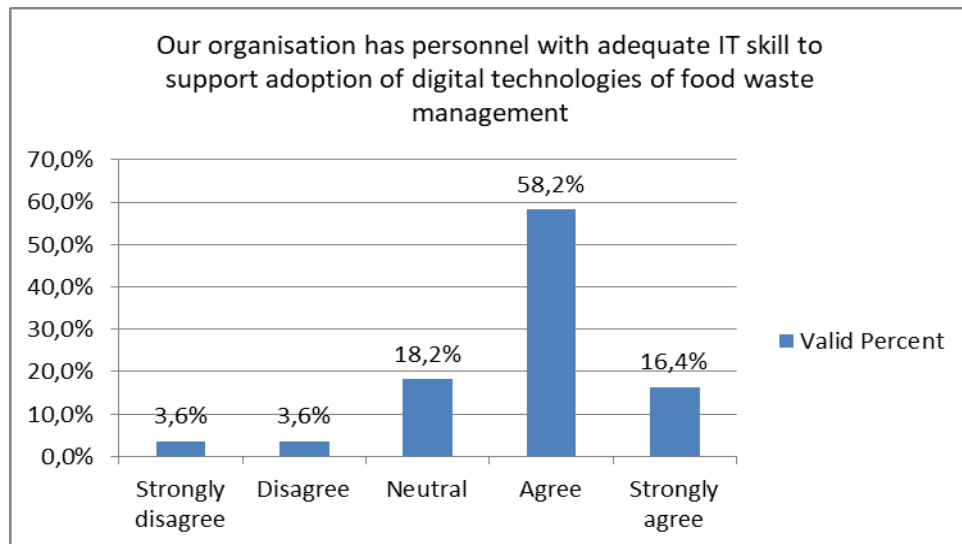


Figure 30. Digital technologies and adequate IT skills

From the results, 74.6 percent of respondents agreed that their organizations' staff members have the necessary IT abilities to facilitate the adoption of new technologies, whereas 7.2 percent disagreed. 18% of respondents were undecided about whether their organizations had qualified staff.

#### 4.6.2.4 Technological readiness

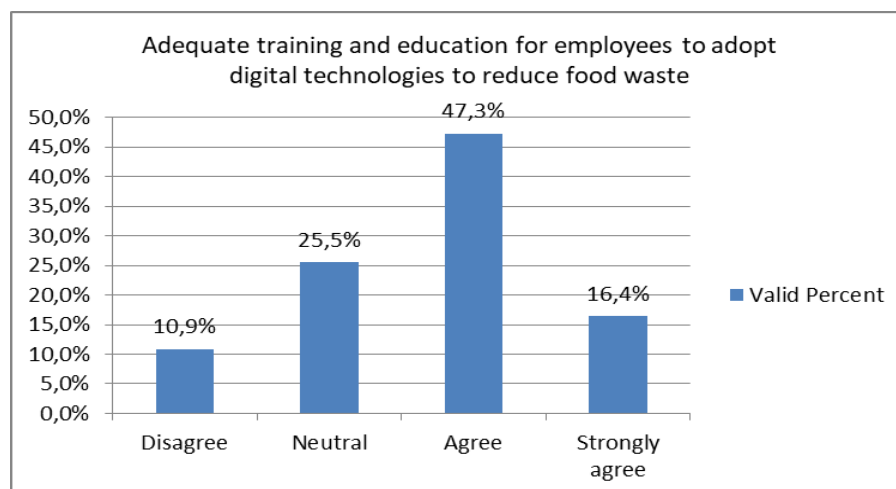


Figure 31. Digital technologies and relevant education/training

According to the survey's findings, the majority of participants (63.7%) believed that there is sufficient and relevant education and training for staff members to facilitate the uptake of digital technologies to reduce food waste in their respective organisations, while 10.9 percent disagreed. A significant number of 25.5 percent of the respondents were neutral on whether the training and education for employees were adequate.

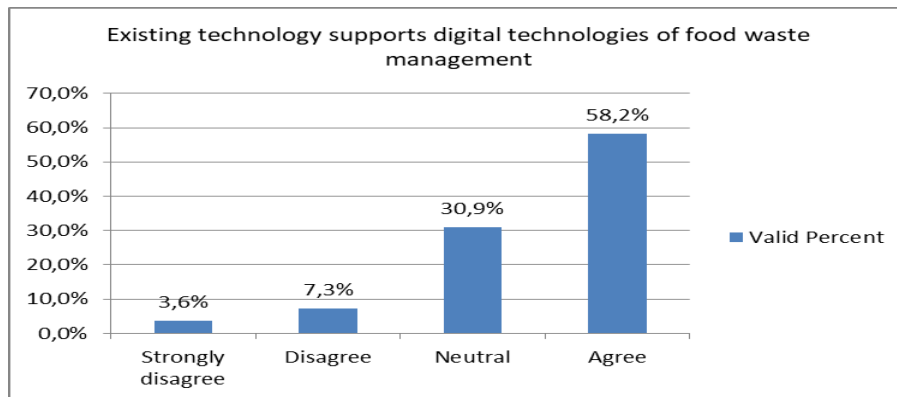


Figure 32. Existing technology supports digital technologies of food waste management.

A large number of the respondents; 58.2 percent, agreed that the existing technology within their organisations supports digital technologies for food waste management, while only 10.9 percent disagreed. The remaining 30.9 percent are respondents who were neutral.

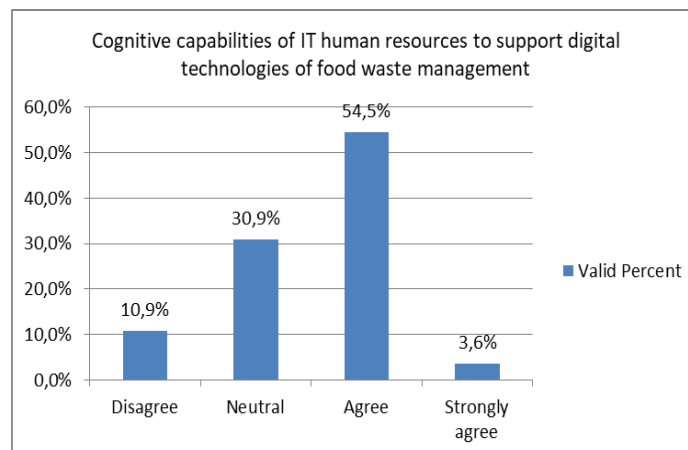


Figure 33. Cognitive capabilities of IT human resources to support digital technologies of food waste management

Of most respondents, 58.1 percent agreed that their organisations have the IT skills and mental abilities to support digital technologies of food waste management, while 10.9 percent of those

interviewed were in disagreement. There was 30.9 percent of participants who were undecided, which is a sizable number.

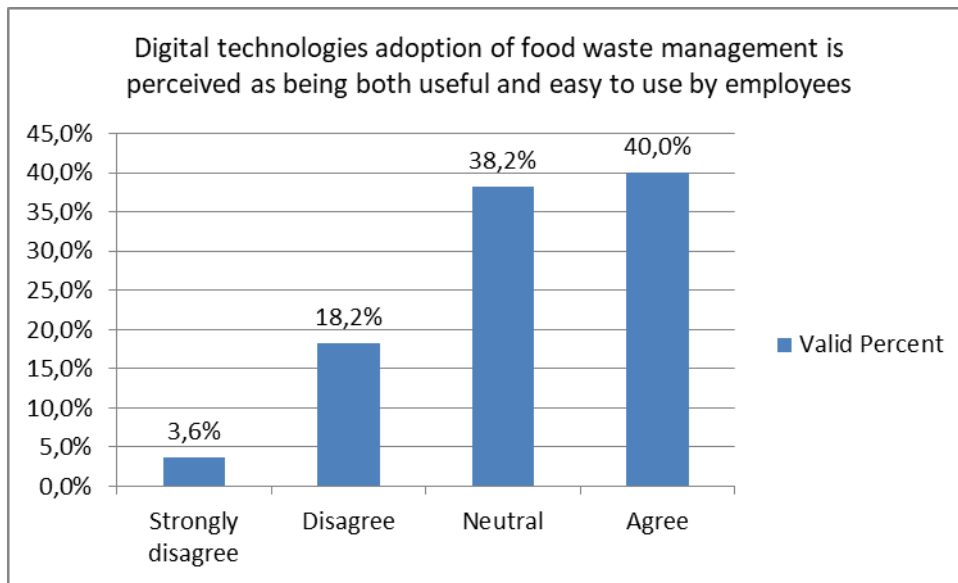


Figure 34. Employees’ perceptions on digital technologies’ adoption of food waste.

The majority of respondents, 40 percent, concurred that employees view the implementation of digital technology in food waste management as being both valuable and simple to use, while 21.8 percent disagreed. A significant 38.2 percent of respondents neither agreed nor disagreed.

#### 4.6.2.5 Organisational innovativeness

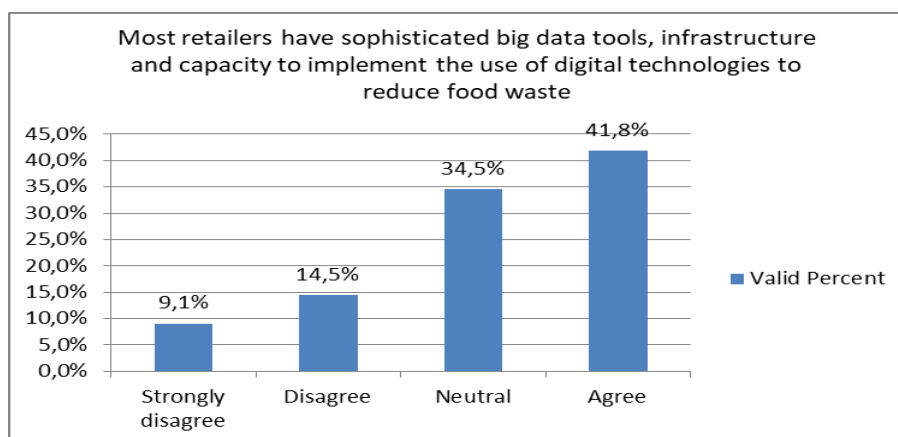


Figure 35. Most retailers have sophisticated big data tools, infrastructure, and the capacity to implement the use of digital technologies to reduce food waste.

The results show that most of the respondents, 23.6 percent of the respondents disagreed, while 41.8 percent claimed that most retailers have the infrastructure, sophisticated big data tools, and capacity to employ digital technologies to minimize food waste. About 34 percent of respondents were neutral on this factor.

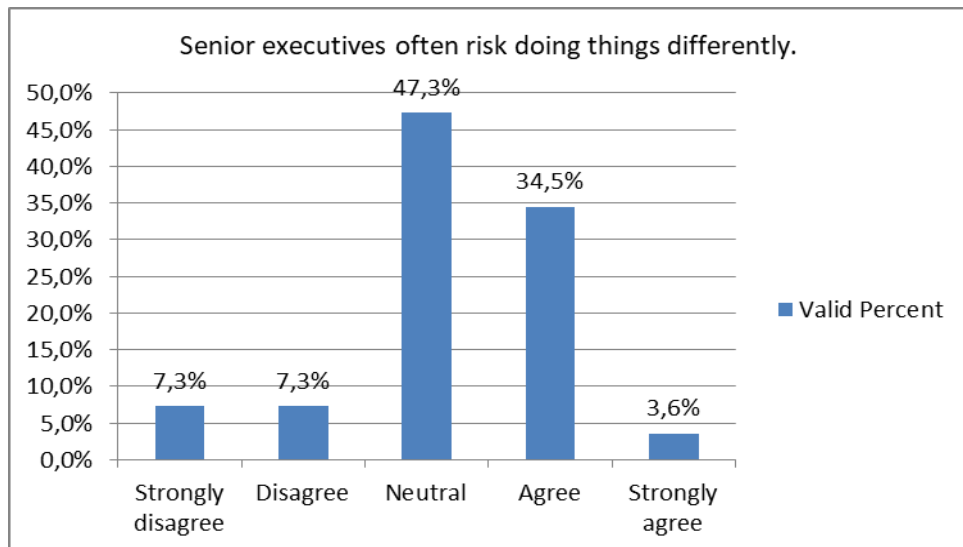


Figure 36. Senior executives and risk.

The majority of respondents, 47.3 percent, were divided on the question of whether senior executives frequently take a chance on doing things a different way. Nevertheless, 38.1 percent of respondents agreed, and just 14.6 percent disagreed, that senior executives do indeed frequently take risks.

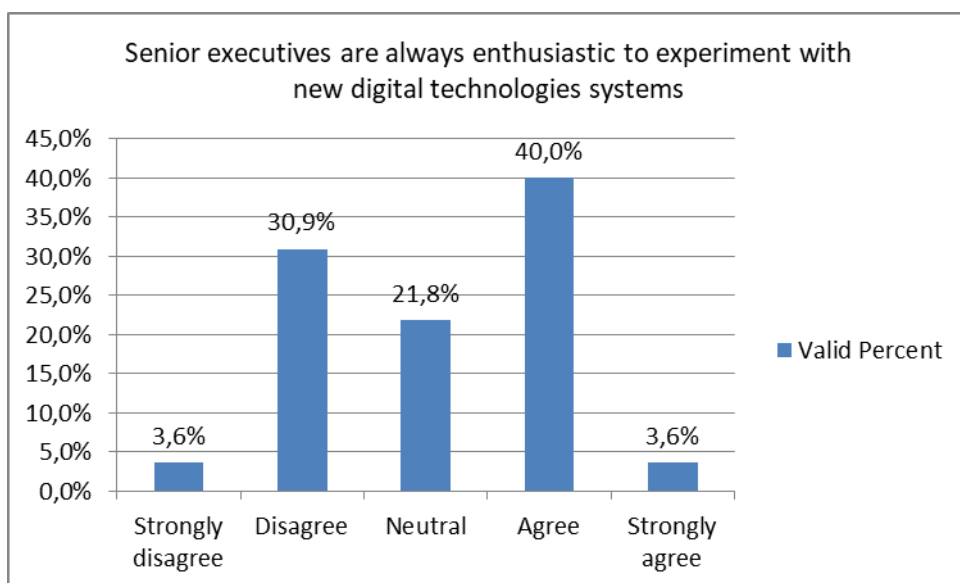


Figure 37. Top leadership eagerness on new technologies.

According to the poll results, top executives are consistently eager to experiment with advanced digital technology solutions (43.6%). A significant 34.5 percent of those surveyed strongly disagreed, and 21.8 percent were neutral.

### 4.6.3 Environmental factors

The third construct deals with environmental factors that influence the implementation of digital technologies to minimize food waste in the retail supply chain. The results have been summarised in tables as per the constructs; competitive pressure, customer, technology vendor support, and social community. The respondents agreed that within their organizations, competitive pressure, customers, technology vendor support and social community all play a role to a certain extent in their intent to adopt digital technologies to reduce food waste.

#### 4.6.3.1 Competitive pressure

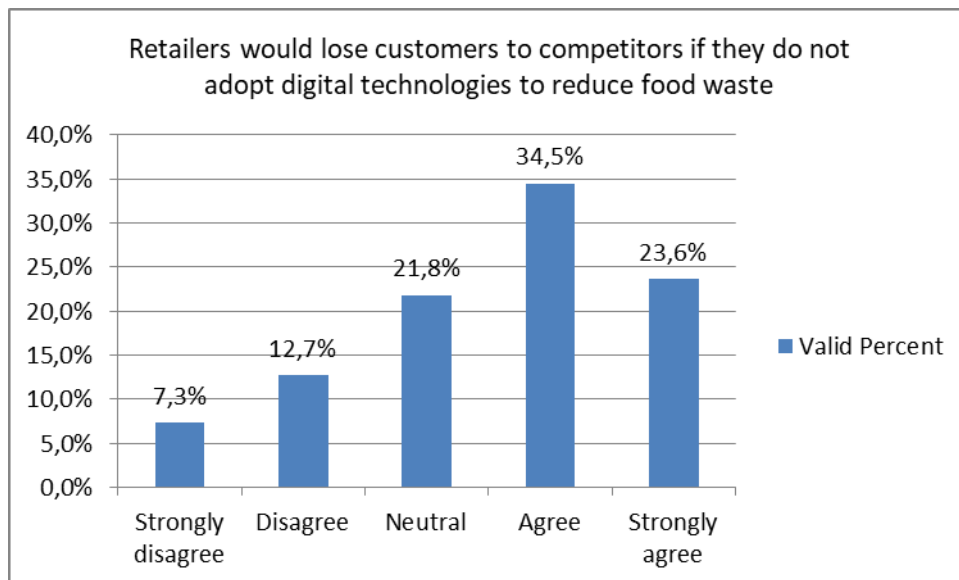


Figure 38. Consequences of failure to adopt.

From the survey results, 58.1 percent of respondents agreed that retailers would lose customers to competitors if they do not adopt digital technologies to reduce food waste, however, 20 percent of respondents disputed the assertion. Neutral respondents made up about 21 percent of the total.

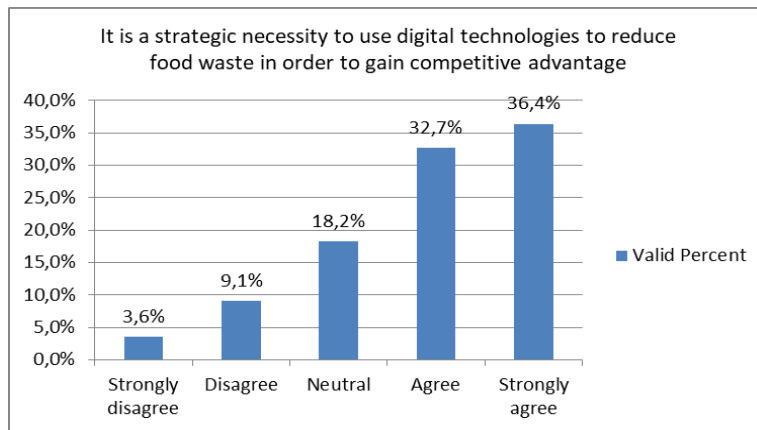


Figure 39. Adoption of digital technologies as a strategic necessity to gain a competitive advantage.

Although 12.7 percent of respondents disagreed, the majority, 69.1 percent, believed that using digital technologies to reduce food waste is a strategic imperative in order to achieve a competitive edge. Neutral replies made up about 18 percent of the total.

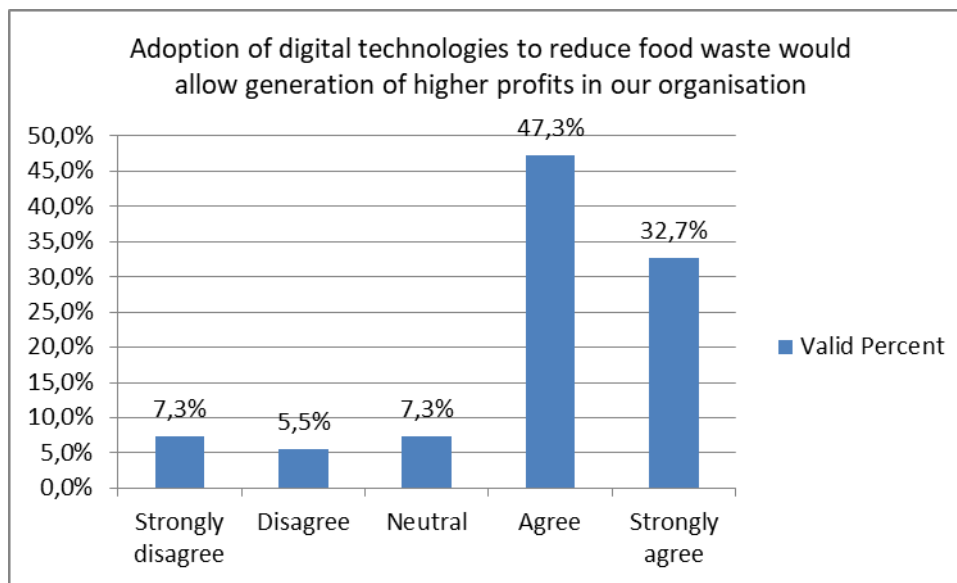


Figure 40. The use of digital technologies to decrease food waste would enable higher profits.

A total of 80 percent of respondents agreed that the use of digital technologies to decrease food waste would allow the generation of higher profits in their organisation, while 12.8 percent disagreed. Only 7.3 percent were neutral.

#### 4.6.3.2 Customer

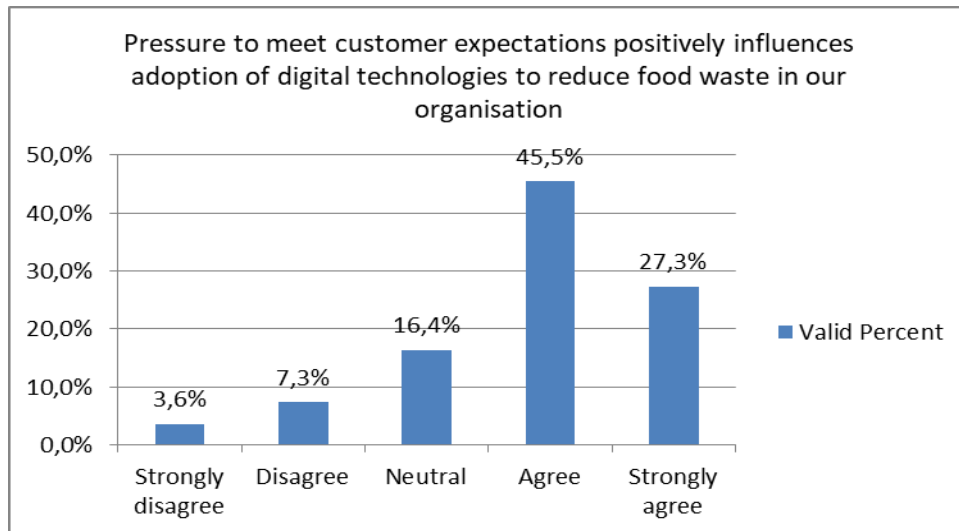


Figure 41. Pressure to meet customer expectations.

A majority of those interviewed (72.8%) concurred that the need to satisfy consumer expectations promotes the deployment of digital technology to minimize food waste in their organizations in a favourable way. On the other hand, 16.4 percent of respondents were ambivalent, and a total of 10.9 percent did not especially agree with the statement.

#### 4.6.3.3 Technology vendor support

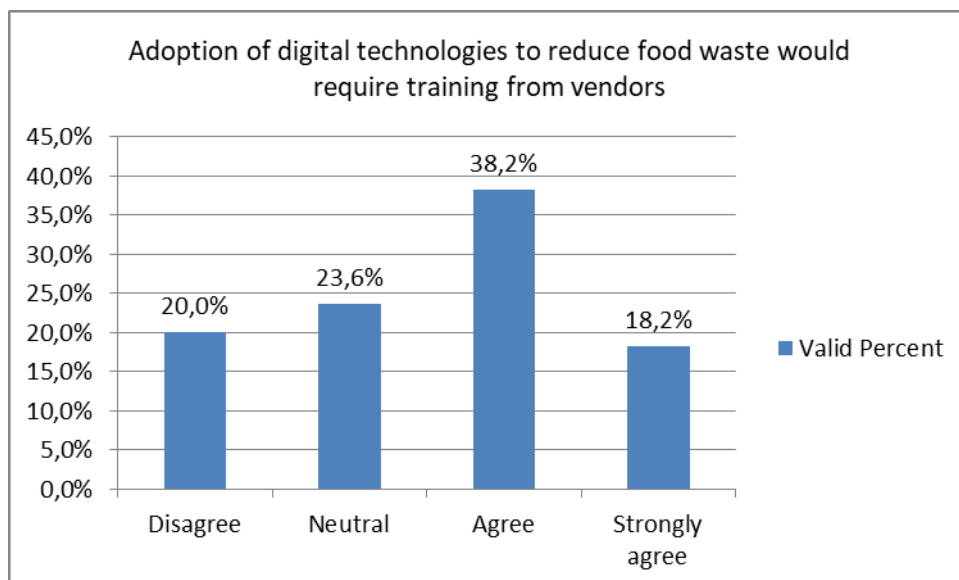


Figure 42. Training from vendors.

A total of 56.4 percent of respondents agreed that sellers would need to be trained before using digital technologies to decrease food wastage, while 20 percent disagreed. Neutral respondents made up about 23 percent of the total.

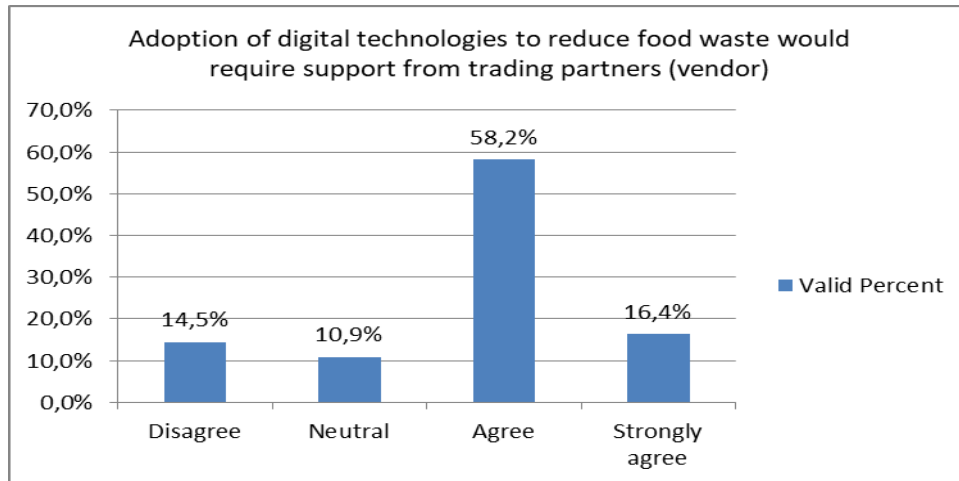


Figure 43. Support from trading partners (vendors).

74.6 percent of respondents agreed with the assertion, while 14.5 percent disagreed, that vendors would need to encourage the use of digital technology to prevent food waste through support. Neutral responses made up the remaining 10.9 percent.

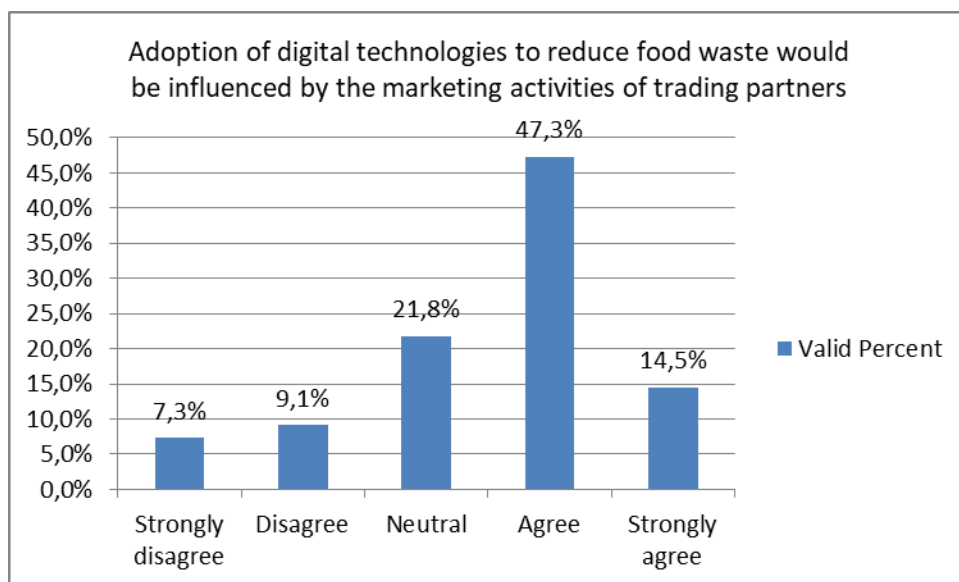


Figure 44. Influence from the market.

The survey results show that 61.8 percent of the respondents agreed that trading partners' marketing efforts would have an impact on the adoption of digital technology to minimize food waste, while 16.4% disagreed. 21.8 percent of respondents overall expressed neutrality.

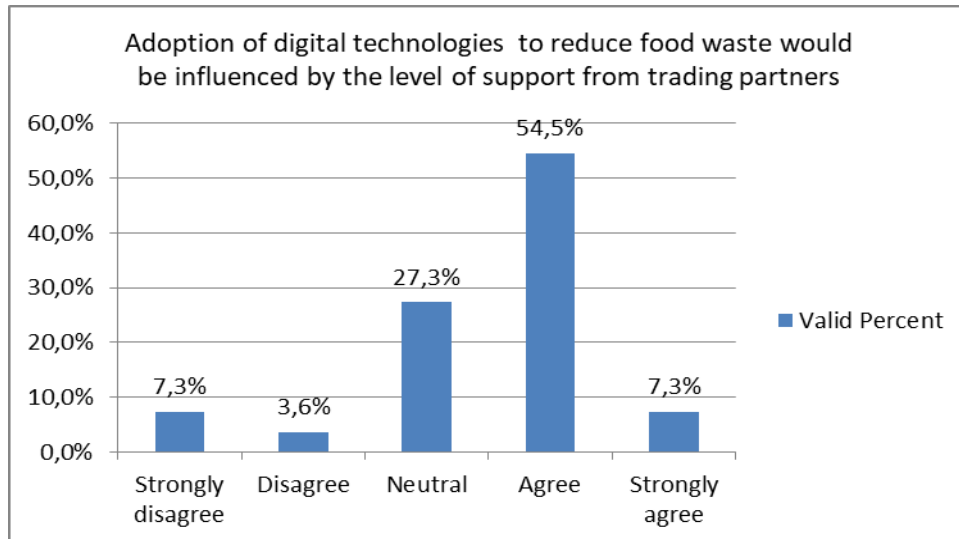


Figure 45. The degree of assistance from business partners.

The study found that 61.8 percent of respondents agreed that the degree of support from business partners will influence the use of digital technologies to minimize food waste, while a final tally of 10.9 percent of participants disagreed. Additionally, the remainder 27.3% were undecided as to whether or not the level of support from business partners will affect the adoption of digital technologies to minimize food waste.

#### 4.6.3.4 Social community

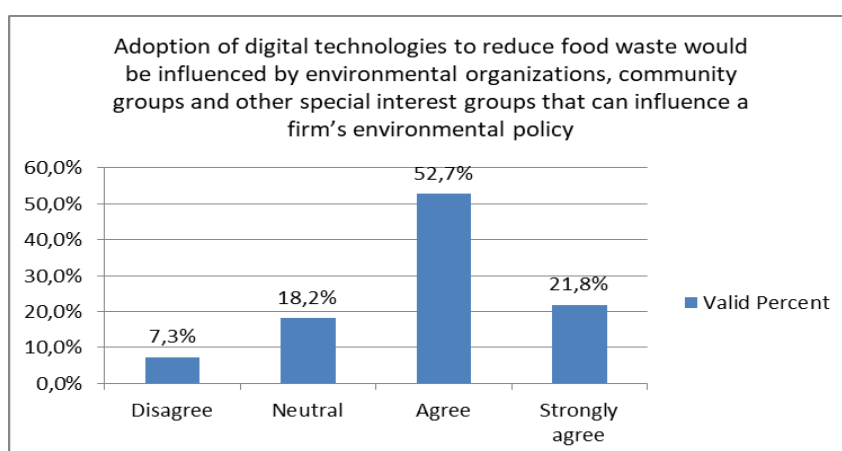


Figure 46. Impact of environmental organizations, community groups, and other special interest groups.

A total of 74.5 percent of respondents believed that community groups, environmental organizations and other pressure groups that might affect a firm's environmental sustainability policy will have an influence on the use of digital technology to minimize food waste, while 7.3 percent disagreed. Neutrality made up the remaining 18.2 percent.

#### 4.6.4 Proposed Framework

The development of a framework to help retailers implement digital technology to minimize food waste in the retail supply chain was the fourth research objective.

##### 4.6.4.1 Principal Factor Analysis

This was done in an effort to identify the elements that have a significant impact on the acceptance of digital technologies to cut down on food waste in the retail supply chain. As Table 4 shows, only factors with Eugene values greater than one should be retained. The three factors cumulatively account for 70.386 percent of the variability in the variables.

Table 4. Principal Factor Analysis

Total Variance Explained <sup>a</sup>						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.876	45.203	45.203	5.876	45.203	45.203
2	2.134	16.414	61.617	2.134	16.414	61.617
3	1.14	8.769	70.386	1.14	8.769	70.386
4	0.988	7.603	77.989			
5	0.746	5.736	83.725			
6	0.555	4.272	87.997			
7	0.485	3.728	91.725			
8	0.396	3.05	94.775			
9	0.327	2.514	97.288			
10	0.135	1.035	98.324			
11	0.12	0.924	99.248			
12	0.067	0.516	99.764			
13	0.031	0.236	100			
Extraction Method: Principal Component Analysis.						
a. Only cases for which Intent = 1 are used in the analysis phase.						

##### 4.6.4.2 Correlation Results

Intent was used as the dependent variable, and correlations between components were determined. Inter-correlations between the constructs were also examined in further detail.

Table 5. Correlations

Correlations					
		Technology	Organisation	Environment	Intent
Technology	Pearson Correlation	1	.372**	.488**	0.2
	Sig. (2-tailed)		0.006	<.001	0.146
	N	54	54	54	54
Organisation	Pearson Correlation	.372**	1	.628**	0.044
	Sig. (2-tailed)	0.006		<.001	0.748
	N	54	55	55	55
Environment	Pearson Correlation	.488**	.628**	1	0.079
	Sig. (2-tailed)	<.001	<.001		0.565
	N	54	55	55	55
Intent	Pearson Correlation	0.2	0.044	0.079	1
	Sig. (2-tailed)	0.146	0.748	0.565	
	N	54	55	55	55

\*\* . Correlation is significant at the 0.01 level (2-tailed).

The findings demonstrate a positive correlation between the constructs. This indicates that environmental, organizational, and technological aspects are positively correlated with one another. According to the findings, there is a weak association (Pearson Correlation of 0.628) between the environment and the organization. At alpha 0.05, the association is significant. Technology and Organization show a modest link, with significance levels of 0.006, which is less than alpha 0.05. Technology and the environment show a moderate association ( $r = 0.488$ ,  $p < 0.05$ ), which is significant. The connections between all of the constructs and the dependent variable intent were negligible.

#### 4.6.4.3 Regression Analysis Results

A regression analysis was conducted to identify the factors that were important in affecting the adoption of digital technologies to minimize food waste in the retail supply chain. The association between multiple variables can be ascertained with the aid of regression analysis. The results for the dependent factor, Intent to Adopt Digital Technologies, are as follows.

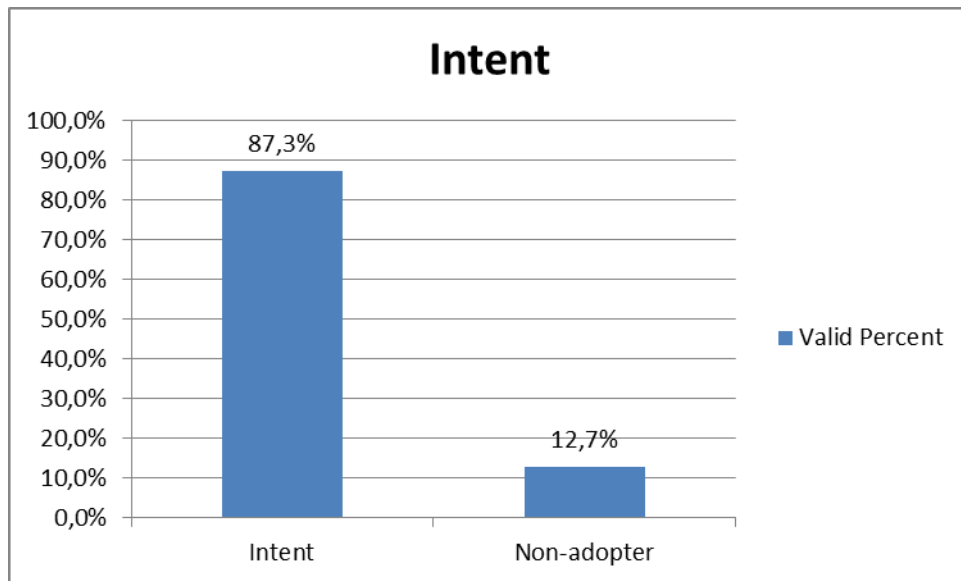


Figure 47. Intent to adopt digital technologies

According to the survey's findings, 87.3 percent of participants agreed that there is intent to utilise digital technologies in retail to minimize food waste. Only 12.7% of those surveyed believed there was no intention to use digital technologies in retail. The independent variables were transformed and grouped into technological, organizational, and environmental factors. The regression analysis's findings are listed below.

Table 6. Independent variables

Case Processing Summary				
Factor	Construct	Variable	Cases	
			Valid	
			N	Percent
Technology	TCompat	Compatibility	55	100.0%
	TComplex	Complexity	55	100.0%
	TRelAdv	Relative advantage	55	100.0%
	TCost	Cost	55	100.0%
Organisation	OrgMS	Top management support	55	100.0%
	OrgSize	Size	55	100.0%
	OrgExpert	Expertise	55	100.0%
	OrgTechReady	Technological readiness	55	100.0%
	OrgInno	Organizational innovativeness	55	100.0%

Environment	EnvComp	Competitive pressure	55	100.0%
	EnvCust	Customer	55	100.0%
	EnvTVS	Technological vendor support	55	100.0%
	EnvSocCom	Social community	55	100.0%

Since the data is on a Likert scale, a test was run to determine the correct regression approach to be used for analysis. An analysis of the data's normality will reveal this.

Table 7. Test for Normality

Tests of Normality						
	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	Sig.	Normality
TCompat	0.141	55	0.008	0.919	0.001	No
TComplex	0.191	55	<.001	0.922	0.002	No
TRelAdv	0.213	55	<.001	0.795	<.001	No
TCost	0.198	55	<.001	0.918	0.001	No
OrgMS	0.161	55	0.001	0.945	0.014	No
OrgSize	0.249	55	<.001	0.849	<.001	No
OrgExpert	0.243	55	<.001	0.845	<.001	No
OrgTechReady	0.184	55	<.001	0.898	<.001	No
OrgInno	0.144	55	0.006	0.932	0.004	No
EnvComp	0.148	55	0.004	0.906	<.001	No
EnvCust	0.284	55	<.001	0.842	<.001	No
EnvTVS	0.272	55	<.001	0.813	<.001	No
EnvSocCom	0.298	55	<.001	0.838	<.001	No
Intent	0.52	55	<.001	0.392	<.001	No

a. Lilliefors Significance Correction

N is less than 100, so the Shapiro-Wilk test was considered. Since the Sig < 0.05 for all the variables, it means that they are statistically significant. This implies that they are not normally distributed. A Log transformation failed to normalize the attributes. At a 95% confidence level, a multinomial logistic regression was conducted. In determining the significant variable, variables that were less than 0.05 or 5% were regarded as significant. On the other hand, variables that were more than 0.05 or 5% were regarded as insignificant. The regression model results are as below.

Table 8. Model Results

Model Fitting Information				
Model	-2 Log Likelihood	Chi-Square	Df	Sig.
Intercept Only	41.929			
Final	0	41.929	13	<.001
Link function: Logit.				

The Sig < 0.05, means the model fitting information is statistically significant, indicating that the model's fit to the data is excellent.

Table 9. Goodness of fit test

Goodness-of-Fit			
	Chi-Square	df	Sig.
Pearson	0	14	1
Deviance	0	14	1
Link function: Logit.			

The Sig value > 0.05, which implies non-significant results. Non-significance indicates that the model's fit to the data is excellent.

Table 10. Pseudo R Square test

Pseudo R-Square	
Cox and Snell	0.533
Nagelkerke	1
McFadden	1
Link function: Logit.	

Using Nagelkerke test, a 100% change in intent to adopt digital technologies was explained by the independent variables under technological, organisational, and environmental factors. On the other hand, the Nagelkerke R-Square suggests a perfect fit. In practice, a perfect fit is highly unusual and often indicative of overfitting.

Table 11. Parameter Estimates

Parameter Estimates						
Intent <sup>a</sup>	B	Std. Error	Beta	t	Sig.	Significance
Intercept	0.448	0.429	0.974	1.044	0.311	Significant
TCompat	0.997	0.052	0.027	19.234	0	Significant
TComplex	0.009	0.019	-0.016	0.488	0.009	Significant
TRelAdv	-0.005	0.018	-0.002	-0.274	0.788	Insignificant
TCost	0.034	0.017	-0.017	-0.027	0.04	Significant
OrgMS	-0.021	0.031	-0.194	-0.42	0.979	Insignificant
OrgSize	-0.099	0.05	0.012	0.239	0.001	Significant
OrgExpert	0.004	0.033	0.034	0.544	0.009	Significant
OrgTechReady	0.018	0.016	0.131	-0.217	0.814	Insignificant
OrgInno	0.073	0.033	-0.012	-1.396	0.594	Insignificant
EnvComp	-0.005	0.033	-0.065	0.577	0.001	Significant
EnvCust	-0.028	0.024	0.042	-1.581	0.181	Insignificant
EnvTVS	0.021	0.02	-0.101	1.31	0.571	Insignificant
EnvSocCom	-0.014	0.037	0.06	0.29	0.132	Insignificant

It can therefore be seen from the table above that only six variables were identified as significant. These variables are technological compatibility, complexity, cost, organisation size, expertise and competitive pressure. The significant values are 0.000, 0.009, 0.040, 0.001, 0.009 and 0.001 respectively, which are all less than the alpha 0.05.

The regression model would look like this:

$$\text{Intent} = 0.448 + 0.997T\text{Compat} + 0.009T\text{Complex} + 0.034\text{Cost} - 0.099\text{OrgSize} + 0.004\text{OrgExpert} - 0.005\text{EnvComp}$$

Coefficients (B) are interpreted as expected changes in log-offs due to being in a higher group on the predictor variable.

#### 4.6.4.4 Hypothesis Evaluation

This section evaluates the hypotheses outlined in Chapter 1 of the study. Based on the significant values of the variables, the null hypotheses were either rejected or accepted. The null hypothesis was rejected for variables with a p-value equal to or less than alpha 0.05, and thus the alternative was accepted. However, for variables with a p-value greater than 0.05, the null hypotheses were rejected. The findings reveal that hypotheses H2, H1, H4, H7, H10 and H6 were rejected, meaning that the alternatives were statistically true. These hypotheses results mean that compatibility, complexity, cost, organizational size, I.T expertise and competitive pressure had been discovered to statistically impact the adoption of digital technologies.

Table 12. Hypothesis evaluation

Hypothesis	Hypothesis	Reject Null Hypothesis
H1	Compatibility does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.	reject
H2	Complexity does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.	reject
H3	Relative advantage does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.	Failure to reject
H4	Cost does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.	reject
H5	Organization's top management does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.	Failure to reject
H6	Organizational size does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.	reject
H7	I.T expertise does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.	reject
H8	Technological readiness does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.	Failure to reject
H9	Organizational innovativeness does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.	Failure to reject
H10	Competitive pressure does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.	reject
H11	Customers do not influence the adoption of digital technologies to reduce food waste in the retail supply chain.	Failure to reject
H12	Technology vendor support does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.	Failure to reject
H13	Social community does not influence the adoption of digital technologies to reduce food waste in the retail supply chain.	Fail to reject

#### 4.7 Chapter summary

This chapter examined the factors influencing the use of digital technology to reduce food waste in the retail supply chain, with data from Gaborone retail employees. It began by presenting demographic results and employed statistical analyses like hypothesis testing, factor correlations, and regression analysis. Despite COVID-19 challenges, a 92% response rate was achieved from 60 questionnaires. The study used a five-point Likert scale and Cronbach's alpha to assess reliability, showing high internal consistency across technological, organizational, and environmental factors. Analysis under the TOE framework indicated that technological compatibility, complexity, and relative advantage were crucial, while organizational factors like top management support, size, and expertise also played significant roles. Environmental factors, including competitive pressure and customer expectations, further influenced adoption. Regression analysis identified technological compatibility, complexity, cost, organization size, expertise, and competitive pressure as significant variables affecting the intent to adopt digital technologies for reducing food waste.

## **Chapter 5: Conclusions**

### **5.1 Introduction**

The knowledge that was gathered from the retail practitioners via a questionnaire was presented, examined, and analyzed in the preceding chapter. The following chapter's goal is to provide a concise summary of the study's findings with regard to its aims, its conclusion, and possible improvements to the framework for adopting digital technologies to minimize food waste in the retail supply chain.

### **5.2 Summary of results**

This study's main goal is to find out what important elements motivate retailers to use digital technology to cut down on food waste in the retail supply chain.

#### **5.2.1 *Objective 1 findings***

The initial objective was to investigate technological attributes that motivate retailers to adopt digital technologies to minimize food waste in the retail supply chain. Sixteen variables were investigated and grouped under four categories using the mean score. The variables were grouped into relative advantage, complexity, compatibility, and cost. From the survey results, respondents agreed that all these factors influence the adoption of digital technologies. However, statistical analysis from the regression model shows that only three technological factors were influential in the adoption of digital technologies, and these factors are technological compatibility, complexity, and cost.

Hypothetically, technological compatibility, technological complexity and technological cost statistically impact the decision to adopt digital technologies to minimize food waste in retail. It is well concluded that technology adoption is affected by challenges with compatibility since software and hardware need standardized interfaces (Duarte and Cruz-Machado 2017). Lastly, financial limitations are viewed by corporate organizations as posing a significant barrier to the development of their competencies with regard to attaining and implementing sustainable innovative solutions (Dawson 2014; Nicoletti, 2018).

### **5.2.2 Objective 2 findings**

In order to lower food waste in the retail supply chain, the second goal was to research organizational characteristics that drive retailers to embrace digital technologies. Fifteen variables were investigated and grouped under top management, size, expertise, technological readiness and organisational innovativeness. Mean scores of the variables were used to group them into these factors. The majority of those who responded to the survey believed that all these organizational characteristics had an impact on whether digital technologies are adopted to decrease food waste in the retail industry.

However, the regression model analysis shows that only variables relating to organisation size and expertise are the most influential factors. Hypothetically, organizational size and I.T expertise within the organization statistically influence the adoption of digital technologies. According to Alam et al (2016) study on the adoption of HRIS, only firm size is consistently the acknowledged element among the probable criteria for the adoption of technology. Human expertise is crucial in adopting new digital technologies as knowledge and skills within organizations are important in designing, setting up and maintaining new technologies (Alam et al., 2016).

### **5.2.3 Objective 3 findings**

The third goal was to look at how the environment affects retailers' adoption of digital technologies to cut down on food waste in the retail supply chain. Nine variables were grouped under four factors, being competitive pressure, customer, social community and technology vendor support. The survey results show that respondents agreed that all the variables under these factors are influential, however, the regression analysis's findings indicate that the only impactful variable from the environmental aspect is competition from the market. Hypothetically, competitive pressure statistically influences the adoption of digital technologies. Organizations are compelled by competitive pressure to become adoption trailblazers, as attested by a study on Taiwan conducted by Hsiao, Li, & Chen (2009).

### **5.2.4 Objective 4 findings**

The fourth goal was to put out a framework to help retailers leverage digital technologies to cut down on food waste throughout the retail supply chain. This section offers an alternative TOE framework with fewer and more significant factors following the regression model and the correlation analysis of significant factors. The predictors formed a proposed conceptual model and framework. Figure 48 shows the regression model coefficients for the significant factors of the conceptual framework of this study.

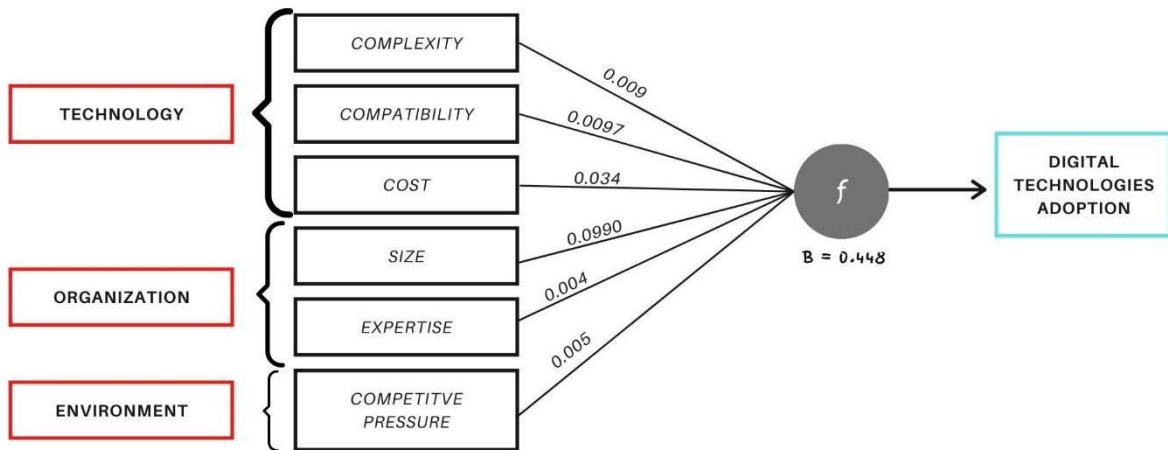


Figure 48. Proposed framework with regression model coefficients

The advantage of the framework is that it does not have many variables which might be redundant in analysing adoption. From the thirteen predictors derived from the TOE framework, only six were statistically significant in predicting the decision to adopt digital technologies to cut down food waste in the retail industry.

### **5.3 Conclusion**

In conclusion, complexity, compatibility, cost, scale, expertise, and competitive pressure are the technological, organizational, and environmental elements that have the most impact on the adoption of digital technologies in food waste management. The factors that were not influential on the adoption of digital technologies were a comparable advantage, top management support, technological readiness, organizational innovativeness, customer, social community, and technological vendor support. Because this study primarily focused on Gaborone retailers, which may be distinct from the organizations that were the focus of earlier studies, the results may vary from those of the earlier models due to factors such as sample size, timing, and how the methodologies are applied.

The study's findings addressed all four research objectives about the impact of organizational, environmental, and technological factors on the use of digital technology to minimize food waste in the retail industry. Further, the results have helped propose a conceptual framework to offer alternative adoption determinants. This study adds to the body of literature by advancing advanced technology adoption within the retail industry, which is an under-researched area, especially in Botswana. Data collection during the COVID-19 pandemic has the drawback of a low response rate and a limited sample size, which is a limitation of the study. The limitation can be remedied by using a different sampling approach or increasing the sample size.

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**Appendix A**

**FACULTY OF ECONOMIC AND MANAGEMENT SCIENCES**

**Department of Information Systems**

**CONSENT FORM**

**RESEARCH TITLE:** Factors Influencing the Adoption of Digital Technologies to Reduce Food Waste in Retail Supply Chain.

I have read the information presented in the information letter about a study being conducted by **Kagiso Elton Mpa** towards the Masters Programme in the Information Systems Department at the University of the Western Cape.

This study has been described to me in a language that I understand and I freely and voluntarily agree to participate. My questions about the study have been answered.

I understand that my identity will not be disclosed and was informed that I may withdraw my consent at any time by advising the student researcher.

With full knowledge of all foregoing, I agree to participate in this study.

Participant Name : \_\_\_\_\_

Participant Signature : \_\_\_\_\_

Date : \_\_\_\_\_

Place : \_\_\_\_\_

Student Researcher : Kagiso Elton Mpa

Student Researcher Signature : \_\_\_\_\_

Student Number : 3716449

Mobile Number : +27 734408498 (+267 72923000)

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I am accountable to my supervisor : Prof Osden Jokonya

Department : Information systems department

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Email : [ojokonya@uwc.ac.za](mailto:ojokonya@uwc.ac.za)

This research project has received ethical approval from the Humanities and Social Sciences Research Ethics Committee, Research Development, of the University of the Western Cape,

Tel. 021 959 4111,

Email: [research-ethics@uwc.ac.za](mailto:research-ethics@uwc.ac.za)

## Appendix B

<b>TECHNOLOGICAL</b>	<b>Variable code</b>	<b>Transformed variable</b>
<b>FACTORS</b>		
<b>Technological Compatibility</b>		<b>TCompat</b>
1. Digital technologies are consistent with the firm's current values and believes in food waste management	Tech_C1	<b>TCompat</b> = Mean (Tech_C1, Tech_C2, Tech_C3, Tech_C4)
2. Digital technologies are compatible with managerial and operational needs of food waste management	Tech_C2	
3. Digital technologies are compatible with existing systems of food waste management	Tech_C3	
4. Digital technologies adoption is influenced by previous adoption experience of other technologies of food waste management	Tech_C4	
<b>Technological Complexity</b>		<b>TComplx</b>
5 The skills required to use digital technologies of food waste management are too complex.	Tech_CX1	<b>TComplx</b> = Mean (Tech_CX1, Tech_CX2, Tech_CX3, Tech_CX4, Tech_CX5)
6 Digital technologies of food waste management in current retail work practices are very difficult.	Tech_CX2	
7 The application of digital technologies in food waste management creates many more requests, problems, or complaints in my job.	Tech_CX3	
8 Integrating digital technologies in food waste management with existing processes is very complex	Tech_CX4	
9 Digital technologies in food waste management are easy to use and manageable	Tech_CX5	
<b>Relative Advantage</b>		<b>TRelAdv</b>
1. Digital technologies of food waste management allow for improved inventory management.	Tech_RA1	
2. Digital technologies of food waste management provide better information accuracy for better decision-making.	Tech_RA2	

3. Digital technologies of food waste management provide improved operational efficiency.	Tech_RA3	<b>TRelAdv</b> = Mean (Tech_RA1, Tech_RA2, Tech_RA3, Tech_RA4)
4. Digital technologies of food waste management provide improved shelf life and reduce food waste	Tech_RA4	
<b>Cost</b>		<b>TCost</b>
1. The implementation cost of digital technologies to reduce food waste is high for our organisation	Tech_Cost1	<b>TCost</b> = Mean (Tech_Cost1, Tech_Cost2, Tech_Cost3)
2. The direct and indirect cost for the implementation of digital technologies to reduce food waste is high for our organisation	Tech_Cost2	
3. The maintenance and support fees for digital technologies applications are high for our company	Tech_Cost3	
<b>ORGANIZATIONAL</b>		
<b>FACTORS</b>		
<b>Top Management Support</b>		<b>OrgMS</b>
1. Top management enthusiastically supports the adoption of digital technologies to reduce food waste	Org_TMS1	<b>OrgMS</b> = Mean (Org_TMS1, Org_TMS2, Org_TMS3, Org_TMS4)
2. The organization provides employees with training on digital technologies of food waste management	Org_TMS2	
3. Top management has allocated adequate resources for the adoption of digital technologies to reduce food waste	Org_TMS3	
4. Top management is aware of the benefits of digital technologies in reducing food waste	Org_TMS4	
<b>Size</b>		<b>OrgSize</b>
1. Organization size is important adoption for the adoption of digital technologies to reduce food waste	Org_Size	<b>OrgSize</b> = Org_Size
<b>Expertise</b>		<b>OrgExpert</b>
1. Greater IT expertise in an organization positively influences digital technologies adoption of food waste management	Org_EX1	
2. Greater strategic IT planning positively influences digital technologies in food waste management in retail	Org_EX2	

3. Our organisation has personnel with adequate IT skills to support the adoption of digital technologies in food waste management	Org_EX3	<b>OrgExpert</b> = Mean (Org_EX1, Org_EX2, Org_EX3)
<b>Technological Readiness</b>		<b>OrgTechReady</b>
1. Adequate training and education for employees to adopt digital technologies to reduce food waste	Org_TR1	<b>OrgTechReady</b> = Mean (Org_TR1, Org_TR2, Org_TR3, Org_TR4)
2. Existing technology supports digital technologies of food waste management	Org_TR2	
3. Cognitive capabilities of IT human resources to support digital technologies of food waste management	Org_TR3	
4. Digital technologies adoption of food waste management is perceived as being both useful and easy to use by employees	Org_TR4	
<b>Organizational innovativeness</b>		<b>OrgInno</b>
1. Most retailers have the infrastructure and capacity to implement the use of digital technologies to reduce food waste.	Org_Ino1	<b>OrgInno</b> = Mean (Org_Ino1, Org_Ino2, Org_Ino3)
2. Senior executives often risk doing things differently to manage food waste in our organisation.	Org_Ino2	
3. Senior executives are always enthusiastic to experiment with new digital to manage food waste in our organisation.	Org_Ino3	
<b>ENVIRONMENTAL FACTORS</b>		
<b>Competitive pressure</b>		<b>EnvComp</b>
1. Retailers would lose customers to competitors if they do not adopt digital technologies to reduce food waste.	Env_CP1	<b>EnvComp</b> = Mean (Env_CP1, Env_CP2, Env_CP3)
2. It is a strategic necessity to use digital technologies to reduce food waste in order to gain a competitive advantage.	Env_CP2	
3. Adoption of digital technologies to reduce food waste would allow the generation of higher profits in our organisation.	Env_CP3	
<b>Customer</b>		<b>EnvCust</b>
1. Pressure to meet customer expectations positively influences digital technologies to reduce food waste in our organisation	Env_Customer	<b>EnvCust</b> = Env_Customer

<b>Technology vendor support</b>		<b>EnvTVS</b>
1. Adoption of digital technologies to reduce food waste would require training from vendors.	Env_VS1	<b>EnvTVS</b> = Mean (Env_VS1, Env_VS2, Env_VS3, Env_VS4)
2. Adoption of digital technologies to reduce food waste would require support from trading partners (vendors).	Env_VS2	
3. Adoption of digital technologies to reduce food waste would be influenced by the marketing activities of trading partners	Env_VS3	
4. Adoption of digital technologies to reduce food waste would be influenced by the level of support from trading partners	Env_VS4	
<b>Social community</b>		<b>EnvSocCom</b>
1. Adoption of digital technologies to reduce food waste would be influenced by environmental organizations	Env_SC	<b>EnvSocCom</b> = Env_SC
<b>Intent</b>		<b>Intent</b>
Please share your thoughts on retailers' adoption intentions.	INT	<b>INTENT</b> = INT