The Use, Benefits and Challenges of using the Internet of Things (IoT) in retail businesses

A Literature Review

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***Abstract*—This paper presents the use, benefits and challenges of using of the Internet of Things (IoT) in retail businesses. The paper aims to inform Chief Information Officers (CIOs), digital strategists or Head of Information Technology in retail of the use, benefits and challenges of using IoT. IoT is a new paradigm that uses different technologies to achieve various tasks. The use of IoT is growing among business and individuals and businesses that are not currently using IoT are set to invest in its use in the coming years. The use of IoT is increasing in the retail market, giving to the vast benefits that IoT offers. For businesses to fully use IoT they will need to change their business processes to realise its benefits. However, businesses to fully realise the benefits of IoT they need to overcome the challenges that it presents, this includes but not limited to security, privacy and network challenges. The Technology Organisation Environment (TOE) Framework was used to study the use, benefit and challenges of using IoT in retail businesses.**

Keywords—keywords that were used in the search included but not limited to: "Internet of Things", "the use of IoT in businesses", "e-tailing", "the potential use of IoT in retail businesses", "benefits of IoT in businesses", "potential benefits of IoT in retail businesses", "challenges of IoT in businesses", "potential challenges of IoT in retail businesses", "conducting Literature Review", "information systems"

I. INTRODUCTION

The growing use of the internet has changed the way retail businesses conduct their everyday business processes [7]. The purpose of this Literature Review is to identify studies, case studies, and models used to examine and inform Chief Information Officers (CIOs), digital strategist or Head of Information Technology in retail of the use, benefits and challenges of using the Internet of Things (IoT). The Literature Review is aimed to inform South African retail businesses using or those who will potentially use IoT of the its use, benefits and challenges as the International Data Corporation (IDC) stated that 33% of businesses in South Africa are planning on investing in IoT in the next three years [1, 34]. The Literature Review will define key terms, definitions and terminology related to the use, benefits and challenges of using IoT in retail businesses in South Africa to answer the main research questions:

1. What is the use and potential use of IoT in South African retail businesses?

2. What are the potential benefits of using IoT in South African retail businesses?

3. What are the potential challenges of using IoT in South African retail businesses?

4. How can the South African retail environment use IoT?

The Internet of Things (IoT) is set to be the enabling force behind the digital future [21]. According to [62, p. 618] "The Internet of Things (IoT) as an emerging global Internet based information architecture that facilitates the exchange of goods and services is gradually gaining importance". Implementing IoT in retail offers various benefits to businesses and innovative ways to interact with its customers [18, 27, 44]. IoT is used to provide devices, objects or things with an anytime, anyplace, with anything and anyone connection through a network or path and any service [23, 43]. IoT encompasses an environment that is made up of things, communication, applications and data analysis [25]. IoT is perceived as a disruptive technology in the retail environment. Retailers use IoT to leverage opportunities such as connecting devices in order to create new services to improve customer experience, optimise supply chain operations, and create new opportunities to generate revenue [22].

A. Search Methodology

The search methodology followed a similar search method by [20] which was conducted as follows:

Resources for executing the search: A combination of databases was used to conduct the Literature Review. The primary databases that were used to gather literature included Google Scholar and the University online library database. From the University online library, databases which were searched included EBSCO Host, Emerald and Science Direct.

Type of Literature: Selected academic journals, academic books, conference papers, business reports and articles were considered for this Literature Review which included, but not limited to Computer Networks Journal, Business Process Management Journal, Computer Law and Security Review, IEEE Transactions on Emerging Topics in Computing, European Conference on Information Management and Evaluation, etc.

Publication Date: The dates of publication that were considered ranged from 2012 to 2016, with a few considerations of older literature.

Language: Even though the researcher is multilingual, the search for literature was limited to English language texts only because a majority of academic research is written in

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English [20]. Ginger Software and Microsoft Word proof reader were used to check grammar and spelling.

Structure of Literature Review: the literature review followed a similar structure as proposed by Okoli and Schabram [37].

II. Definition of Terms

Retail Business: is defined according to the Standard Industrial Classification (SIC) of all economic activities in South Africa, as businesses that buy new or used goods from other businesses or manufacturers for resale to the general public without transforming or altering the goods [31]. Retail businesses range from general dealers, grocery stores, speciality stores, exclusive boutiques, chain stores, department stores, supermarkets, cash and carry wholesale-retail outlets, and co-operative stores in rural areas.

Use and Potential Use: are defined as a key method to improve the business's competitive advantage by means of technology [2, 58]. The use or the potential use of technology is largely driven by the notion that the technology will provide benefits that were not there before, giving the business a competitive advantage over other businesses in the same market [58].

Things: "A thing, in the Internet of Things, can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensor to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an IP address and provided with the ability to transfer data over a network" [47]. However, for this Literature Review, things will refer to non-living objects. This will include Radio Frequency Identification (RFID) tags, sensors, actuators, smartphones, smart objects, computers, etc. [4, 30].

III. The use of IoT in retail businesses

IoT technologies are used in retail businesses because of their ability to uniquely identify products, ease of communication and their ability to provide real time information [48]. With the rise of competition in the retail market, more and more retailers are using IoT to gain market share [32]. It is worth noting that IoT technologies have changed the amount of data available to a business as well as the accessibility to that data; businesses can easily gather data about their customers and their behaviour by using IoT [41].

Retail businesses use IoT to optimise their store layout by installing sensors that track the movements of customers to identify aisles with the highest traffic, thus, placing goods on those aisles to increase purchases [7]. For example, Hugo Boss makes use of heat sensors in their clothing store to track the movements of their customers and thus using that data to identify aisles with high traffic and therefore placing premium products in those aisles to increase sales [22].

Retail businesses use the data received from IoT devices to gather information about their customers' behaviour and use that information to recommend products that the customer is more likely to purchase [15, 22]. "Dohle (the German grocery retailer) uses smart shopping carts that can provide information related to products in store. It can retrieve and store information in real time, answer queries and enable checkout without waiting in the line" [5, p.2].

Retail businesses also use IoT to help customers find products that they are looking for in the store [18, 22], this process is enabled by IoT technologies that have the ability to track and locate products to help customer find those products easier [7]. Retail businesses install IoT devices on their shelves that notify the supply department when products are running out, it is estimated that retail businesses lose 3.9% in sales when their shelves go empty, with the use of IoT this can be significantly reduced [50]. Alternatively, businesses can use IoT to assess the quality of their products, this is more popular within supermarkets because they keep fresh produce [22, 52]. Panasonic as an IoT vendor offers hardware and software technologies to monitor store shelves [14].

A. Technologies used for IoT

The key components that make up IoT are RFID systems, which are made up of readers, which trigger transmission of signals and tags, and are equipped with unique identifiers in the objects, tags, sensors, and actuators [4, 64]. RFIDs are said to improve the traceability and visibility of products in retail businesses by increasing accuracy, efficiency and the speed of processes. RFIDs can also "reduce storage, handling and distribution costs and improve sales by decreasing the number of stock outs" [48, p. 78]. IoT offers various benefits to retail businesses which result in cost reduction, increase in revenue, process improvement, service quality among others [48].

However, [4] contended that there are many technologies that exist that enable IoT, and these technologies work together to offer IoT its capabilities. These include Wireless Sensor Networks (WSNs), cloud computing, ubiquitous communication, Near Field Communication (NFC), smartphones, location based services, etc. [16]. Therefore, it is important for businesses to know which technologies or a combination of technologies are best to use in the business to harvest the opportunities IoT provides [3]. However, most IoT technologies are not a complete set needed to build an IoT business solution, the technologies still need to be configured, modified and integrated with back end systems and data to build an IoT solution best suited for their business [57].

B. Business Processes enabled by IoT in retail

IoT will inevitably impact the everyday processes and behaviour of the business, which is its main strength, giving way to new business processes [4]. Business processes in retail businesses have changed significantly with each passing year and IoT is set to cause more significant changes. For example, with the use of IoT, customers can be guided directly to the item they want to purchase when they enter a store using a connection enabled by IoT devices and the customers mobile phone. IoT devices in retail businesses create new business models, improve productivity, reduce

costs and increase sales [33] with new business processes such as automatic checkouts.

Checkouts are one of the biggest processes in retail businesses, they can be time consuming and costly to a business [7]. Retail businesses can therefore use IoT to optimise this process, allowing for automated checkout processes where customers need not to stand in queues to pay for purchased goods, but they can be charged automatically when they walk out the store, reducing labour costs and cutting the time a customer spends in the store [22, 52].

Apple Pay is an example of an automatic checkout system where customers can use their iPhones, iWatch or iPad to pay for the products they have purchased, a process enabled by contactless readers that read the customers' fingers on Touch ID [59]. If businesses use or plan to use IoT, they will have to plan for the reinvention of their business processes [21]. Market competition and new customer demands drive businesses to willing or unwilling change from their traditional business models to service based models and provide solutions that are both product and service based [29].

Research sub-questions:

1. What technologies will be used for IoT in South African retail?
2. What business processes will be enabled by IoT in South African retail?
3. How will IoT be used in the South African retail environment?

IV. The Benefits Of Using IoT in Retail Businesses

The undeniable and basic benefit of using IoT is its ability to impact and potentially change the everyday processes of its user [4]. IoT offers the ability for businesses to access information about physical objects that was not easily available, this provides more information to businesses which could lead to innovation, high efficiency and productivity [6].

IoT technologies produce large amounts of information and data that was not previously available in the business [64], such as customer profiles or customer behaviour which informs businesses about the activities of their customers' that can be used in the business to improve marketing strategies to enable awareness of the customer preferences and therefore can recommend products that the customer is most likely to purchase, increasing business revenue and the market of IoT analytics [21, 49].

Other benefits that IoT offers include the reduction of data acquisition costs because devices, objects, machines or things work together and share resources; availability of previously unavailable data as IoT technologies will have the ability to interact with humans and real time data for decision making as IoT provides data in real time from different machines, objects or things that are connected and helps the business to make decisions quicker [42]. Efficiency improvement, asset optimisation, physical premises, equipment security and safety improvement as benefits offered by IoT [21]. Through innovation provided by IoT in business, businesses can enter and create new markets and increase their competitive advantage [9].

IoT technologies enable retail businesses to trace their products and enables the business to monitor their products with the information received from the IoT technologies. Businesses can, in turn, ensure production efficiency as there is a consistent flow of information between the business and the supplier. Retail businesses have a variety of products they sell and IoT technologies improve the supply chain management of those products and reduce complexity of the amount of data the business handles and the transactions performed [9].

While IoT may be seen as a vision, retailers that do not grab the opportunity are opening doors for competitors to reap all the benefit IoT is offering [22]. The Chief Executive Officer (CEO) of Samsung mentioned that Samsung is leveraging on this new trend and by 2017, 80% of their products will be enabled by IoT and by the year 2020 all their products will IoT capable [56].

Research sub-questions:

1. What technological benefits will IoT have in South African retail?

2. What organisational benefits will IoT have in South African retail?

3. How will IoT benefit in the South African retail environment?

V. The Challenges of using IoT in Retail Businesses

For businesses to fully reap the benefits of IoT, they will need to overcome its challenges and more as the number of connected things is escalating with each passing year [13, 17]. Security and privacy remain the most important issues of IoT and are the centre of trust, relationship building and exchange [63].

A. Security Challenges

Security challenges posed by using IoT remain one of the greatest challenges to businesses [54]. The increase in the use of IoT inevitably increases data attacks on the new devices [40]. Example of businesses that have recently had their security compromised and had customer information conceded include; Anthem, Apple, Home Depot, JP Morgan Chase, Sony, and Target [63].

In this regard, security is a major challenge which businesses need to overcome to effectively use technologies such as IoT [46]. However, the security of IoT technologies is seen as a complex task because there is a connection of billions of devices and as more devices are connecting, there is an increase in the potential attacks of IoT technologies. These attacks can affect communication channels, through physical threats [46].

The Federal Trade Commission (FTC) of America recently published a checklist on how businesses that use IoT can enhance the security of their IoT technologies – this can be applied to any retail business across the world [11]. The recommendations include [19]:

1. "Build security into devices at the outset, rather than as an afterthought in the design process;"
2. "Train employees about the importance of security, and ensure that security is managed at an appropriate level in the organisation;"
3. "Ensure that when outside service providers are hired, that those providers are capable of maintaining reasonable security, and provide reasonable oversight of the providers;"
4. "When security risk is identified, consider a "defence-in-depth" strategy whereby multiple layers of security may be used to defend against a particular risk;"
5. "Consider measures to keep unauthorised users from accessing a consumer's device, data, or personal information stored on the network;"
6. "Monitor connected devices throughout their expected life cycle, and where feasible, provide security patches to cover known risks."

B. Privacy Challenges

"Privacy is defined as a process of anonymity preservation and so it is strongly connected with control over information about the self" [51, p. 822]. IoT technologies receive and send large amounts of data between devices and therefore are prone to a high risk when it comes to the privacy of data [62].

Therefore, it remains a fact that data privacy remains one of the major challenges of IoT, the data that is used by different connecting devices creates trust and privacy issues [53]. Businesses need to ensure that they can ethically keep customer information private, and that their customers are not forced to reveal information about themselves to others by using IoT [10].

Privacy challenges can be overcome by the use of service agreements between the business and its customers as well as technological advancement, i.e. bug fixes [62]. Encryption can be used to protect the data produced by IoT technologies at the application level protecting sensitive data and access to this data using mandates such as Payment Card Industry Data Security Standard (PCI DSS) which is ideal for retail businesses [35].

C. Network Challenges

With the increase of IoT in retail businesses, businesses will be required to take care of their networking elements to ensure the efficient transmission of data between wired and wireless networks [11]. The increase in the use of IoT technologies poses capacity and bandwidth challenges causing failures in the networks [35]. Current traditional networks do not provide technical features and operational cost for IoT devices that require wide-area coverage and low bandwidth, good battery life, low hardware and operating costs, and high connection density [26].

Selecting the right wireless network for IoT also presents challenges with regard to conflicting requirements such as range, battery life, bandwidth, density, endpoint cost and operational costs [26]. Therefore, it is essential that retail businesses select IoT technologies that can efficiently and effectively communicate with wired, wireless and mobile networks [11].

Research sub-questions:

1. What technological challenges will IoT pose in South African retail?

2. What organisational challenges will IoT pose in South African retail?

3. What challenges will South African retail environment have when using IoT?

VI. THE FUTURE OF IOT IN RETAIL

By the year 2020 every role in a business structure will be changed by IoT as over 20 billion things will be connected and technologies that are currently consumer centric will be used by businesses and vice versa [54].

Businesses that use IoT aim to reduce costs, improve efficiency and create new business models through physical products, services and data analysis, however, the impact of IoT differs among businesses [5]. Industries such as retail, utilities and manufacturing anticipate that IoT will have a noticeable impact on their businesses as compared to other industries such as government, education, insurance and banking [25].

Additionally, with the increase in the use of IoT, businesses will need to acquire new data centres that are flexible and scalable to support the escalation [46]. A stand-alone IoT strategy may add value, but greater value is realised when the IoT strategy is incorporated within a business wide digital strategy [59]. "For many organisations, the IoT will be a cornerstone of their digital business strategies, but will also be very disruptive, requiring them to master many new technologies and capabilities" [26, p. 2].

VII. THEORETICAL FRAMEWORK

The Technology Organisation Environment (TOE) theoretical framework was used as a lens to study the use, benefits and challenges of using IoT in South African retail businesses [36]. TOE has been widely used to study different technologies that make up IoT such as RFIDs and Cloud Computing [12]. TOE has three underlying paradigms that determine the adoption and implementation of innovations, these are the technological context, organisational context and environmental context [8], as shown in Fig. 1.

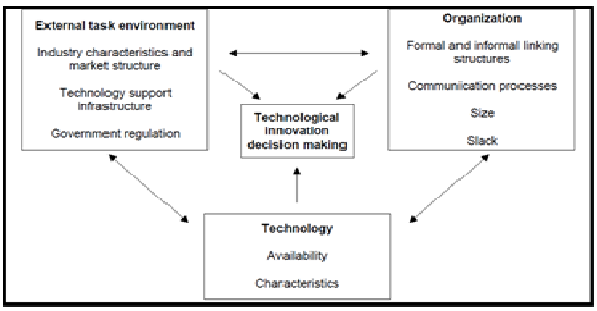

Fig. 1: TOE Framework [38, p.112]

A. Technological Context

The technological context refers to all the external and internal technologies available to the businesses [24]. "These technologies can be those that the business owns and those technologies available in the business market" [28, p. 131]. For the purpose of this paper, technology refers to IoT [24].

B. Organisational Context

The organisational context refers to the business characteristics such as the scope, size, trust, managerial structure, technology readiness, the quality of human resources and the amount of slack resources available in the businesses [24, 39]. This construct fits the definition of this paper as the Literature Review considers the organisation as the retail businesses.

C. Environmental Context

The environmental context refers to the market in which business operates and includes the industry, competitors, access to resources and the dealings with the government [28]. For the purposes of the paper, the environmental context is South Africa.

VIII. Conclusion

This Literature review aims to inform Chief Information Officers (CIOs) in retail businesses on the use, benefits and challenges of using IoT for business as about 70% of businesses globally will use IoT for internal business processes through 2020 [21]. "The CIO has to be the leading IoT decision-maker to ensure that there is a holistic view of business needs and you don't have disparate approaches driven by different lines of business" [1].

"The Internet of Things (IoT) is the network of physical objects (things) that contain embedded technology to sense or interact with their internal state or external environment" [25, p. 2]. Businesses that use IoT are set to gain from the use of IoT and grow exceptionally compared to other businesses in the same market provided they are willing to change their business structure and processes [21, 55].

IoT will inevitably impact the everyday processes and behaviour of the business, which is its main strength, giving way to new business processes [4]. IoT use is growing at a fast rate and business that will use IoT effectively and efficiently are guaranteed financial returns [17], IoT creates innovation in businesses adding to an innovative economy as well [30].

With IoT, new opportunities arise in the business environment which will allow the business to connect their activities, resources and with its partners [3].

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