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Retail Internet of Things: A Retailer- and Consumer-Oriented Literature Review

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Abstract
Purpose: The retail sector is currently one of the most prominent areas in which IoT applications are being utilised. This paper intends to provide a basic understanding on the deployment of IoT in retailing from the perspective of retailing organisations as well as end consumers.
Design/methodology/approach: Sourced from established databases, this study reviewed and discussed relevant and key published studies which have been published within the period of 2013 to 2022 on the use of IoT in retailing.
Findings: Generally, the benefits of implementing IoT in retail be centred around 4 main themes, which are customer experience, supply chain performance, data management, and revenue streams. Factors that can either enable or inhibit retail organisations to successfully deploy IoT in their retail operations include the cost of deployment, privacy and data security, standards and regulations, and talents and workers. For consumers, ease of use (simplicity) of the IoT application, its utility or functionality, the pleasure or enjoyment it provides, its presence, the user's right to privacy and security affect customer's decision to adopt IoT in their shopping behaviour.
Research limitations/implications: An important implication to be considered in IoT implementation is whether IoT would be capable of making in-person shopping safer or more hygienic, as well as whether or not IoT would be able to improve the experience of shopping online through a web or mobile application.
Originality/value: This study has uncovered important themes regarding the adoption of IoT in retail while raising new concerns that emerged in IoT's implementation in light of Covid-19's impact.

Keywords: IoT; Internet; Retailing; Mobile app; Industry 4.0

Introduction

Businesses and everyday life in the modern era have been thrust into the throes of a profound technological upheaval as a direct result of the advent of Industry 4.0. Conventional practises in manufacturing and service-related industries have now been disrupted by state-of-the-art, enabling technologies of IR4.0 such as big data, cloud computing, Internet of Things (IoT), machine learning, augmented reality (AR), real-time optimization, cyber physical systems, artificial intelligence (AI), and the like. IoT for one, is becoming more noticeable in the public eye and important for businesses, especially retailers. The retail sector is home to one of the most prominent applications of the IoT (Balaji & Roy, 2017). It is projected that the market for retail that is enabled by IoT will be worth USD 94 billion by the year 2025. This is due to the fact that IoT is increasingly being implemented to improve a variety of facets of the company, including warehousing, equipment maintenance, supply chain management, and shopping (Thomas, 2019). Although there has been coverage of retail IoT (RIoT) in mainstream media, studies on RIoT are only just beginning to gain traction among researchers. Through a discussion of previously published research on the application of IoT in retailing, the goal of this paper is to provide academics and industry professionals with a fundamental understanding of the deployment of IoT in retail from the point of view of retailing organisations as well as end consumers. This will be accomplished by examining existing studies on the application of IoT in retailing. Sourced from established databases, relevant and key published studies which have been published within the period of 2013 to 2022 on the use of IoT in retailing are discussed.

IoT Defined

IoT is a collective network of physical devices and other electronic appliances that are embedded with a variety of software sensors and many other components for the purpose of enabling these objects to connect with one another and share the data that they collect (Dlamini & Johnston, 2016). Because of the interconnection of physical devices and electronic appliances, it is now feasible for business partners in different locations to remotely monitor and track events, collaborate on project management, and make joint decisions. The consumer, the business world, and the government all stand to benefit significantly from the IoT. Consumers may utilise IoT devices to capture personal data, such as monitoring their health and automating home tasks. This information can be used for a variety of purposes. IoT has the potential to help businesses improve their efficiency and cut costs by streamlining their processes. Devices connected to the internet of things can help public sectors and communities address issues such as shifts in the environment (Jusman et al., 2017).

The State of IoT in Malaysia

Given IoT is one of the essential building blocks that support Industry 4.0, the Malaysian government is taking the promotion of IoT adoption in the country very seriously. Already in 2014, the Malaysian government had begun laying the groundwork for the development of the Internet of Things in the country. SME Corporation Malaysia (SME Corp. Malaysia) was named as one of the key players after the establishment of the National IoT Strategic Roadmap as a result of what transpired. It is anticipated that the development of IoT will be beneficial to and create value for the academic and research communities, as well as the business world, society, and government. The most prominent impact to be observed will be efficiency in regard to the business sector. This will result in enhancements to product and service design, which will then lead to the development of additional value for consumers and, in the majority

of situations, an increase in income for the firms (National IoT Strategic Roadmap, 2014). This indicates that businesses of all sizes, including SMEs, will benefit from the IoT, both in terms of their current performance and their potential for future growth. Particularly, the primary effects of IoT in Malaysia are as follows: it improves economic efficiency and productivity by automating and prescribing activities; it reduces environmental risks by providing "just-in-time" information and real-time sensing; and it aids the government in establishing better infrastructure and utility planning, monitoring, and management by augmenting data.; and/or it expands people's knowledge by making it possible for them to comprehend an issue (Zaidi, 2017).

Multiple reasons contribute to the growth of the IoT in Malaysia. To begin with, the country currently has a nearly perfect broadband penetration rate of 100 percent, which is projected to rise to 170 percent by the year 2025 as a direct outcome of the increased number of Internet users with broadband subscriptions. In addition, the annual expenditure on online shopping by Malaysians is an average of 2,000 US dollars (Saariko et al., 2017). In addition to this, approximately one out of every two people in Malaysia participate in some form of social networking, leading to a social networking penetration rate of 75%. In a nutshell, Malaysia is well positioned to become a fertile ground for the implementation of IoT as a result of the increased usage of mobile devices and the increased prevalence of broadband internet (Badarudin et al., 2018).

IoT in the Retail Sector

IoT technology has a wide range of potential applications, including the fields of energy, transportation, and healthcare; however, the retail industry is one of the most prominent areas in which it has been put to use. To illustrate, Dohle, a grocery retailer of German origins, utilizes intelligent shopping carts that can impart information about goods within the store, retrieve and store information in real time, respond to consumer questions, and enable customers to check out without needing to queue. Jewellery retailer BaubleBar provides customers with additional information about the items they sell through the use of interactive displays that are equipped with sensors and unique identifiers. Retail establishments may construct a considerably improved retail environment with the support of Internet of Things (IoT) technology, which allows retailers to engage with customers in real time and in both directions. Furthermore, IoT retail technology has the potential to assist customers in making decisions and improve their entire shopping experience (Gregory, 2015).

We found that the benefits of implementing IoT in retail can, in general, be centred around four main themes, namely customer experience, supply chain performance, data management, and revenue streams. IoT's capability has a favourable and substantial influence on the integration of processes connected to internal operations, customers, and suppliers, which in turn enhances the performance of the supply chain and the organisation (Vass et al., 2018). According to Anderseck and Hille (2013), the utilisation of Real Time Location Systems (RTLS) makes it possible to keep constant tabs on each and every asset in real time. The manual counting step can be eliminated from the process by automating the management of transports and orders, which will make the process of the supply chain run more smoothly. Since the advent of omnichannel retailing, there has been a growing gap between the provision of information and the delivery of products. Caro and Sadr (2019) provided justification for the notion that the implementation of an adequate IoT strategy will assist these businesses in bridging this gap. According to Latif et al. (2020), IoT provides a fantastic chance to manage and deal with a growing amount of data. Due to their restricted capacities and time constraints, most humans

are unable to deal with this sort of data. Tan et al. (2021) investigated the application of augmented reliability (AR), a prominent instrument in the IoT. Their findings support each other's conclusions that AR works best when there is a lot of confusion about the product. This illustrates that the technology has the ability to improve sales by decreasing client uncertainty and creating purchasing confidence.

If retailers want to take full advantage of IoT, they must first understand the elements that drive adoption. The research conducted by Patil (2016) suggests that the formation of positive adoption attitudes and intentions among retail staff is aided by trust. Employees who trust IoT technology are less prone to overestimate dangers, place a higher importance on communication and knowledge transfer, and are more inclined to adopt IoT. Even more intriguing is the fact that subjective norms have a significant influence, in addition to perceived behaviour control, on the intentions of retail employees to adopt IoT. Therefore, it is possible to conclude that social pressure, faith in IoT strategy, and perceived comfort or discomfort with IoT adoption all play a substantial impact in retail employees' judgments about whether or not to use IoT technology. According to the findings that Balaji et al. (2017) uncovered, key influences of value co-creation for IoT retail technology include user-friendliness, superior functionality, aesthetic appeal, and presence. Customers' intentions to make additional purchases and to spread the word about retail IoT can be influenced by the value that they co-create with the company. Đurđevic et al. (2022) who evaluated shoppers' response to beacon-triggered promotions found that shoppers welcomed beacon technology and acknowledged that beacon-triggered promotions had a positive effect on their attention, purchasing patterns, and purchasing decisions. Generally, the usefulness of the promotion, the promptness of the reward, and the ease of redemption leads to increased acceptance and redemption of the beacon-triggered promotions.

According to Nord et al. (2019), IoT does not occur without its challenges, despite the fact that it is beneficial because it creates data that is invaluable in every industry. Therefore, in order for companies to completely profit from IoT, they must overcome the difficulties such as those regarding security, privacy, and networks (Dlamini & Johnston, 2016). The challenge of content management in terms of sensitive data and the secure sharing of such data will form the foundation of architecture design in the retail business (Shankara et al., 2015). According to Kamble et al. (2019), the absence of government regulations and the inadequate infrastructure of the internet were significant barriers to the adoption of IoT. Based on their findings, three primary leading factors should be addressed by retail supply chain practitioners: a paucity in legislation and oversight, insufficient internet infrastructure, and shortage of human capabilities. These are the three main contributing factors. The study's findings suggest that retail organisations anticipate government participation in the formulation of laws and regulations governing data storage and utilisation, as well as the use and functioning of equipment. This is implied by the fact that the retail organisations participated in the study.

Table 1 presents an overview of the relevant research related to the deployment of IoT in the retail context.

Table 1: Summary of Studies on the Deployment of IoT in the Retail Context

Author (Year)	Objectives of the research	Theory & variables used in the study	Nature of study; Method/Type of Analysis	Country /Sample Size	Findings
Anderseck & Hille (2013)	To describe smaRTI, a cloud-based tracking and tracing system that is based on IoT principles.		Descriptive		Benefits can be gained from this approach, particularly through the integration of redistribution processes, such as automated asset management. The system is being developed in close collaboration with retail supply chain partners. Using common standards allows for adaptation to other branches and supply chains. Every asset can be tracked in real time using RTLS. Transport and order management can be automated, eliminating the need for manual counting.
Shankara, Mahanta, Arora & Srinivasa-murthy (2015)	To examine the impact that the IoT will have on the retail industry in the coming years from the perspective of a new business outlook based on factors such as security, reliability, integration, discoverability, interoperability, adaptability, profitability, etc.		Qualitative; Case study		Businesses have changed in terms of scalability, dynamicity, heterogeneity, and interconnectedness. The cornerstone of retail architecture design will be the difficulty of managing content with regard to sensitive information and the secure interchange of such information. In contrast, the IoT domain comprises not only sensors and sensor networks, but also interests, characteristics, and the self-governing integration of sensor raw data and resources into business process and execution requirements. This method of innovation will not only have an impact on the retail industry, but it may also be used to revitalise ideas in the health sector and other essential industries.
Dlamini & Johnston (2016)	To educate Chief Information Officers (CIOs), digital strategists, and heads of IT in retail about the application, advantages, and challenges of utilising IoT.	Technology Organisation Environment (TOE) Framework	Qualitative; literature review		Businesses will need to adapt their business operations to truly profit from IoT. They must overcome the hurdles that IoT poses, which may include, but are not limited to, security, privacy, and network concerns, in order to fully profit from it.
Patil (2016)	(1) To examine the factors affecting retail personnel' adoption and utilisation of IoT; (2) To offer management techniques/strategies for retail IoT implementation.	Technology acceptance model (TAM); perceived ease of use, perceived usefulness, trust, subjective norm, perceived behavioural control, attitude and intention	Quantitative; Survey, structural equation modelling (SEM)	India, 180 retail employees	Employees who have faith in IoT technology are less prone to overestimate risks, place a higher importance on communication and information transfer, and are more inclined to adopt IoT. Subjective standards and workers' views of behavioural control have a substantial impact on their adoption intentions. Employees' acceptance or rejection of IoT technology in retail is influenced by societal pressure, confidence in IoT strategy, and perceived comfort/ discomfort with embracing IoT.

Balaji & Roy (2017)	(1) To investigate the concept of customer value co-creation using IoT retail technology; (2) To investigate the antecedents and results of value co-creation using IoT retail technology in a B2C scenario.	Service-dominant logic; Superior Functionality, Aesthetic Appeal, Ease of Use, Presence, Perceived Value Co-creation, Continuance Intentions, Word-of-Mouth Intentions	Quantitative; Partial least squares structural equation modelling (PLS-SEM)	Australia, 289 users of IoT technology in the retail setting	For IoT retail technology, ease of use, improved performance, visual appeal, and presence are major factors of value co-creation. Value co-creation has an impact on customer retention and word-of-mouth intentions.
de Vass, Shee, & Miah (2018)	To examine how IoT adoption affects supply chain process integration, which benefits both the supply chain and the organisation.	Organizational capability theory; IoT capability, Supplier integration, Internal integration, Customer integration, Supply chain performance, Organisational performance	Quantitative; Cross-sectional survey, SEM-AMOS	Australia, 227 retail firms	IoT capabilities have a big and positive effect on how well internal, customer, and supplier processes work together. This has a positive effect on the performance of the supply chain and the organisation as a whole. The results showed that IoT-enabled process integration can improve the performance of both the supply chain and the organisation as a whole.
Nord, Koohang & Paliszkiewicz (2019)	To synthesise existing IoT literature in order to gain a better understanding of IoT		Qualitative; Systematic review and synthesis		The number of IoT applications has grown, spanning industries as diverse as business and manufacturing, as well as residential, health care, and information management. Although IoT can create important data in any company, it is not without its drawbacks.
Kamble, Gunasekaran, Parekh & Joshi (2019)	To identify the numerous hurdles that impede IoT adoption in the retail supply chain in India, as well as the interdependen-cies between the elements.	ISM model	Quantitative; MICMAC, DEMATEL Process	India, food retail industry	IoT adoption is hindered by government regulations and a lack of internet access, according to reports. Retail supply chain practitioners should instead focus on three primary leading causes: paucity in legislation and oversight, insufficient internet infrastructure, and shortage of human capabilities. Retailers anticipate government involvement in the formulation of standards and rules for device use and functioning, data storage, and usage.
Caro & Sadr (2019)	(1) To establish a strategic framework that places IoT initiatives on a geographically organised opportunity map; (2) To outline obstacles that must be overcome in implementing IoT; (3) To justify IoT implementation		Qualitative; Exploratory		As it enables businesses to rebalance supply and demand, IoT may play a vital role in channel integration. Using an opportunity map, a strategic framework is offered that differentiates projects based on the value they generate and their primary impact area. Adoption of IoT is justified with regard to its enabling capabilities - those instantly realised by installing IoT sensor data - but its full potential rests at the confluence of supply and demand in its enhancing capabilities - unforeseen advantages following IoT adoption. Adopting a suitable IoT strategy assists firms in bridging the gap between information providing and product delivery that has arisen as a result of omnichannel commerce.

Latif, Alghazo, Maheswar, Jayarajan & Sampathkuma (2020)	(1)To investigate the most prevalent and effective retail methods and technology (2) To discuss the concept of IoT (3) To identify the obstacles to IoT use in online clothing and retail stores		Qualitative; Exploratory		(1) IoT allows for direct communication between objects, including humans. It offers a tremendous opportunity to manage and deal with a big amount of data that is developing over time, which normal humans are unable to handle due to limited resources and time, (2) Each technology was discussed in detail, including its benefits, drawbacks, outcomes, and other supporting techniques for implementing and utilising it effectively.
Tan, Chandukala & Reddy (2021)	(1) To investigate the impact of employing augmented reality to help in product appraisal on product sales. (2) To explore how the influence of AR on sales varies based on product attributes (such as brand awareness, product attractiveness, rating, and pricing). (3) To examine how past consumer experience with an online channel and a product category influences the sales impact of AR.	Product Sales, AR Usage, Brand Popularity, Appeal, Rating, Price	Quantitative; Online and offline survey, Poisson regression, models, logit/probit/tobit , quasi-experiment/natural experiment and diff-in-diff	International cosmetics retailer	AR utilization on the retailer's mobile app has been linked to increased sales of less popular goods, those with a narrower appeal, and more costly products. In addition, AR has a bigger influence on customers who are unfamiliar to the online channel or product category, therefore the sales increase is a result of online channel adoption and category expansion. These statistics reveal that augmented reality is most effective when there is a great deal of product-related uncertainty, indicating that augmented reality has the power to improve sales by reducing uncertainty and fostering buyer trust.
Đurđevic, Labus, Barać, Radenković, & Despotović-Zrakić (2022)	(1) To evaluate shopper response response to beacon-triggered promotions in terms of noticeability, acceptance, and impact on purchase behaviour; (2) To develop a prediction model that businesses can employ during the planning phase of beacon implementation in order to target the ideal consumer reaction and to maximise the desired business outcome.	UTAUT; Performance Expectancy (PE), Effort Expectancy (EE); Social Influence (SI); Facilitating Conditions (FC); Behaviour Intention (BI); Technology Use (TU)	Quantitative, in-market experiment using SimplyTasty mobile app	Shoppers at 10 presentative retail stores with 10 twin control stores in Belgrade, Serbia	Shoppers welcomed beacon technology and acknowledged that beacon-triggered promotions had a favourable effect on customers' attention, purchasing patterns, and purchasing decisions. The usefulness of the promotion (PE), the immediacy of the reward (PE), and the ease of redemption (EE) appear to generate increased acceptance (BI) and redemption (TU), resulting in incremental revenue for the retailer. The proposed model (Notifications Index x Total Acceptance Score = Predicted Notifications Efficacy) make a good foundation for the application of beacon technology in retail, particularly in planning beacon-triggered shopper engagement activities.

RIoT technologies to enhance the customer experience

Since the industry was first established, retailers have been quick to adopt a variety of RIoT technologies in an effort to improve the shopping experience of their end customers. Before the technology in question can be finally integrated in their store's operations or services, the degree to which such technologies are deployed varies (from many to few) from retailer to retailer due to the fact that numerous factors, such as cost and suitability, need to be taken into consideration. Augmented reality virtual mirrors, virtual fitting rooms, visual search, QR codes, mobile wallets, self-checkout stations, and other similar technologies are some examples of various technologies that are included in the RIoT. The various types of RIoT technologies that are currently being used by retailers to improve the shopping experience for customers are outlined in Table 2.

Table 2: Various RIoT technologies applied in the retail sector

RIoT category	Application	Data sources	Details
Immersive/ immobile systems	Product experience wall	RFID, cameras for face recognition, third-party services (e.g., real-time weather data), store data	Interactive, context-specific recommendation system
	Interactive fitting room	RFID, third-party services (e.g., product ratings), store data	Interactive environment that emotionally and functionally connects the consumer with the product
	Smart & social mirrors	RFID, cameras for body scans, third-party services, store data	Interactive, social systems that emotionally involve consumers (e. g., connected to social media)
	Smart shelf	Weight sensors, beacons	Digitally enhanced shelf that allows retailers to keep track of inventory, dynamically change prices, and communicate with consumers in-store based on proximity to a certain product (direct message on smartphone)
	Touch Screen	Digitally linked content	(Non)-interactive device that offers informational and emotional content
Mobile Systems	Mobile apps	Beacons, barcode scanners, sensors	Application that uses of consumers' own mobile devices
	Mobile augmented reality (MAR)	Camera, computer vision-based augmented reality, GPS	Interactive, real-time supplement of real and virtual images by computer-generated data, such as sound, graphics, or GPS data

Hybrid systems	Virtual reality (VR)	Smartphone technology (e.g., 360-degree camera)	360-degree view enabled by a wearable device that immerses consumers in a virtual world and shields them from reality
	Service robots	Cameras for face recognition, third-party services (e.g., real-time weather data), store data GPS, digitally linked content	Interactive device that identifies, addresses, and (emotionally) involves consumers; connects to social media; stores databases of product information; and creates two-sided humanoid interactions
Payment technologies	Self-checkout stations/kiosks	Beacons, barcode scanners, sensors	Customers pay for their purchases without human intervention through digital means.

Source: adapted from Riegger et al. (2021)

IoT in Retail: during and post Covid-19.

Due to the Covid-19 pandemic, many larger retail companies have turned to the use of IoT tools in order to better manage their businesses. For instance, these companies have turned to the use of these tools in order to create a pleasant shopping experience online in order to replace what the customers have been denied as a result of the pandemic, which is the ability to shop in physical stores. The development of contactless and secure shopping experiences has been significantly aided by augmented reality (AR) tools in particular. However, once the Covid-19 pandemic has passed and normal movement has been restored, businesses will return to selling through experiences, which is something that is still very relevant because customer expectations are always shifting. It is anticipated that customers will keep looking for products that offer a higher level of convenience, better value, excitement, relevance, and other forms of social connection. They want to physically interact with, feel, and try out the service before making a final decision. As a result, in order to provide a seamless combination of digitally driven channels and individualised services, retailers need to implement an online-to-offline (O2O) strategy. This is necessary for them to do so because they will be under pressure to connect the dots between online and offline customer interaction. As a direct result of this, retailers are required to seriously consider making investments in omnichannel retail models and the most recent 'Internet of Things' (IoT) technology in order to develop physical stores that are more dynamic and abundant in personalised experiences. While at the same time stores should become technologically enlivened, they should also continue to be attractive, comfortable, and most importantly, safe places for customers to be immersed in the brand and the product. As a consequence of this fact, the Internet of Things (IoT) has been unexpectedly thrust into the spotlight as one of the most significant strategies that has been taken into consideration to combat the spread of COVID-19 around the world.

Concluding Remarks

In this age of Industry 4.0, the deployment of Internet of Things technologies is no longer a choice for businesses; rather, it is a requirement for their continued existence. As a result of the breakneck speed at which technology changes these days, businesses are having trouble keeping up with the most recent technological developments and figuring out how to profit from them. The inability of businesses to take advantage of game-changing tools and innovations like the internet of things is one of the primary contributing factors that led to their demise. Therefore, in order to enable customers to shop (better) in their retail outlets, retailers need to embrace disruptive technologies such as IoT and deploy them strategically in their operations (for example, supply chain). Additionally, retailers need to create immersive in-store experiences for customers. This article has provided some basic understanding of the factors that contribute to or hinder the deployment of IoT in retailing as well as the various types of IoT applications that can help to create an immersive, seamless, and engaging retail experience for end consumers. It is the hope of this article that retailers can utilise these insights to increase their competitive advantage within the industry. The ability of retailers to be both efficient and appealing would allow them to boost domestic consumption while also stimulating spending by tourists.

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