

# Harvesting the digital green: A deeper look at the sustainable revolution brought by next-generation IoT in E-Commerce

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## ABSTRACT

The primary research question investigated was: What is the impact of next-generation Internet of Things (IoT) applications on the e-commerce sector? The specific objectives included exploring the challenges and benefits of IoT in e-commerce and examining the different IoT technologies used in e-commerce. The current study employed a qualitative method of conducting online interviews among seven participants in the e-commerce industry. A key finding was that IoT generally positively affects the e-commerce sector by improving operational efficiency and saving on costs. The advantages of using IoT in e-commerce were also noted to include enabling personalized consumer shopping experience and optimizing supply chain and inventory management that keeps costs. However, increased cybersecurity threat was realized to hurt IoT adoption in e-commerce. The IoT technologies that impacted e-commerce included radio frequency identification (RFID), sensors, and GPS. One limitation of this study was the small sample size, which restricted the generalization of the results. Meanwhile, one recommendation was that e-commerce firms should be encouraged to adopt IoT technologies to increase their efficiency and profitability in the long run.

**Keywords:** Internet-of-things, sustainability, impact, E-commerce, next-generation applications, E-business, Jordan.

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## 1. Introduction

The term Internet of Things (IoT) first appeared in 1999, referring to a network connection of devices to the Internet that allows for the exchange and sending of data through implanted chips and sensors between devices [1]. IoT was considered a revolution in the Internet because it enabled the connection of machine to machine, people to people, and people to machines to the Internet through wireless connection [2]. The unprecedented growth of the Internet since the mid-1990s has fundamentally changed how many organizations run and perform, not only in Jordan but across the globe. One of the revolutions relates to the e-commerce or online business model, which has led many businesses to adapt appropriately [3]. According to the UNCTAD report on e-trade readiness in Jordan, the country's e-commerce state is considered relatively advanced, with a medium readiness index of the UNCTAD B2C E-commerce Index [4]. In other words, e-commerce businesses in Jordan have adopted relevant technologies that enhance e-commerce, such as IoT, to a significant level. The trend reflects the global status of IoT adoption, reported by the "State of IoT—Spring 2023" report as having grown by 18% in 2022 to hit 14.3 billion active IoT endpoints [5].

The statistics point to a growing adoption of IoT by the e-commerce sector. Global IoT connectivity is dominated by Wi-Fi, RFID, sensors, Bluetooth, and Cellular IoT [5]. The IoT has been hailed as having various impacts on e-commerce, with the key benefits being cited to encompass increased efficiency, creation of new revenue streams, improved productivity and sustainability, and enabling higher accuracy. Significant cost reductions through automation can also be considered a crucial impact on e-commerce [2]. On a

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global scale, the impacts have facilitated the growth of e-commerce on a wide range of products [6]. Specifically, IoT has been a crucial digital assistance to e-commerce, as demonstrated by its applications in inventory management, consistent marketing, and dash buttons [7, 8]. In essence, trends indicate that adopting technology in e-commerce has continually facilitated positive contributions in terms of competitiveness and improved consumer experience. There has been a transformation to the global business landscape due to the proliferation of the Next-Generation Internet of Things (IoT), leading to substantial implications for various industries [9-12]. The technology has also been considered to contribute to the spread of the e-commerce sector on a global scale [3]. Despite these observations, there is inconclusive evidence on the actual influence of this evolving technology on the local e-commerce landscape through localized studies such as on the Jordan e-commerce landscape. The available evidence has yet to fully understand the challenges and opportunities posed by next-generation IoT applications in regional settings, such as Jordan's e-commerce sector and market dynamics, including mundane aspects such as sustainability factors [13]. As such, there needs to be more research on the effect of IoT on market dynamics, security, competitiveness, and consumer behavior in e-commerce in Jordan. The current study will adopt the technology adoption model (TAM) in underpinning the study. The model was introduced by Fred Davis in 1989 and has become one of the most popular models for predicting users' perception and adoption of technology [14]. The TAM is shown in Figure 1.

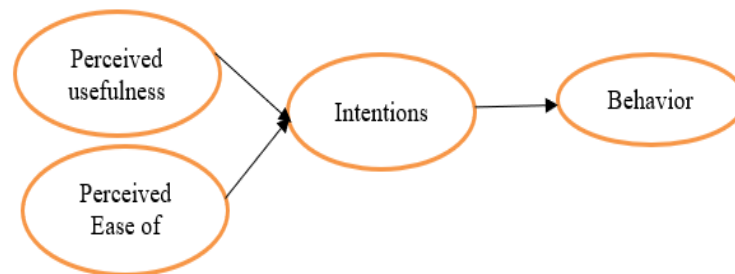


Figure 1. TAM Model

TAM posits that the ease of use of technology and its perceived usefulness are the main determinants of the intention of individuals to use and subsequently adopt a particular technology [14]. According to the model, the perceived ease of use refers to the degree to which technology can be effortlessly integrated into the existing systems without extensive training [15]. The model will be used to demonstrate how IoT can be integrated into the current e-commerce infrastructure in Jordan. The model will also be vital in assessing the technical complexities and challenges businesses face in technological implementation. On the aspect of perceived technological usefulness, the model will be crucial in exploring the business value of IoT and the extent to which it can provide tangible benefits to e-commerce in Jordan. The model will then be applied in determining the behavioral intention towards adopting technology by determining factors that drive the choices of individuals to use next-generation IoT since the theory models how users come to accept technology [16]. As such, the idea will be crucial in modeling the application of various factors that influence technological adoption. The aspect of competitive advantage through the application of IoT has attracted numerous views from researchers. One key finding is that IoT can provide a competitive edge for e-commerce. Specifically, Zhu studied the optimization of e-commerce through IoT. According to the researcher, IoT enables a closer supply chain network structure, hence facilitating stronger business relationships and generating positive attributes such as smoother logistics and transportation, thus enhancing the competitiveness of e-commerce [17]. Through IoT adoption, business can integrate their activities in a much more organized and interactive manner that, in turn, enhances competitiveness in the e-commerce sector. Similar opinions have been asserted by Daryanto and others who investigated the telecommunication industry's competitiveness after the IoT era. The researchers came up with findings pointing to the fact that the development of IoT has facilitated the competitiveness of the e-commerce sector [18].

In the same breath, the views posited by Song and others also pointed out that IoT is crucial in enhancing the performance of e-commerce. The study carried out a case study of Xiaomi, with the results indicating the role of IoT in improving the competitiveness and profitability of the e-commerce sector [19]. The three researchers' results point to IoT's impact in enhancing the competitiveness of e-commerce. In both studies, the researchers utilized methodologies that enhanced the reliability of the observations, hence improving the validity of the results. However, insights from Murdiana and Hajaoui indicate that IoT does not necessarily improve competitive advantage as it has gained widespread application, leveling the playfield for businesses [20].

Despite these differences in evidence, it is clear that the adoption and application of IoT portends significant efficiency and effectiveness for e-commerce. The concept of e-commerce in Jordan is crucial in understanding how IoT helps promote online businesses. Various researchers have noted the concept of e-commerce in Jordan, with one of the findings indicating that aspects of cultural resistance have negatively influenced its adoption. Specifically, Al-Husban and others studied factors facilitating e-commerce in Jordan. The researchers found that e-commerce in Jordan is convenient, with the trade being influenced by several factors, among them cultural resistance, which prevents consumers from using IoT because of fear of their data being gathered by unknown parties [6]. In other words, the observations indicate that despite the trade being considered a convention, its acceptance still experiences significant societal factors. Similar assertions were also made by Abbad, who studied limitations to the use of e-commerce in various developing countries and noted that e-commerce is still not optimally used in Jordan due to concerns related to personal data safety as well as a combination of lack of awareness on e-commerce and practice [21]. In essence, e-commerce can be promoted by addressing data privacy and protection concerns, which enhances confidence in applying the technology. The current study aims to analyze Next-Generation IoT applications' impact on the E-commerce sector. To realize this aim, the study objectives include the following:

1. To examine the benefits of using IoT in e-commerce.
2. To explore the challenges of IoT adoption in the e-commerce sector.
3. To investigate the different types of IoT technologies used in the e-commerce sector.

## 2. Materials and methods

In this section, the methods used to implement this study are presented. The current section also highlights sampling, data collection and analysis, and ethical considerations. A qualitative approach was employed to examine how IoT affects the e-commerce sector. According to Bell et al., the qualitative method involves collecting and analyzing non-numerical data to understand the experiences and perceptions of targeted individuals regarding a topic [22]. For this study, the qualitative approach was deemed suitable because it enables the gathering of detailed data that allows a comprehensive understanding of a phenomenon [23]. The qualitative method was applied in this study by conducting interviews to gather detailed data among participants to understand how IoT impacts e-commerce. The issues considered in the qualitative approach included participant sampling, data gathering, data analysis, and ethical principles. The current study employed purposive sampling in identifying individuals to include as participants. Campbell et al. explain that purposive sampling involves the researchers using their judgment to select participants based on perceived skills, knowledge, or experience that can provide insight into a specific topic [24]. A crucial benefit of purposive sampling is that it is time and cost-effective because the researcher selects a small sample depicting certain pre-determined qualities [25]. This study implemented purposive sampling by first identifying e-commerce and logistics companies in Jordan and recruiting employees working in different IT and supply chain departments. The participants were contacted via LinkedIn after placing their respective e-commerce companies. An essential inclusion criterion was that the participants selected should be conversant with IoT in e-commerce operations. Eventually, a total of seven individuals were included as participants. The selection of seven participants was consistent with the views of Moser and Korstiens, highlighting that for qualitative research, a minimum of five participants is required to reach saturation [26]. A summary of the participants' profiles is shown in Table 1.

Table 1. Profile of selected participants

Participant code	Job Title	Age	Gender
- P1	- Logistics manager	- 26-35	- Male
- P2	- Logistics planner	- 26-35	- Female
- P3	- Warehouse manager	- 36-45	- Female
- P4	- Physical logistics manager	- 46-65	- Male
- P5	- Logistics manager	- 26-35	- Male
- P6	- Logistics manager	- 18-25	- Female
- P7	- Physical logistics manager	- 46-65	- Male

Firstly, the targeted individuals were contacted through LinkedIn and then emailed consent forms to provide permission to engage as participants. The consent form used is shown in Appendix A. Secondly, the participants who provided consent were involved in online interviews via the Zoom platform. According to Oliffe et al., online discussions provide advantages of flexibility in data collection and participants' convenience and cost savings [27]. The interviews were conducted over three days, each lasting about 30 minutes. The interview sheet used in gathering data is shown in Appendix B. The questions used in the interviews were aligned with research questions to ensure the accuracy and reliability of the findings.

Moreover, the questions were modified from the work of Bieringer and Muller, who also explored a similar topic in the German context [28]. In conducting the interviews, the researcher helped to moderate the process by clarifying the questions to ensure the participants understood them. Due to the qualitative data gathered, this study relied on thematic analysis to synthesize the collected data. Thematic analysis provides flexibility in data interpretation to ensure that perceived critical responses are used as supportive evidence to conclude a phenomenon [29]. Several steps were taken to complete the thematic analysis, as explained by Clarke et al. [30]. Specifically, the first step involved transcribing audio files to textual format and then going through the data to familiarize with the major issues highlighted by the participants. The second step involved coding the data by highlighting sentences that express similar ideas with the same color to show the codes. The developed codes were categorized into subthemes and themes, and a write-up of the findings was then done. In addition, the first ethical principle followed involved informed consent, which involved seeking permission from targeted individuals before engaging them as participants. Seeking informed consent in research helps to show that participants are not coerced but instead voluntarily agree to share opinions in the study [31]. The second ethical principle observed was autonomy, which entails allowing participants to withdraw from a study without adverse consequences. Freedom protects participants from physical and psychological harm during research [32]. The third ethical principle involves confidentiality, which entails hiding the personal details of participants, such as their names and email addresses [33]. The strategy ensures that participants are not victimized based on their opinions expressed in the study. For this study, confidentiality was defined as restricting access to interview data by storing them in computer files with solid passwords [34-41].

### 3. Results

The analysis enabled the generation of several themes summarized in Table 2.

Table 2. Themes from data analysis

<b>Benefits of IoT in E-commerce</b>	<b>Challenges Affecting Adoption of IoT in E-commerce</b>	<b>Impact of IoT on E-commerce</b>
- IoT optimizes supply chain and tracking of orders	- Requires extensive training of employees to be implemented	- Positively impacted e-commerce by improving efficiency
- IoT ensures personalized shopping experience by consumers through tailored recommendations	- Limited budget to acquire IoT technology and equipment can hinder adoption	- Positively impacted e-commerce by reducing costs
- IoT ensures automation, thereby improving inventory management	- Breach of customer privacy data can lead to legal troubles	- Negatively affected e-commerce by increasing cybersecurity threat

The current study explored the benefits of using next-generation IoT in e-commerce. One finding from participants 1 and 3 was that IoT optimizes inventory management [42]. Specifically, participant 1 explained [39, 40, 43-45]. "One advantage of IoT related to RFID is that it improves inventory management through automated stock monitoring to ensure purchased products are automatically detected and data issued for replacements needed without physical stock-taking." (P1) The quote indicates that IoT can provide detailed data on consumer purchase patterns, enabling e-commerce retailers to identify peak and low seasons and plan appropriately.

Similarly, participant 7 noted that IoT optimizes the supply chain by allowing retailers to keep track of shipments from suppliers and those dispatched to customers. In particular, participant 7 stated: "IoT technology

has RFID and GPS enabled systems which ensure retailers can track orders from suppliers and those sent to customers from the store, thereby optimizing the supply chain.” (P7). The result implies that through next-generation IoT, e-commerce retailers can find out whether damage to products occurs during the shipping process, identify delays, and better communicate with suppliers and customers. The other result noted by participants 2, 4, and 5 was that IoT helped to improve customer satisfaction by enhancing shopping experience. On this issue, participant 5 highlighted:

“IoT can gather data on consumer behavior in smart devices and enable e-commerce retailers to anticipate customer needs and develop personalized shopping experiences.” (P5). The quote shows that IoT ensures e-commerce retailers can make suitable product recommendations to online consumers based on their previous purchase patterns, increasing customer satisfaction and improving sales.

The current research also examined the challenges of adopting next-generation IoT in e-commerce. One challenge noted by participants 3 and 4 was that IoT adoption is accompanied by extensive training of employees on how to use the technologies for route optimization in logistics and marketing strategies. Specifically, participant 3 explained: "Implementing IoT requires a large budget to be allocated for employee training, which can hinder adoption by smaller firms." (P3). The quote shows that expenses related to educating employees on using IoT to benefit the company can be high. Hence, the company's financial stability is an essential eligibility criterion for adopting IoT. Similar views were shared by respondents 2 and 6, who noted that the high costs of acquiring cloud infrastructure to support IoT technologies could limit the adoption of IoT. On that note, participant 2 explained: “IoT relies on cloud infrastructure since IoT can only communicate data to e-commerce retail systems through the cloud. Therefore, investment in cloud infrastructure and stable Internet is needed in e-commerce IoT usage.” (P2). The finding reveals that IoT technologies are accompanied by high costs in acquiring related supporting infrastructure, which small businesses need help to afford, hindering IoT adoption in such cases. Although participants 4 and 7 also recognized cloud infrastructure as a challenge in IoT use in e-commerce, the respondents highlighted that the risk of hacking in such cases was the bigger problem in the long run. In particular, participant 4 noted:

“The risk of data being hacked when using IoT cloud systems is high, which can lead to customer information being stolen and culminate in legal battles.” (P4). The quote indicates that IoT presents an opportunity for cybercriminals to illegally acquire crucial customer information, such as credit cards and passwords, which they can use to steal money from their online accounts. The finding shows the need to develop extensive cybersecurity systems when implementing IoT in e-commerce.

The interview data gathered revealed that most participants perceived IoT to have a generally positive impact on e-commerce. Specifically, participants 1 and 6 agreed that IoT helps to improve operational efficiency in e-commerce. On this issue, participant 6 posited: “Yes, I think that IoT has positively impacted e-commerce. The use of RFID tags has significantly helped improve operations efficiency because it can detect goods entering and leaving the storage facility. This reduces the need to scan every item for the company and saves costs.” (P6) The views suggest that IoT is beneficial when suppliers use required RFID tags on their products, thereby reducing the logistics process of identifying products that enter or leave storage facilities in e-commerce. The views of Participant 6 were also supported by Participant 2, who explained that IoT has a positive impact by highlighting that: “Yes, e-commerce has been positively impacted by IoT. Currently, there are sensor devices that can detect the changes in pressure, temperature, and vibration and provide feedback to the industrial equipment on optimizing conditions in storage facilities, thereby reducing losses related to perishable goods getting damaged.” (P2). The quote reveals that IoT technology supports e-commerce businesses through autonomous maintenance of storage conditions to ensure the goods are in good condition over the long run. However, a few participants, such as participants 3 and 4, also expressed the view that IoT negatively affected their e-commerce operations by increasing risks of cybersecurity threats. In particular, participant 4 explained: “No, IoT has negatively affected e-commerce because of increased vulnerability to cybersecurity threats. Currently, attackers can easily access consumer passwords and credit card numbers without implementing security systems.” (P4). The finding suggests that IoT lacks an inbuilt security system and requires the company to spend on setting up such systems alongside IoT implementation. In this regard, IoT use is restricted to medium and large-sized firms with the financial ability to implement cybersecurity systems.

#### 4. Discussion

A discussion of results from the interview conducted is presented in this section. The subtopics covered include the benefits and challenges of IoT adoption in E-commerce and the impact of IoT in e-commerce. Moreover,

the study's limitations and recommendations are presented. The first objective explored in this study involved the benefits presented by IoT in e-commerce. The objective was addressed with the obtained result showing that IoT technologies involving RFID and GPS enabled optimization of supply chain and inventory management because they helped to improve the tracking of goods from the suppliers to the consumers. The finding was consistent with the view of Zhu, who also noted that IoT improved interactions of stakeholders in the supply chain and ensured better logistics management, which gave online businesses a competitive advantage of faster customer service [13]. The obtained result can also be explained using the TAM model, which demonstrates that the perceived usefulness of a technology influences whether it is adopted by different players in an industry [11]. In this study, the findings showed that IoT provided the benefit of improved efficiency of e-commerce operations, which influenced its increased adoption in the sector. The second result from the interviews was that IoT enhances consumer shopping experience through tailored marketing and product recommendations. However, the result contrasts the views of Al-Husban, who noted that Jordanian consumers resisted online shopping because they feared IoT technology could be used to monitor their online shopping behavior and infringe on their privacy [6]. In this respect, it is noted that while IoT can present the benefit to e-commerce retailers of a better understanding of consumer behavior, the perceived advantage can generate distrust among consumers. The second objective of this research involved examining the challenges associated with IoT adoption in e-commerce. The first result showed that adopting IoT is associated with higher costs of training employees and high costs of acquiring the technologies and related cloud infrastructure. The result contrasts Song et al., who pointed out that IoT adoption increased profitability by reducing operation costs [15]. In this respect, it is realized that while IoT can reduce costs in the long run, the initial costs of setting up the IoT system, employee training, and related cloud infrastructure are expensive and can prevent smaller firms from adopting the technologies. The obtained result can also be explained by TAM, where Davis explained that technology adoption depends on perceived ease of use. Hence, companies will likely adopt technologies with lower operational costs [11]. As such, it is realized that IoT use is complex and requires extensive training of e-commerce employees, which may limit its usage in the sector. The second result noted was that IoT adoption increased the risk of breaching customer privacy data, which can lead to legal disputes. The result is consistent with the views of Al-Husban et al. and Abbad, who highlighted that concerns about data integrity when using IoT systems hinder most firms and consumers from using IoT-related products [6][16]. Therefore, addressing data protection issues in IoT can improve confidence in using the technologies and increase applicability in e-commerce. The primary aim of this study was to analyze the IoT effect on the e-commerce sector. The aim was achieved with the obtained findings showing that despite a few issues, IoT has a largely positive impact on e-commerce operations. Firstly, the results indicated that IoT improved the efficiency of e-commerce and reduced operational costs in the process. In particular, it was realized that IoT technologies such as sensors and RFID ensure goods entering and leaving storage facilities do not need manual scanning and verification since RFID automatically does so. Similarly, the sensors help keep the storage environment regulated to ensure the products are in good condition for the long term. The result resonates with that of Song et al., who observed that firms that adopted IoT depicted higher profitability related to increased competitiveness [15]. Therefore, the results suggest that when IoT technologies such as temperature sensors and RFID are used, the cost savings incurred during storage and improved product management efficiency enable e-commerce firms to record higher profits. The finding can also be explained by the TAM, which emphasizes that technologies are likely to be adopted if they present perceived usefulness, which adds value to a company [12]. As such, the positive impacts related to IoT were noted to have positive financial effects, which provides incentives for their adoption in the e-commerce sector. Despite the positive effects of IoT, a negative impact is also noted, involving an increased risk of data hacking, which can adversely affect customer trust and satisfaction. The result was similar to that of Abbad, who underlined that in Jordan, concerns of personal data safety where IoT is used limited optimal use of the technologies in the e-commerce sector [16]. In this respect, the current study findings revealed that to increase the positive impact of IoT on e-commerce, more efforts should be directed towards developing strict regulations on data privacy where IoT is involved to improve consumer confidence.

## **5. Conclusion and recommendations**

The significance of current research will be crucial to several stakeholders. The findings will expand knowledge and academic understanding of how the next-generation IoT technologies can influence various industries. The results of this study will also be crucial to policymakers in identifying essential policies that can aid in fostering an environment conducive to IoT innovation in the e-commerce sector. The study will also guide businesses in gaining an understanding of IoT adoption in a manner that can enhance their competitive edge. The current

research is crucial in linking the study case to the global perspective, providing valuable insights on leveraging IoT to promote e-commerce in various contexts. Overall, the study dissemination will aid in improving outcomes in the e-commerce sector through enhancing operations. One recommendation for practice is that e-commerce companies should clarify with customers the type of data collected using IoT technology installed on products to prevent legal disputes. The other recommendation for training is that e-commerce firms adopt next-generation IoT to improve inventory management, optimize the supply chain, and enhance profitability in the long run due to reduced operational costs. Meanwhile, one recommendation for future research is that future researchers should conduct quantitative analysis to determine the IoT benefits that can significantly impact profits to ensure more relevant proposals are made concerning IoT use in e-commerce. Additionally, more research is needed to develop a solid legal framework to address data privacy issues in IoT systems.

### Declaration of competing interest

The authors declare that they have no known financial or non-financial competing interests in material discussed in this paper.

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