2023

Secure Strategies for Internet of Things Implementation in Warehouse Environments

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This is to certify that the doctoral study by

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has been found to be complete and satisfactory in all respects,
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Walden University
2023

Abstract

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MS, Walden University, 2018

BS, University of North Texas, 2014

Doctoral Study Submitted in Partial Fulfillment

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Abstract

The internet of things (IoT) in warehouse environments may present security issues and challenges. These issues and challenges may impact information technology (IT) leadership in warehouse environments because a lack of security strategy adoption may lead to increased network breaches. Grounded in the technology acceptance model, the purpose of this quantitative correlational study was to examine the relationship between IT leaderships' perceived ease-of-use, perceived usefulness of IoT devices, and their intent to adopt security strategies for IoT implementation in warehouse environments. Data were collected from IT leaders in North Texas warehouse environments using a peer-reviewed adoption survey from PsycTESTS.org. The results of the regression indicated that the model was insignificant, $F(2, 66) = 1.721$, $p > .05$, $R^2 = 0.50$. However, IT leadership's Perceived Usefulness ($\beta = .233$) contributed more to the model than IT leadership's Perceived Ease of Use ($\beta = -.044$). A key recommendation is for IT leaders to incorporate strategies to increase their perceived ease of usefulness. The implications for social change include the potential to increase the efficiency of warehousing and ensure the successful delivery of product for citizens.

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Dedication

I dedicate this work to my wife Tola. I appreciate all the support you have given me. Thank you for being there for me during the long nights while on this journey. Without you, this would be impossible to achieve.

I also dedicate this work to my daughters Omina and Zara. You all are the motivating factor that allowed me to continue in every moment I felt stuck. You both mean the world to me, and I am forever thankful.

To all of my family and close friends who supported me on this journey, thank you.

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Section 1: Foundation of the Study

In this study, I used a quantitative methodology with correlational design to examine the relationship between information technology (IT) leaderships' perceptions as they related to the adoption of security strategies. The findings from this study may provide a foundational knowledge for IT leadership on establishing secure processes when implementing internet of things (IoT) and automation in the warehouse.

Background of the Problem

IoT bridges the gap between the digital and physical world in warehouse environments while increasing the possibility of network breaches and cyber-attacks using handhelds, smart glasses, and automation. Introducing this concept to enterprise networks has improved the supply chain and technologies such as edge computing, which has allowed organizations to monitor and perform real-time tracing of products and goods (Sergi et al., 2021). IT leaders are deploying smart lockers, IT room smart thermal sensors, and conveyor systems in warehouses across the supply channel. However, as these IoT devices are deployed on the network, the possibilities for network breaches or cyber-attacks increase in the supply chain. Paulsen (2020) identified that 50 to 80% of network breaches originate within the supply chain. Thus, deploying and leveraging IoT devices, such as drones and robotics, in the warehouse requires specific standards and protocols (Paulsen, 2020). Due to the variety of atypical devices and connections to the network, a level of understanding surrounding the vulnerabilities of IoT deployment must be met from an IT security standpoint. Within the literature review, a gap was identified, characterized as a need for more research surrounding the lack of security strategy adoption when implementing IoT in warehouse environments. In this study, I aimed to determine the relationship between IT leaderships' perceived ease-of-use and perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation in warehouse environments.

Problem Statement

Warehouses are improving the efficiency of logistic processes and supply chains with IoT devices, such as drones and robot automation, while generating potential vulnerabilities for network breaches (Cheung et al., 2021). In the United States, since 2015, the frequency in which data breaches occurred increased considerably by 60% (Tawalbeh et al., 2020). The general IT problem is that some IT leaders in warehouse environments lack knowledge of how to implement security strategies. The specific IT problem is that some IT leaders in warehouse environments lack knowledge of how to implement security strategies when using IoT devices.

Purpose Statement

The purpose of this quantitative correlational study was to examine the relationship between IT leaders' perceived ease-of-use and perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation. The independent variables were IT leaderships' perceived ease-of-use of IoT devices and IT leaderships' perceived usefulness of IoT devices. The dependent variable was IT leaderships' intent to adopt security strategies for IoT implementation. The target population of this study consisted of IT leaders from warehousing organizations in North Texas who have (a) implemented IoT devices and are experiencing challenges, (b) implemented IoT devices without challenges, and (c) intend to adopt security strategies for IoT implementation. The implication for positive social change lies in the potential to improve and assure the supply channel in North Texas through improved security practices. Secure IoT implementations may help the supply chain channel push products to the public within North Texas more efficiently without disrupting services due to network outages caused by security breaches. IoT implementations may assist in increased production and performance of warehouse employees as the use of automation and robotics increases the efficiency of work. As warehouse environments adopt strategies to implement IoT devices securely, the focus can be placed on reducing delays in the supply channel and less on security-related network breaches and outages.

Nature of the Study

I used a quantitative research method to address the research questions in this doctoral study. The specific research design was correlational. Quantitative studies are designed to capture numerical data, investigate relationships between variables, and allow other researchers to replicate (Adam, 2022). In this study, I examined the relationship between both independent and dependent variables. Qualitative methods aim to examine observations and reports of the phenomena as they occur in everyday life or natural settings (Aspers & Corte, 2019). I did not aim to explore in-depth understandings concerning everyday life or natural settings. According to Dossett et al. (2020), mixed-methods research combines both quantitative and qualitative within a single study by integrating two data types, allowing for a comprehensive and enhanced understanding of a research question. I did not use qualitative methodology. Due to the lack of qualitative methodology, a mixed method was also unsuitable for this study.

The design within the quantitative method was a nonexperimental correlational design. Correlational research is nonexperimental research that explains the relationship among variables (Seeram, 2019). Researchers use this design to investigate the extent to which variables are related. In this study, I aimed to determine the existence of relationships between independent and dependent variables. Experimental and quasi-experimental were not suitable for this study. Quasi-experimental designs are observational studies that lack randomization, as groups can self-select (Maciejewski, 2018). I did not provide descriptions of the characteristics of population samples solely; therefore, a descriptive design was not suitable. Instead, I aimed to determine if relationships exist between independent and dependent variables.

Research Questions

1. What is the relationship between IT leaders' perceived ease-of-use of IoT devices and their intent to adopt security strategies for IoT implementation?

2. What is the relationship between IT leaders' perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation?

Hypotheses

$H1_0$: There is no statistically significant relationship between IT leaders' perceived ease-of-use of IoT devices and their intent to adopt security strategies for IoT implementation.

$H1_1$: There is a statistically significant relationship between IT leaders' perceived ease-of-use of IoT devices and their intent to adopt security strategies for IoT implementation.

$H2_0$: There is no statistically significant relationship between IT leaders' perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation.

$H2_1$: There is a statistically significant relationship between IT leaders' perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation.

Theoretical Framework

The theory that grounded this study was the technology acceptance model (TAM). The TAM model is an influential TAM that includes two primary factors influencing an individual's intention to use new technology: perceived ease of use and perceived usefulness (Charness & Boot, 2016). Developed by Davis in 1989, this model assumes that beliefs surrounding usefulness and ease of use are the primary determinants of technology adoption (as cited in Zamani & Shoghlabad, 2012). The critical concepts of TAM include perceived usefulness and perceived ease of use (Zamani & Shoghlabad, 2012). The TAM framework applied to this study as I examined the relationship between IT leaderships' perceived ease-of-use and perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation in warehouse environments. The logical connections between the framework presented and the nature of this study included adoption and the intention to use new technology based on perceived usefulness and perceived ease of use. Perceived usefulness is the degree to which people believe that using technology can help them increase performance, while perceived ease of use is easy and free of effort (Attié & Meyer-Waarden, 2022). The TAM framework assisted me in examining the relationship between IT leaderships' perceptions of security strategy adoption and the intent to adopt those strategies related to IoT implementation.

Definition of Terms

Internet of Things (IoT): Well-defined scheme of interconnected computing tactics, digital, and mechanical devices possessing the capability of transmission of data over the defined network without having any human involvement at any level (Singh et al., 2020).

Third-party logistics: Third-party logistics is a logistics as a service provider, primarily focusing on warehouse management activities such as inventory control, packaging, and order processing (Kodithuwakku et al., 2022).

Warehouse: A warehouse is a large facility where manufactured goods and raw materials are stored (Żuchowski, 2022).

Warehouse automation: Warehouse automation is the use of robotics to move goods within a warehouse facility while reducing the labor tasks categorized as labor intensive for warehouse employees (Balachandran et al., 2022).

Assumptions, Limitations, and Delimitations

Assumptions

Assumptions in research are assumed to be true about the information gathered within the study and assist in shaping the interpretation of findings (Almasri &

McDonald, 2021). Although assumptions are considered facts about the study, they are not verified. Researchers need to identify assumptions within a study so they are addressed, as assumptions may not be accurate. Assumptions are considered implicit beliefs and values that guide the development and implementation of a study (Tracey & Tice, 2020). The first assumption of this study was that participants would not complete more than one questionnaire concerning this study. I also assumed that the participants understood the basics surrounding IoT devices. Another assumption was that participants voluntarily took part in this study.

Limitations

Limitations are implications within a study that should be addressed in future research studies on a similar topic (Olufowote, 2017). A limitation addressed while conducting this study was that participants were limited to IT leadership in warehouse environments in North Texas. Furthermore, participants in this study are likely not representative of other IT leaders in other industries. Another limitation was the closed-ended nature of the survey questions. As a result, responses were narrowed, and questions did not allow for additional insight. A third limitation was the use of an internet-based survey. Internet-based surveys limited some access to participants as they may not have had internet access. Lastly, generalizability to a more significant population was not feasible as the study was limited to warehouse environments in North Texas.

Delimitations

Delimitations in research establish boundaries and assist in making the study more replicable (Naar, 2021). The scope of this study was limited to warehouse environments in North Texas. The study's boundaries were limited to a survey of IT leadership in warehouse environments.

Significance of the Study

Contribution to IT Practice

This study was significant in that the implications of the study's results for researchers may add to the body of knowledge surrounding IoT and IoT security. This study may be of value to IT practitioners in that it may provide organizations with the knowledge to understand the factors influencing the adoption of security strategies for IoT devices in warehouse environments. Examining secure IoT implementation may lead to improved warehouse efficiency and increased use of automation and robotics in warehouse environments.

Implications for Social Change

The results of this study might contribute to social change by significantly and positively impacting the supply channel in the North Texas region due to decreased disruption to services in warehouse operations. Citizens may be positively impacted as consumer products such as groceries and clothing are ordered and delivered on time due to network outages in warehouses and distribution centers. Positive social impact may be realized as necessity items get to the citizens and consumers more efficiently. IT leaders may use this study’s results to establish security processes when implementing IoT and automation in the warehouse. IT leaders may also use this study’s conclusions to better understand warehouse metrics using IoT devices to ensure that no disruption in the warehouse will impact the supply chain and consumers.

A Review of the Professional and Academic Literature

In this quantitative correlational study, I aimed to examine the relationship between IT leaders' (a) perceived ease-of-use, (b) perceived usefulness of IoT devices, and (c) their intent to adopt security strategies when using IoT devices in warehouse environments. The null hypotheses stated that there is no statistically significant relationship between IT leaders' perceived ease-of-use and perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation. The alternative hypotheses stated that there is a statistically significant relationship between IT leaders' perceived ease-of-use and perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation. According to Kremenak (2010), the literature review should be as comprehensive as necessary to describe and provide a background on previous studies that are related to the same topic. In doing so, there was justification provided for the research and the gaps are presented within the current literature. This literature review consists of a compilation of literature that examined the relationship between IT leaders' perceived ease-of-use and perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation. This literature review contains peer-reviewed articles mostly confined to the past 5 years. The literature review includes content from Google Scholar, EBSCO, ProQuest, Walden University Library, and Thoreau. In conducting a comprehensive search for literature, I identified 189 resources in this study, with 160 (85%) peer-reviewed and published within 5 years. There are 90 citations included in the literature review. Of the citations listed in the literature review, 85% are peer-reviewed, and 80% were published within the last 5 years. I reviewed literature on IoT security, warehousing, supply chain, security strategies, and TAM. The strategy used in searching for literature comprised of keyword searches within the database. The keywords included *IoT, supply chain, warehouse, security, cloud deployment, AWS well architected framework, IoT lens, IoT architecture, IoT connectivity, supply chain management, IoT challenges, supply chain challenges, warehouse challenges, IoT infrastructure, IT infrastructure,* and *IoT-SC.* This academic literature primarily focused on adoption of security strategies and intentions to adopt security strategies as it relates to IoT devices and their implementation in warehouse environments.

Warehouse

Overview of Warehouse Environments

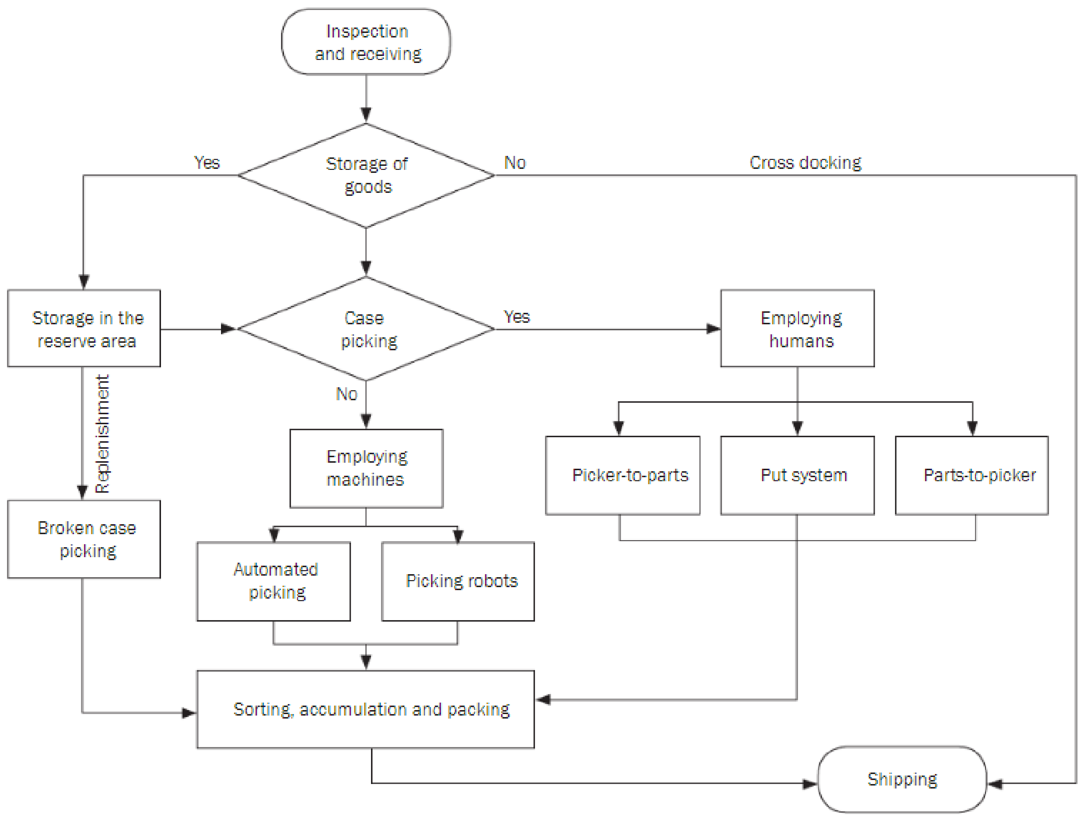
Warehouses are identified as a vital component of the supply chain, and their optimization is fundamental to accomplishing global efficiency (Alonso-Ayuso et al., 2013). Similarly, Chakroun et al. (2018) identified warehouses as a vital piece of the supply chain and contributed 20% of the cost from a logistics perspective. Warehouses allow organizations to receive and ship products in and out of their distribution centers. It is estimated that organizations spend $350 billion a year on warehousing (Dekhne & Sigh, 2020). This number has continued to rise due to increased costs and decreased pick sizes, further highlighting the importance of warehousing as part of the supply channel. A warehouse is a large building in which goods or raw materials are stored before being released from distribution to the market for sale (Dragomirov, 2019). A warehouse environment's functionality allows for increased logistics system efficiency, as an organization must continue its sales, distribution, and revenue flow. Most businesses that conduct business in manufacturing, importing, exporting, and transporting goods must have a warehouse as part of their logistics. These environments provide more control over the organization's inventory while ensuring customers receive their ordered products on time, which leads to increased revenue (Picincu, 2019).

Additionally, these environments create and ensure price stabilization. Costs for any particular product fluctuate yearly and from month to month. The ability to store products for a later date to match the high demand of a particular market assists in ensuring price stabilization and reduced revenue loss (Picincu, 2019).

From an operational standpoint, warehouse operations comprise receiving products inbound, shipping products outbound, storing material, and order picking. Receiving is the initial step for warehouse operations and is initiated when the facility is notified of the arrival of goods, raw materials, or products (Karásek, 2013). Once received by warehouse operation, the product is stored in a put-away location in racking within the warehouse. Storage in a put-away location is vital for the operation as the process requires roughly 15% of the operational cost due to the multiple transfers from the truck to the storage location (Karásek, 2013). The last key component in warehouse operation is outbound or shipping. Outbound involves tasks to ensure the product vacates the warehouse based on market dynamics (Faber et al., 2013). Figure 1 shows the standard warehouse operation flow.

Figure 1

Standard Warehouse Operation Flow



Note. Reprinted with permission from Habazin et al., 2017, p. 58

These functionalities within a warehouse are controlled or handled by a warehouse management system (WMS). According to Fauzan et al. (2020), the WMS primarily aims to control the movement and storage of products in warehouse environments related to outbound, inbound, put-away, and picking. This technical solution assists in streamlining the warehouse process better to manage the supply chain operation from the distribution center to store shelves while managing the organization's physical inventory (Dakic, 2021). WMSs also allow for improved access to inventory, better access to shipping data, and quick identification of issues within the warehouse to avoid shipping delays (Kodithuwakku et al., 2022).

Supply Chain

The supply chain is a network of resources that have a role in the inception and distribution of any product (Lutkevich, 2021). In differing literature, Waters (2019) also stated that supply chain consists of a series of activities and organizations combined in which materials funnel through to customer locations. A supply chain includes raw materials, manufacturers, warehouses, and distribution centers. Considering that a warehouse consists of inventory, issues at this point in the supply chain may negatively impact a supply chain's product availability (Chinello et al., 2020). Waters also identified that 52% of managers reported globalization as a vulnerability in the supply chain. These factors outline the importance of our supply chain. Warehouses are the focal point of the supply chain as warehouses are needed to ensure costs are managed while improving the efficiency of the supply chain in its totality. A disruption in the warehouse portion of the supply chain may entirely impact the supply channel (Van den Brink et al., 2020). Welburn (2021) identified the ransomware attack on Colonial and the SolarWinds network breach as examples of cyber-related supply chain disruptions, as gas supply and software supply were limited for customers.

Warehouse Technology Challenges

Warehouse environments consist of many challenges, from operational to technological. These environments have relied on human processes traditionally. With the advancement of technology, organizations have worked to adopt innovative technology to improve the efficiency of warehousing and logistics. Challenges in the logistic process are mitigated by implementing new technology that enables efficiency and increases production (Buntak et al., 2019). Warehouses are also faced with the challenge of adopting new and innovative technologies. However, with the adoption of new technology such as the IoT, blockchain, big data analytics, artificial intelligence, machine learning, deep learning, and robotics, warehouses may have the ability to be positively transformed (Van Geest et al., 2021). Warehouses are also often faced with challenges related to labor, labor control, worker resistance, and staffing (Vallas et al., 2022). Technologies such as automation in the warehouse may assist in reducing labor and staffing challenges by creating an environment where warehouse workers can become interchangeable with robots (Delfanti & Frey, 2020).

Warehouse Network Security

Warehouse environments are continuously working to improve and develop from a technology perspective. As warehouses improve, the communication channels between other endpoints within the supply chain also grow. Bandyopadhyay et al. (2010) identified that communication networks and supply chain integration exacerbate information security risks. In addition to the lack of security in the communication channels within the supply chain, warehouses face network security challenges such as software or WMS vulnerabilities and physical network security vulnerabilities. The WMS is the technology responsible for the operational processes of a warehouse and manages to receive products inbound, ship products outbound, store material, and order picking (Fauzan et al., 2020). Many organizations face challenges related to network security concerning the operational supply chain (Martin, 2020). Thus, warehouse environments are still looking to identify strategies to grow their security posture in this arena. According to Melnyk et al. (2022), security in the warehouse environment is growing in criticality, and cybersecurity across the supply chain presents a gap in research. Cybersecurity in warehousing, logistics, and the supply channel is vital for everyday functionality. As these components are impacted, consumers will experience delays in receiving the product, or no delivery may occur.

IoT

IoT interconnected systems can provide a platform for machine learning and analytics (Singh et al., 2020). Similarly, Dorsemaine (2015) mentioned that IoT is connected objects associated with architecture, including data that must be transported and made readily available. Although this technology is relatively new, IoT's impact from a societal perspective is essential. The literature review addresses the fundamentals of IoT, the benefits of IoT use, and the challenges that IoT presents. Additionally, the literature review addresses those components of IoT as it relates to warehouse environments and the supply chain.

Fundamentally, the architecture surrounding IoT is based on three components or layers that comprise the system. Hassan (2019) identified that the elements involved in an IoT system include the device and hardware, messaging protocols, and services. The hardware component can be items such as sensors or actuators. At their core, sensors are responsible for the technology in which one form of energy is converted into another

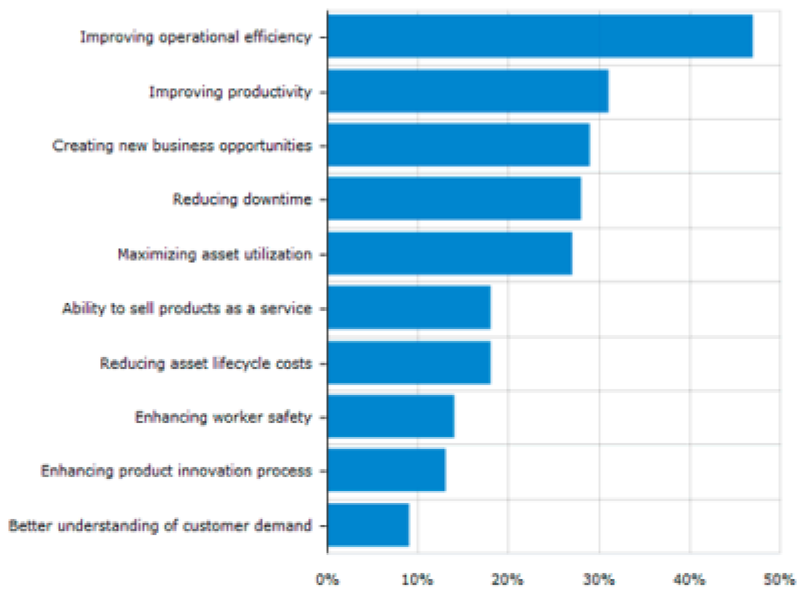
(Stergiou et al., 2018). Closely related to the sensor, the actuator converts particular energy, such as electrical, magnetic, or thermal, into physical actions or objects (Kamal, 2022). From an IoT perspective, sensors allow for a collection of any specific device's performance, while actuators assist in automating actions or tasks in the environment. The second component of IoT architecture involves messaging protocols. A variety of protocols exist, such as Message Queue Telemetry Transport, Extensible Messaging and Presence Protocol, and Data Distribution Service, to name a few. Selecting a particular protocol during development depends on the type of IoT device being deployed in addition to the layer and functionality (Stergiou et al., 2018). Lastly, cloud or cloud service providers provide services to IoT systems, such as IBM Cloud or Amazon Web Services (Hassan, 2019). These service providers make for more availability in the IoT environment.

IoT's fundamental premise and goal are to interconnect devices not currently connected to a network to allow communication and interaction (Hanes et al., 2017). This technology has grown exponentially since the term IoT was coined by Ashton in 1999 while working for Proctor and Gamble (Hanes et al., 2017). IoT has an impact and implications on society and its end users. IoT fundamentally alters warehouse environments, businesses, human interactions, and differing technology.

The IoT assists in everyday activities. Using IoT technology to tag vehicles to identify their location is a benefit of IoT to prevent theft. From a benefits perspective, IoT may assist organizations in increasing production and processes while having the ability to obtain real-time data for organizational analysis (Fetahu et al., 2022). The ability to gather and obtain rich data from sensors and tooling from IoT devices benefits society. Like Fetahu, Balaji et al. (2019) identified IoT as a platform that eases the work from a manufacturer and end-user point of view. Figure 2 displays IoT adoption in relation to efficiency and productivity.

Figure 2

IoT Adoption in Relation to Efficiency and Productivity



Note. Reprinted with permission from Fetahu et al., 2022, p. 402

IoT Challenges

With the many positive factors related to IoT, such as consumer satisfaction, improved data collection, and technology monitoring, IoT is accompanied by many challenges (Hendrik Sebastian & Hartmann, 2019). The advancements in this technology have allowed for a proliferation of new IoT devices to be implemented and deployed in the field. Kumar et al. (2019) stated that the extensive development and expansion of IoT network and the number of these interconnected devices are exponentially and swiftly increasing. The challenge then becomes how businesses maintain the security component of IoT devices when there is rapid growth in the amount and varying types of devices. Security is a key factor and aspect of IoT deployment and is a major challenge. Security from an IT standpoint is necessary for IoT deployment to ensure network functionality, protect data privacy, and ensure the exchange of sensitive data maintains integrity (Bodei et al., 2019). Bodei et al. (2019) also identified that former manual processes that have been automated due to IoT are more susceptible to cyber-attacks. As IoT devices are accessed from various locations, the challenge is to ensure the devices are protected. The lack of security is identified in IoT devices. Furthermore, Yousefnezhad et al. (2020) identified network security as a primary challenge related to IoT environments. As this technology continues to proliferate, it is more readily a target for adversaries and network breaches. Cyber security and network breaches have been identified as top issues due to novel vulnerability attacks (Cangea, 2019). These devices are a key focus as IoT devices involve user data and sensitive information that is obtainable.

Additionally, physical security is a concern or challenge for IoT devices. Physical security is defined as securing the physical and tangible components of the hardware (Yousefnezhad et al., 2020). From an IoT perspective, many devices deployed in environments lack maturity in their physical security posture. Warehouse environments consist of environments in which network and physical security are lacking from an IoT point of view. In the literature review, I will discuss further the connection between IoT devices, security challenges, and warehouse environments.

IoT in Warehouse and Supply Chain

Understanding technical challenges related to IoT may assist in the future development of the supply chain (Eryarsoy et al., 2022). Organizations are adapting to innovative and new technology. More specifically, innovations in warehouse environments force the adaptation of current business models into models based on current and modern technology (Buntak et al., 2019). An example of innovative IoT technology in a warehouse environment is when corrosive goods are stored, and sensing functions of IoT positioning are used to understand the storage environment and mitigate environmental changes risks (Chen et al., 2022). The use of IoT devices in warehouse environments improves the supply channel's efficiency, assists consumers, and enhances the receipt of products or goods. Sun et al. (2020) identified that using IoT devices in warehouse environments increases the efficiency of logistical product movement. Another example of IoT in the supply channel is using the Azure Sphere platform with the MT3620 device (Sergi et al., 2021). The Azure Sphere platform allows for end-to-end tracing of transported goods.

Adoption

Theoretical Foundation

Multiple theories exist surrounding the adoption of innovative and original technology. This study aims to examine the relationship between IT leaders perceived ease-of-use and perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation in warehouse environments. Malatji et al. (2020) identify that the TAM can be used to study intentions about perceived ease of use (PEOU) and perceived usefulness (PU). The TAM model is an influential TAM that includes two primary factors influencing an individual's intention to use new technology: perceived ease of use and perceived usefulness (Charness & Boot, 2016). The TAM model has been used in a previous study to measure farmers' perceptions of the usefulness and ease of use of Internet-based WRS for agricultural financing, which included a sample of 193 respondents consisting of farmers and Islamic bank employees in the finance sector (Prasetyowati, 2022). The study by Prasetyowati showed the direct effect of usefulness and ease of use on usage attitude and behavioral intentions as it relates to system usage (Prasetyowati et al., 2022). This doctoral study will use similar concepts to understand the intent to adopt security strategies for IoT implementation in warehouse environments. Alsharida et al. (2021) identified that with continuous effective use of TAM, user intention could be further explained regarding technology.

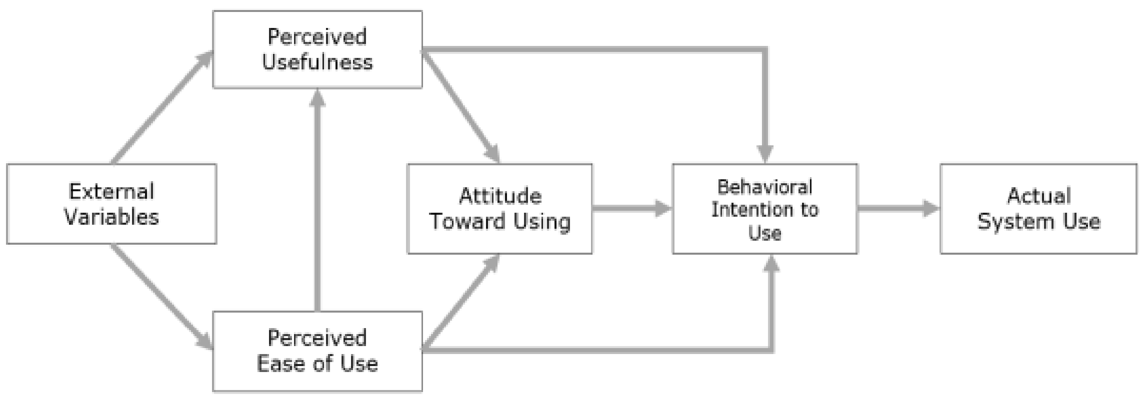
Identified by Fred Davis in 1989, TAM contributes to technology acceptance by displaying the direct effect of the intent to use technology (Attié & Meyer-Waarden, 2022). The adoption of technology is dependent on subjective norms. According to Ostrom et al. (2019) and Wirtz et al. (2018), privacy and security have been emphasized as key components. TAM is an early model used in literature that explains the acceptance or rejection of technology use. TAM framework is used to identify intentions in organizations when looking to adopt new technology (Malatji et al., 2020). Tu (2018) identified IoT as an emerging technology in supply chain environments. With this new technology in the logistical environment, strategies are to be adopted to implement the devices.

More specifically, strategies from a security standpoint to ensure the supply channel and warehouse environments are secure. TAM is primarily used to understand the influence on intent based on ease of use and usefulness (Felea et al., 2021). The key concepts of TAM include perceived usefulness and perceived ease of use (Zamani & Shoghlabad, 2012). Perceived usefulness relates to a belief that a strategy or technology would be useful to the organization or individual. On the other hand, Perceived ease of use relates to ease to use and free of effort (Davis, 1989). Warehouse environments have the ability to use this acceptance model to fully understand the intent when adopting security strategies for IoT implementation. The TAM model will assist in understanding if the security strategies being implemented are reducing efforts by IT leadership or if the security strategies are benefiting the organization or are useful to IT leadership. TAM will provide this study the framework to examine the relationship between IT leaders perceived ease-of-use and perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation in warehouse environments. If IT leadership in warehouse environments finds adopting security strategies for IoT implementation difficult, strategies may not be adopted.

Similarly, if IT leadership finds the security strategies are useless, they may not be adopted when implementing IoT devices in warehouse environments. TAM allows the evaluation of the variables to determine the intent to adopt security strategies in the environment. According to Laksana (2022), TAM is also used to measure user IoT technology acceptance in the IoT field, making this framework suitable and relatable to this doctoral study. Additionally, the TAM model is used to evaluate factors that impact decisions on rejection (Alrabia et al., 2022). Figure 3 displays a conceptual view of TAM.

Figure 3

Technology Acceptance Model



Note. Reprinted with permission from Joo et al., 2018, p. 51.

TAM Limitations

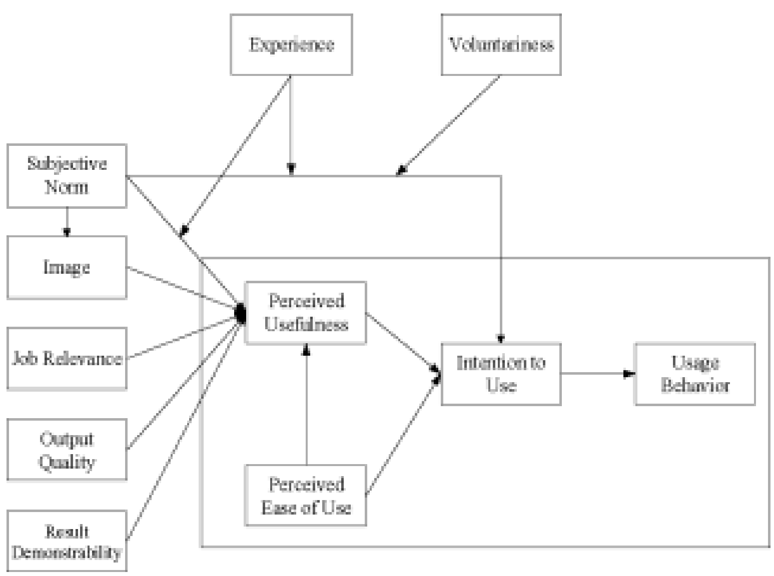
Organizations may use TAM to make use of technologies available to end users more efficiently and IT leadership (Malatji et al., 2020). Although TAM allows for an improved acceptance of technology, limitations exist. One limitation of the TAM is the predictability component with emerging technologies such as artificial intelligent products (Sohn, 2020). Another limitation of TAM is the inability to quantify observed research, such as norms of society and attributes of personality (Malatji et al., 2020). A third limitation of TAM is the need for more variance when conducting investigative studies (Zaineldeen et al., 2020). These limitations should be considered when researching to apply the TAM framework (Ajibade, 2018).

TAM 2

Venkatesh and Davis (2000) extended the initial model with seven constructs to address some inadequacies associated with new variables associated with TAM. The constructs include subjective norms, image, output quality, voluntariness, job relevance, result demonstrability, and experience (Wang et al., 2022). TAM2 introduces social influences on the subjective norm and is used in consumer technology studies (Wang et al., 2022). Output quality, result demonstrability, and job relevance fall under the cognitive category. Figure 4 displays a conceptual view of TAM2.

Figure 4

Technology Acceptance Model 2



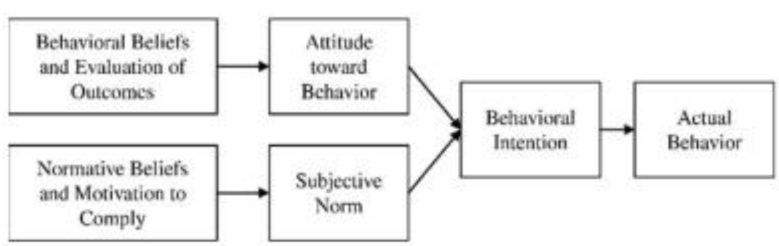
Note. Reprinted with permission from Paramaeswari & Sarno, 2020, p. 507.

Supporting Theories

Theory of Reasoned Action (TRA). The TRA theory is a theory that could be considered for this doctoral study. This theory aims to explain or predict the specific behavior of an individual under the condition that behavior is related to the free will of performing or not performing the particular behavior (Prachaseree, 2021). This study examines the intent to adopt security strategies for IoT implementation in warehouse environments as a dependent variable. This theory could be considered as TRA describing behavioral intention caused by attitude towards behavior and subjective norm to perform (Fishbein & Ajzen, 1975). TAM is related to the TRA theory. Zaineldeen et al. (2020) state that TAM replaces several of TRA's attitude variables with the two technology acceptance factors of perceived usefulness and ease of use. According to Byamukama et al. (2022), TAM is backed by TRA but rejects subjective norms as the predictor of behavioral intention. TRA assumes that implications are considered before participating in a specific behavior. The TAM better aligns with this study as the focus is not on individual beliefs or subjective norms. The TAM theory better aligns with the study's research question and is most suitable for this study.

Figure 5

Theory of Reasoned Action



Note. Reprinted with permission from Alwahaishi, S. & Snasel, V. 2013, p. 28.

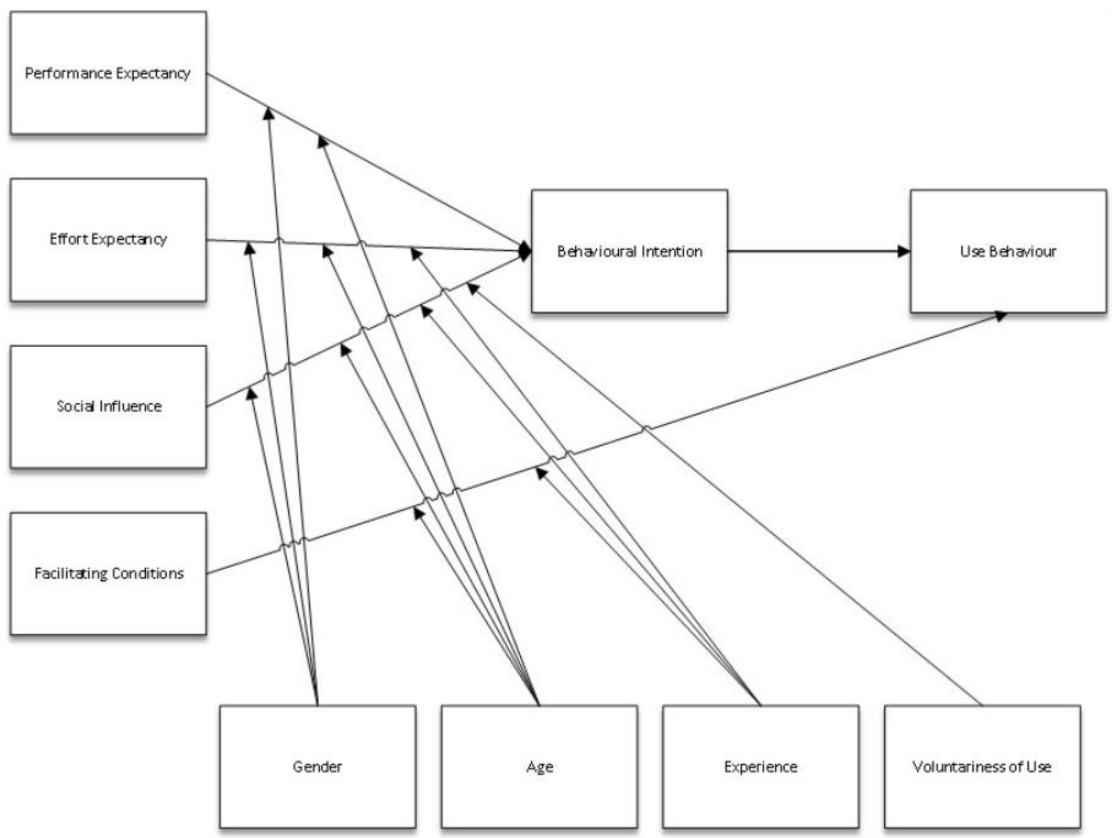
Theory of Planned Behavior (TPB). TPB is a theory that extended from the TRA and was formulated by Ajzen in 1991 (Black et al., 2022). TPB identifies behavioral intention as a determinant of actual behavior, formulated by subjective norms and attitudes toward behavior (Black et al., 2022). TPB is foundationally based on the assumption that an individual intentionally performs targeted behavior. The cognitive constructs related to TPB include the variables (a) attitude towards behavior, (b) subjective norm, and (c) perceived behavioral control (PBC; Wykes et al., 2022). Attitudes toward behavior are the sum of knowledge and prejudice from both a positive and negative perspective (Brookes, 2021). An individual is evaluating a particular behavior both negatively and positively. Subjective norms consider the viewpoint of others' thoughts and ideas regarding a specific behavior, such as family or friends (Brookes, 2021). The third variable, PBC, is the belief that individuals can control their behavior. Behavioral control may impact an individual on how hard an individual will try to succeed at a specific behavior and the strength of the intention to perform a specific behavior. TPB may assist in determining behavioral intentions and the levels at which individuals aim to succeed in IT leadership in warehouse environments.

Unified Theory of Acceptance and Use of Technology (UTAUT). The UTAUT theory is another approach that was considered for this doctoral study. Researchers in technology have used this theory previously to test new technologies with the expected performance and effort as critical factors in the research (Robles-Gomez et al., 2021).

The UTAUT model uses performance expectancy, effort expectancy, facilitating conditions, and social influences to explain user intentions to adopt new and innovative technology (Nur & Panggabean, 2021). TAM highlights perceived ease of use and usefulness as critical factors influencing the person's attitude toward adopting the technology (Lazim et al., 2021). TAM and UTAUT share similarities related to the intention to adopt the technology. TAM and UTAUT differ as UTAUT covers and focuses on the social psychological challenges, and TAM focuses on technological aspects (Robles-Gomez et al., 2021). Although UTAUT has some elements of TAM embedded, UTAUT is used to explain acceptance based on the four primary constructs rather than perceived ease of use and perceived usefulness (Fauzi et al., 2021). The research question was developed to examine the relationship between IT leadership's perceived ease of use of IoT devices, perceived usefulness of IoT devices, and intent to adopt security strategies for IoT implementation in warehouse environments. The TAM model better aligns with the research question and is more suitable for this study. Figure 6 displays a conceptual view of UTAUT

Figure 6

UTAUT Conceptual Model



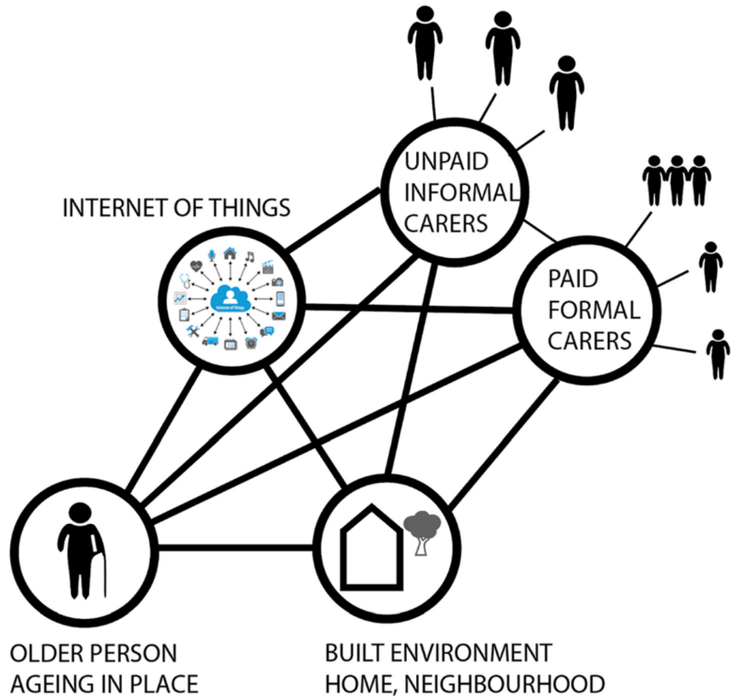
Note. Reprinted with permission from Habeeb et al., 2021, p. 3.

Contrasting Theories

Actor-Network Theory (ANT). The basis of the ANT theory is that society and technology cannot be conceptualized as ontologically separate entities (Ozuem et al., 2021). This theory focuses on the treatment of humans, and non-human participants are treated and viewed as equals (Donelle & Deborah Compeau, 2021). The ANT theory was introduced by Bruno Latour, Michael Callon, and John Law in 1986, which commits to symmetrical recognition of humans and non-humans (Stalph, 2019). ANT theory focuses on the problem of sociality in two conditions: a movement during the process of assembling and an explanation of some state of affairs (Dilaveroglu, 2021). This theory primarily aims to seek an understanding of processes to stabilize practices, negotiations, and controversies when stabilization is the primary goal of the researcher (Bussular et al., 2019). This differs from the focus, and goal TAM aims to establish. ANT emphasizes the social relationships that view technology and society as coconstructed, while TAM hones in on acceptance from a technology standpoint (Heinsch et al., 2021). The fundamental differences in the contrasting theories make TAM more suitable for this study. As ANT primarily focuses on social interactions, the theory is unsuitable for this study that examines the relationship between IT leadership's perceived ease-of-use of IoT devices, perceived usefulness of IoT devices, and intent to adopt them security strategies for IoT implementation in warehouse environments. Figure 7 displays the Actor Network Theory conceptual analysis.

Figure 7

Actor Network Theory Conceptual Analysis



Note. Reprinted with permission from Carnemolla, 2018, p. 4

Grey Systems Theory (GST). Grey Systems Theory, which emerged in 1982 by Julong Deng, is used to understand, model, and incorporate uncertainty in systems analysis (Javanmardi & Liu, 2019). According to a more recent study, Javanmardi et al. (2020) identified that the primary characteristic of grey systems is incomplete information. GST deals heavily with multiple-meaning environments and uncertain environments that lack precise values (Zanon & Carpinetti, 2018). In studies that apply the GST model, calculations are to be reported clearly to make the findings' replications more simplistic for the reader (Javed et al., 2018). Grey systems theory does not focus on adoption strategies, nor does it assist in examining the lack of strategies IT leadership possesses for secure IoT implementation in warehouse environments. This study examined the relationship between IT leadership's perceived ease of use to adopt security strategies, perceived usefulness of IoT devices, and intent to adopt security strategies for IoT implementation in warehouse environments.

Analysis of Independent Variables

The independent variables of this study included IT leaderships' perceived ease-of-use of IoT devices and IT leaderships' perceived usefulness of IoT devices. The TAM model was used to understand the independent variables PEOU and PU. PEOU may signify the level at which individuals begin to accept or assume that employing a technology-related process is effortless. At the same time, PU represents individual acceptance that employing a technology-related process will enhance the organization's performance (Zaineldeen et al., 2020).

IT Leaderships' Perceived Ease-of-Use of IoT Devices

Perceived ease of use has been identified as a primary construct when measuring acceptance (Nofal et al., 2021). This independent variable denotes how easy IT leadership perceives the use of IoT devices may be. PEOU is directly associated with adoption. This independent variable may influence decisions about adopting strategies to implement IoT devices securely. This study discussed IT leadership adopting security strategies. For IT leadership in warehouse environments to intentionally adopt the strategies for secure IoT implementation, IoT devices must be easy to use. Zulkarnain (2021) identified in a study on Instagram and Instagram sales that PEOU has proven to influence the intention to purchase on Instagram. Organizations in warehouse environments must also understand the security challenges related to IoT and new technology to improve storage and transportation (Bai et al., 2022). A lack of security from an IoT perspective may leave the network environment vulnerable and susceptible to attacks such as Denial of Service attacks, Man in the Middle attacks, and Phishing attacks (Kenaza et al., 2022). This independent variable assists in understanding IT leadership's intention to adopt security strategies for IoT implementation in warehouse environments.

IT Leaderships' Perceived Usefulness of IoT Devices

Perceived usefulness can be defined as an indicator to identify to what extent an end user will use an application or system that is deemed effective and efficient (Zulkarnain, 2021). This independent variable was used to denote how useful IT leadership perceives the use of IoT devices may be. Davis (1989) identified that perceived usefulness is strongly linked to behavioral intention to use technology. This independent variable may influence IT leadership decisions regarding security strategy adoption for secure IoT implementation. For IT leadership in warehouse environments to intentionally adopt the strategies for secure IoT implementation, IoT devices must be useful for the organization. Indicators related to defining usefulness are increased productivity, easier job flow, increased job performance, and the ability to work more quickly (Prasetyowati et al., 2022). Identifying security strategies for IoT devices is considered best practice and prevents security breaches (Alferidah & Jhanjhi, 2020). This independent variable assists in understanding IT leadership's intention to adopt security strategies for IoT implementation in warehouse environments.

Analysis of Dependent Variable

The dependent variable of this study included IT leadership's intent to adopt security strategies for IoT implementation in warehouse environments. Dependent variables can be described as what is being measured or studied in research (Sarikas, 2020). This dependent variable represents the possibility that IT leadership in warehouse environments will adopt secure strategies for IoT implementation. The intent to adopt secure strategies for IoT implementation is a behavioral intention that may be influenced by the independent variables: IT leaderships' perceived ease-of-use of IoT devices and IT leaderships' perceived usefulness of IoT devices. Behavioral intention determines actual use (Billanes & Enevoldsen, 2021). Additionally, the role of variables supports behavioral intentions to adopt (Agustina et al., 2021). To measure IT leadership's intent to adopt security strategies for IoT implementation, this dependent variable was used based on IT leaderships' perceived ease of use of IoT devices and IT leaderships' perceived usefulness of IoT devices.

Measurement of Variables

This quantitative correlational study used a validated survey instrument geared towards strategies to implement IoT devices securely. PsycTESTS provided online written permissions. Using a known and validated survey instrument assists in ensuring and maintaining study validity (Habib et al., 2021). To maintain consistency with the researchers' instrument, this study used Likert-type scaled questions with ordinal values to measure the variables. The questionnaire captured data related to IT leaderships' intent to adopt security strategies for IoT implementation, IT leaderships' perceived ease-of-use of IoT devices, and IT leaderships' perceived usefulness of IoT devices.

Relationship of the Study to Previous Research and Findings

This study examined the relationship between IT leaderships' perceived ease of use of IoT devices, perceived usefulness of IoT devices, and intent to adopt security strategies for IoT implementation in warehouse environments. From an IoT security perspective, this study related to previous literature. There needs to be more plentiful research on secure IoT implementation in warehouse environments. This study took the point of view from a warehousing and supply chain lens as it related to IoT devices and technology. Understanding new technology and properly implementing technology is vital. The end-to-end process of securing IoT in the supply chains should be reliably provisioned (Masip-Bruin et al., 2021). Previous research places a focus on IoT and the impacts it has on improving efficiency in the warehouse. Few studies use TAM as the primary framework to examine the adoption intention of security strategies when implementing IoT devices in warehouse environments.

Transition and Summary

Section 1 provided an introduction to the problem identified in this research and presented an overview of the background of the study. This section includes a presentation of the problem statement, purpose statement, nature of the study, research question, hypothesis, theoretical framework, and the significance of the study. In addition, section 1 included additional information on the study via operational definitions, assumptions, limitations, and delimitations as it relates to IT research. The literature review segment concluded this section and attempted to provide insight into IoT related to warehouse environments and a lack of security strategies. The literature review discussed in-depth the theoretical framework, instruments used in the study, warehouse environments, and concepts of IoT security.

Section 2 begins with a high-level overview of the study by restating the purpose statement. Section 2 highlights the research methodology used in data collection, the role of the researcher, participants, and the design. Additionally, this section provides information on population and sample strategies. This section concludes with a detailed discussion on validity, threats to validity, and strategies to ensure the study's validity.

Section 3 includes an overview of this study. Additionally, section 3 presents the data analysis results of the online surveys collected. Lastly, the implication for social change, application of findings, and recommendations for further studies are summarized in section 3.

Section 2: The Project

In Section 2, I restate the purpose statement and define in detail the research method and research design. This is followed with a discussion surrounding my role as the researcher. Additionally, this section covers population and sampling, ethical research concerns, research instrument, data collection technique, and study validity. To conclude this section, an overview and introduction to Section 3 is outlined.

Purpose Statement

The purpose of this quantitative correlational study was to examine the relationship between IT leaders' perceived ease-of-use and perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation in warehouse environments. The independent variables were IT leaderships' perceived ease-of-use of IoT devices and IT leaderships' perceived usefulness of IoT devices. The dependent variable was IT leaderships' intent to adopt security strategies for IoT implementation in warehouse environments. The target population of this study consisted of IT leaders from warehousing organizations in North Texas who have (a) implemented IoT devices and are experiencing challenges, (b) implemented IoT devices without challenges, and (c) intend to adopt security strategies for IoT implementation. The implication for positive social change lies in the potential to improve the supply channel in North Texas. Secure IoT implementations may help the supply chain channel push products to the public within North Texas more efficiently without disruption of services due to network outages. IoT implementations may assist in increased production and performance of warehouse employees as the use of automation and robotics increases the efficiency of work. As warehouse environments adopt strategies to securely implement IoT devices, the focus can be placed on reducing delays in the supply channel and less on network breaches and outages.

Role of the Researcher

Quantitative research can be defined as a statistical discipline that measures statistical attitudes, behaviors, and performances (Raheela, 2021). As the researcher of this quantitative study, I made use of statistical measurements with the use of a survey instrument. This survey was implemented to examine the relationship between IT leaderships' perceived ease-of-use and perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation in warehouse environments. As the researcher, I identified threats to internal and external validity. Validity ensures that the study includes statistical elements representative of all facets of the study (Ahmed & Ishtiaq, 2021). In order to ensure reliability, I, as the researcher, detailed and outlined the methodology, processes, and techniques used within this quantitative study. Additionally, I was responsible for the design, data collection, a thorough analysis of the collected data, and objectively presenting the results to the readers. This study was designed to allow the hypothesis to be tested and to collect relevant data independently (see Sukamolson, 2007).

I was familiar with this topic due to my experience working as a network engineer for a third-party logistics organization that manages several warehouses across the United States. As a network engineer, some responsibilities included deploying network infrastructure in warehouse environments, deploying new and innovative technology based on customer demand, and facilitating discussions on vulnerabilities within warehouse technology currently in production. Although familiar with the industry, there has yet to be a prior engagement or involvement with potential participants. The survey was administered anonymously with an online questionnaire to further limit the interaction. Additionally, conclusions were solely based on the data collected in this doctoral study.

As the researcher of this doctoral study, I adhered to the guidelines and fundamental ethical principles outlined by The Belmont Report. Ritchie (2021) stated that researchers should practice beneficence and consider maximizing the benefits of research participation while minimizing harm. I also viewed participants autonomously as it related to the decision-making process, ultimately mitigating any coercion of the participants. I was fair and acted with respect.

Participants

In quantitative studies, it is imperative to identify participants who thoroughly represent the ideal population while adhering to the study's sample size and power requirements (Manohar et al., 2018). Determining the quality of participants and narrowing down the pool of eligible candidates is an integral part of participant selection in research studies, which necessitates the formulation of specific eligibility criteria that researchers must define prior to the selection process to ensure the attainment of desired research objectives (Cantor et al., 2021). Criteria defined in this doctoral study included IT leadership in a warehouse environment, IoT knowledge, and must have been in North Texas.

The participants selected for this doctoral study included IT leadership from warehouse environments in the local area or region of North Texas. These participants were adults ages 18 to 75. These participants knew of IoT devices and had experience in warehouse environments from an IT standpoint.

Gaining access to participants means engaging and negotiating with potential participants for research (Shenton & Hayter, 2004). The procedure for gaining access to participants in this study was to reach out to leaders within the organization via official communication via email and letter. According to Shenton and Hayter (2004), researchers may seek endorsement from a sponsor to be a gatekeeper and introduce the researcher to potential participants within the organization. In the initial communication, I included the purpose of this doctoral study, information regarding ethics, and benefits from a participant standpoint. Researchers should ensure that participants are thoroughly informed about the study while understanding the benefits involved (McCullagh et al., 2014).

The strategy for establishing a working relationship with participants was to ensure the contact person fully understood the purpose of the study and had provided permission to conduct research involving IT leaders within the organization. Effective working relationships are key in quantitative research as they promote collaboration, communication, and trust among researchers (Fernández-Aráoz et al., 2021). I provided potential risks, study details, and informed consent forms. Requirements from the Belmont Report include the protection of human participants and the definition of informed consent (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979).

Research Method and Design

Research methodology is the study of how research is conducted from a systematic perspective (Mishra, 2022). As a researcher, I needed to identify which method and design was most suitable for the type of research that I conducted. According to Kimmons (2022), research has given rise to qualitative, quantitative, and mixed-methods approaches. The research methodology must align well with the proposed study, research question, and problem statement. Kothari (2004) identified that aligning methodology enhances research and assists the consumers of research more effectively evaluating the research.

Method

Qualitative research typically refers to a methodology that focuses on subjective interpretations, while quantitative research relies on the analysis of measurable data through a statistical method (Kimmons, 2022). From a qualitative perspective, researchers construct theories in which there may not be complete certainty (Kang & Evans, 2020). Qualitative methods address observations and reports of the phenomena as they occur in everyday life or natural settings (Aspers & Corte, 2019). Additionally, qualitative studies address interview artifacts, introspections, and cultural productions (Johnson et al., 2020). In this study, I did not aim to examine observations and reports of phenomena, making qualitative research unsuitable for addressing the problem statement and research questions. Mixed methodology involves small sample sizes, in-depth exploration of a phenomenon, and the integration of qualitative and quantitative data (Onwuegbuzie et al., 2020). Mixed methodology is considered more resource-intensive and time-consuming (Onwuegbuzie et al., 2020). In this study, I did not aim to use qualitative data while avoiding the time-consuming downside of the methodology. Instead, I examined the relationship between IT leaderships' perceived ease-of-use of IoT devices, perceived usefulness of IoT devices, and intent to adopt security strategies for IoT implementation in warehouse environments. Quantitative research primarily focuses on observed or measured data to examine research questions related to the sample population (Allen, 2017).

Additionally, quantitative methodology shows relationships among data and stands in contrast to qualitative research (Coghlan & Brydon-Miller, 2014). In the problem statement, I stated that IT leadership in warehouse environments lacks information about the relationship between IT leaderships' perceived ease-of-use of IoT devices, perceived usefulness of IoT devices, and intent to adopt security strategies for IoT implementation. In this study, I aimed to examine the relationships between the independent and dependent variables. The quantitative method was most appropriate for researching the problem statement.

Research Design

Research design aims to orchestrate the study to allow for an accurate assessment of the relationships between variables (Jang, 1980). The research design should act as a strategy in which the researcher answers research questions and hypotheses (Cantrell, 2011). For this doctoral study, I used a nonexperimental correlational design. As stated in the problem statement, I examined the relationship between independent and dependent variables. Nonexperimental correlational design hones in on those components. Seeram (2019) stated that correlational research is a nonexperimental research methodology that explains the relationship among different variables. Researchers use this design to investigate the extent to which variables are related. I used this nonexperimental correlational design to examine the relationship between IT leadership’s perceived ease-of-use of IoT devices, perceived usefulness of IoT devices, and intent to adopt security strategies for IoT implementation in warehouse environments. Experimental and quasi-experimental were not suitable for this study. Quasi-experimental designs are observational studies that lack randomization, as groups can self-select (Maciejewski, 2018). Roe-Prior (2022) stated that quasi-experimental designs examine cause and effect nonrandom samples. I did not intend to randomly assign participants to various test groups during the study or examine cause and effect. Descriptive designs describe a population's characteristics and involve the researcher's lack of manipulation of variables (Siedlecki, 2020). However, I did not intend to provide descriptions of population samples' characteristics. Unlike descriptive designs, I examined the relationship between independent and dependent variables. Therefore, descriptive designs were not suitable. Nonexperimental correlational design was justified over other research designs as it is used in quantitative research to explore relationships between variables in naturalistic settings where manipulating variables may not be ethical or feasible (West et al., 2021). To further justify, nonexperimental correlational designs assist in understanding and predicting intricate relationships among variables (Cano-García et al., 2022).

Population and Sampling

Population in research is defined as a large group of people in which the findings of a particular study are inferred by the individual research (Haegele & Hodge, 2015). A critical first step and the key element in quantitative research is to identify and select the individuals who will participate. Haegele and Hodge (2015) defined selecting participants from the population level to sample as sampling. The population from which the sample was drawn consisted of IT leaders who worked for distribution centers or warehouses in North Texas. More specifically, these IT leaders possessed a background and knowledge of IoT and its interworkings while having familiarity with technical deployments in warehouse environments.

Berndt (2020) stated that sampling methodology guides the researcher on sample size to ensure conclusion confidence and generalizability. Probability and nonprobability methodologies are categories into which sampling may fall (Berndt, 2020). As a researcher, all factors must be considered, such as pros, cons, sampling bias, and type of inference, when selecting which method is suitable for the study. In this study, I used a nonprobability sampling method. More specifically, I used convenience sampling. Haegele and Hodge (2015) stated that the convenience sampling method uses individuals based on their availability for the study. Convenience sampling helps gather a range of attitudes when identifying a hypothesis that can be tested in future research (Galloway, 2005). According to Baxter et al. (2015), researchers have access to a population who makes themselves available when working with convenience sampling. There were some limitations to using this sampling methodology. Galloway (2005) pointed out that convenience sampling may provide a lack of statistically significant conclusions from the findings, ultimately skewing final results. Therefore, I engaged participants categorized with predefined criteria. The participants for this study were IT leaders in warehouse environments with a working knowledge of IoT and its innerworkings. The participants had familiarity with technical deployments in warehouse environments. Another predefined criterion was that they were in North Texas.

The population used in this doctoral study aligned well with the overarching research question. At the same time, the sample size was calculated with the help of the G*Power software for sample estimation and calculation. A power analysis determined the appropriate sample size for this doctoral study. Faul et al. (2009) identified that G*Power statistical software could be used to identify a study's sample size. The input parameters of effect size, alpha error, and power were modified to calculate the sample size. According to Cohen (1988), the effect size is depicted as small (.02), medium (.15), and large (.35). The minimum sample size of 68 was calculated for this study using version 3.1.9.4 of G*Power. I used a medium effect size of .15, an alpha value of .05, and a .80 statistical power to mitigate Type II errors for calculating the minimum sample size. To mitigate type II errors in quantitative research, a statistical power of at least .80 should be achieved to decrease the risk of failing to reject a false null hypothesis (Barker & Wolen, 2019). Figures 8 – 10 display the Power analysis outputs.

Figure 8

*G*Power Analysis to Calculate the Required Maximum Sample Size*

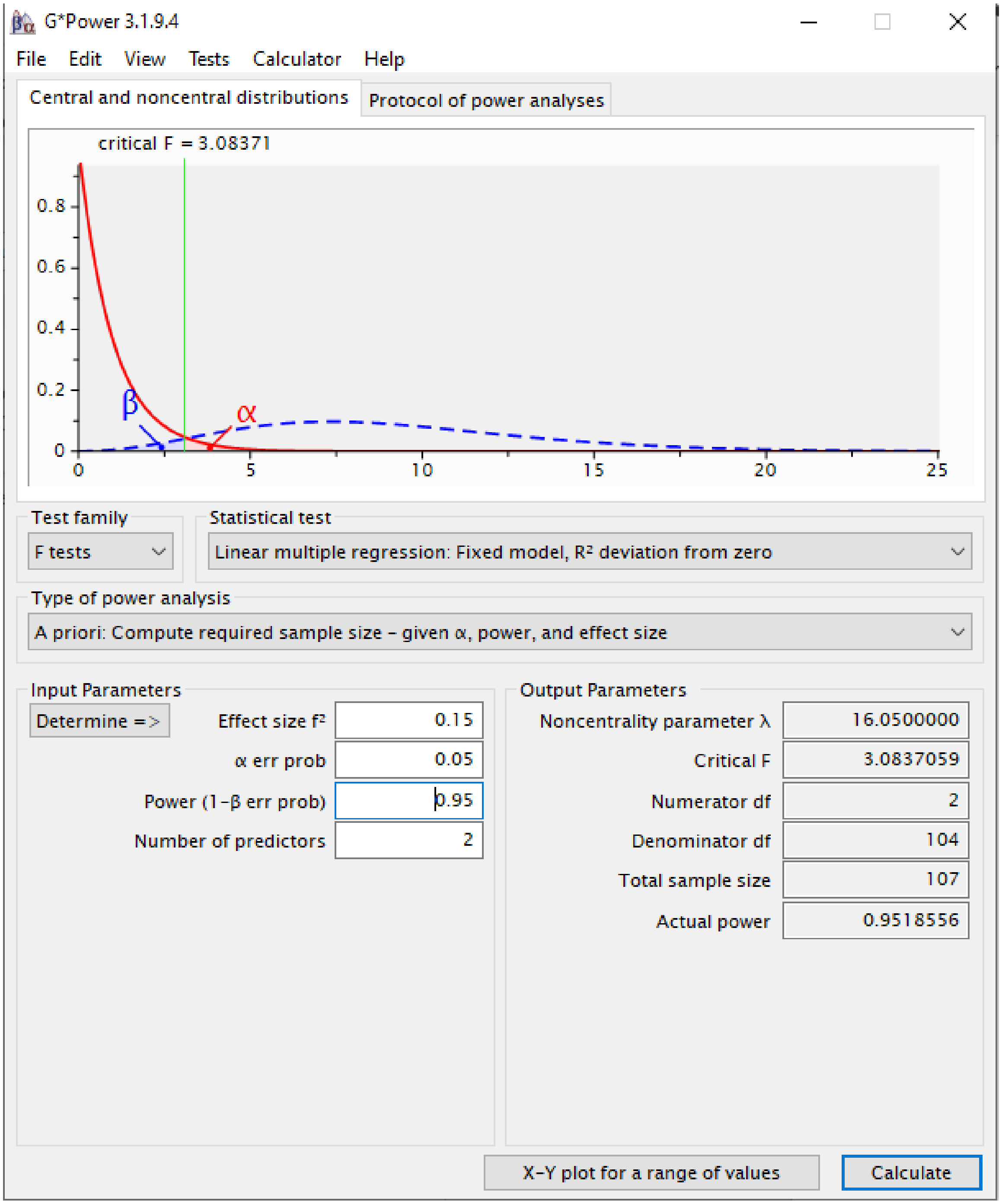


Figure 9

*G*Power Analysis to Calculate Required Minimum Sample Size*

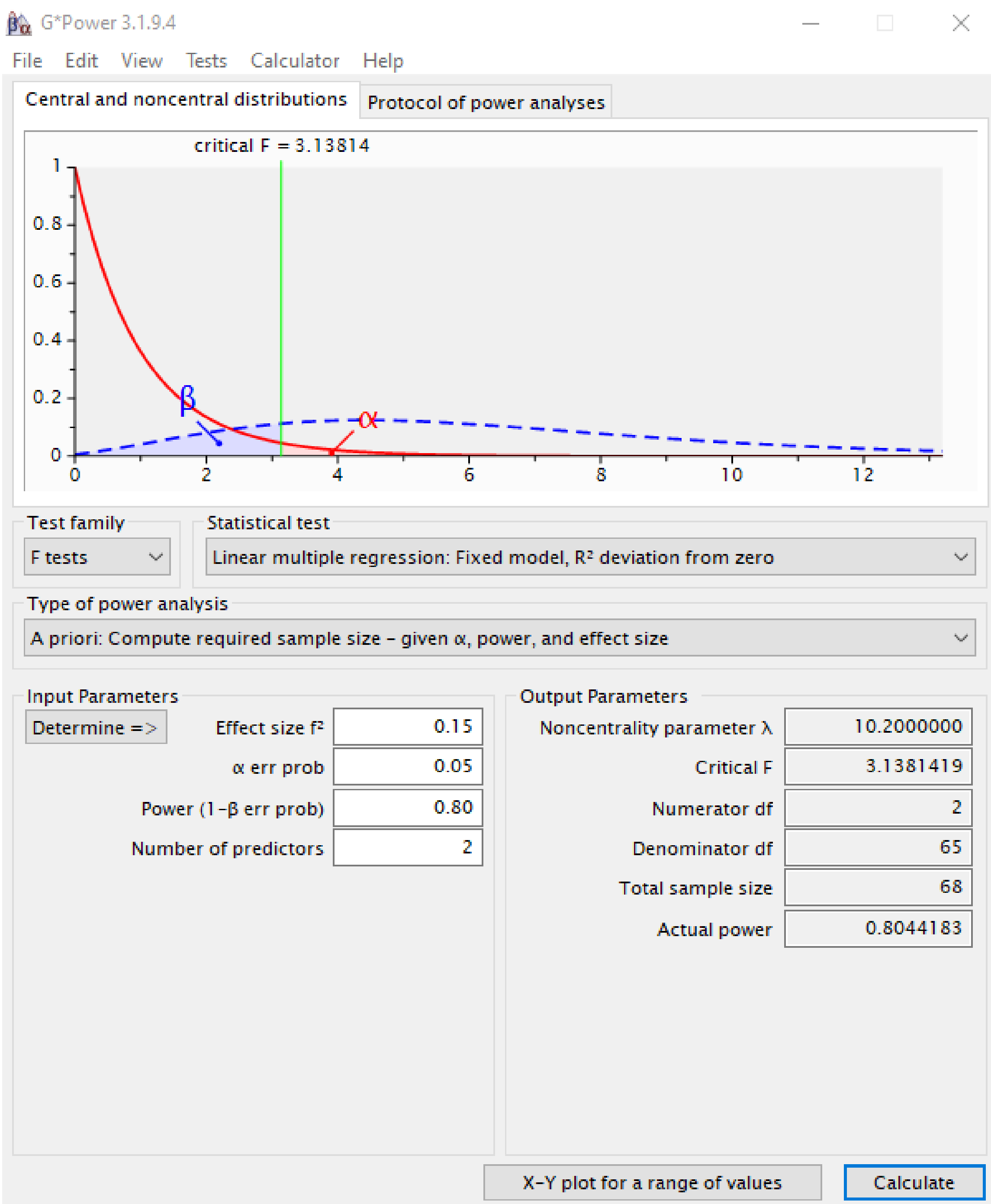
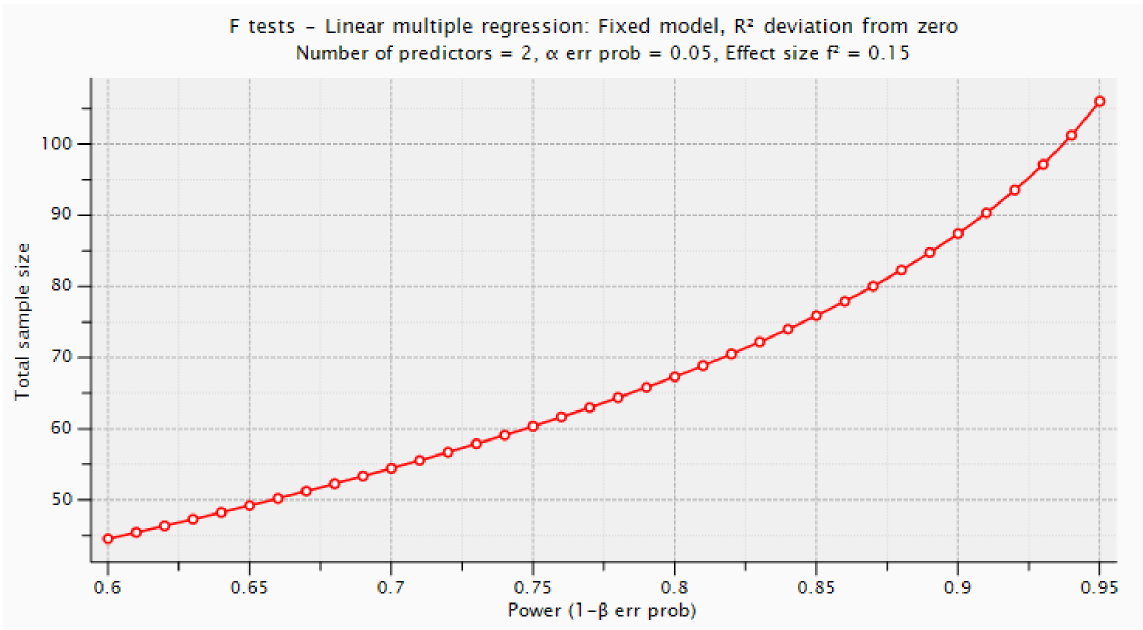


Figure 10

Power as a Function of the Sample Size Calculated



Ethical Research

Ethics must be considered when conducting scholarly research. Ethics in research may be defined as the identification of right or wrong and the inclusion of proper protocols to ensure participants are treated respectfully (Bos, 2020). Included in ethical research is informed consent. Informed consent consists of parties involved in a particular study signing an agreement or documentation which explains and clearly outlines the nature of the research or study (Drolet et al., 2022). Participants made decisions based on the information provided in the informed consent documentation. Participants could participate or decline participation in the study..

According to Rudy et al. (1994), researchers have used incentives to improve research participant retention and research compliance. Although incentives when conducting research can be beneficial to the participant, these incentives may unintentionally influence decisions for participation (Halpern et al., 2021). This study did not make use of monetary or tangible incentives for participants. I stressed to the participants that this study may have a positive societal impact by improving the efficiency of warehousing and supply chains.

Clarification of the ethical protection of participants is essential to doctoral research. As the researcher, the primary ethical concern is to protect the participant's dignity and welfare while maintaining confidentiality (Henley & Frank, 2006). Anonymity was maintained for the participants from other researchers and individuals outside this study. Participants were informed that the data collected will be deleted from the survey platform after the completion of this study. I also stored study data on an encrypted external hard drive. Once granted IRB approval, the IRB approval number was provided in the doctoral manuscript. I will store collected data for five years to further protect participant confidentiality on an encrypted external hard drive. Lastly, personally identifiable names of individuals and organizations were not collected to protect participants further. A commitment to protecting participant data is an important aspect of conducting research (Drolet et al., 2022).

I understood the requirements of conducting research and protecting the participants of this doctoral study. I have completed the required web-based training on "Protecting Human Research Participants" (Certification Number: 2986555) and

“Collaborative Institutional Training Initiative” (Record ID: 43613854). The certifications of completion are made available in Appendix A.

Data Collection

Instrumentation

I used a previously developed peer-reviewed adoption survey from PsycTESTS.org. The survey is based on technology adoption. I tailored the instrument to strategies to implement IoT devices. The adjustments made did not invalidate any previous research. The original survey from the author discussed near-field communication (NFC) mobile payments and comprises 47 items rated for agreement with 5-point, Likert-type scales. Likert scales in research provide a way to measure unobservable constructs and nomological test relationships (Jebb et al., 2021). Morosan, Cristian published this instrument, and DeFranco, Agnes in 2016 and is titled "It is about time: Revisiting UTAUT2 to examine consumers' intentions to use NFC mobile payments in hotels". The concept measured in this instrument was the intent. More specifically, to examine consumers’ intentions to use NFC mobile payments in hotels. The content can be reproduced for educational purposes such as doctoral studies. Per the permissions, I included a credit line that contains the source citation and copyright owner. Permission of use for the survey instrument is documented in Appendix B. Appendix C includes the original survey instrument with the original questions. The version of this study’s survey instrument measured IT leaderships’ perceived ease-of-use of IoT devices, IT leaderships’ perceived usefulness of IoT devices, and IT leaderships’ intent to adopt security strategies for IoT implementation in warehouse environments.

Morosan and DeFranco (2016) measured the constructs performance expectancy, effort expectancy, social Influence, facilitating conditions, hedonic motivation, habit, general privacy, system-related privacy, perceived security, and intentions performance in their original study. I intended to use the questions related to the constructs of Perceived security and Intentions. Modifications were made to the questions from the original survey to align with the purpose and research question. The modifications measured the constructs in this study, which included IT leaderships' perceived ease-of-use and perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementations within warehouse environments. The original survey measures its constructs using 47 close-ended questions to obtain responses from participants. Close-ended questions are fixed, or dichotomous questions utilized in quantitative research to elicit specific responses from participants (Smith, 2022). The original authors aimed to gather demographic information such as age and gender. Additionally, the original survey questions elicited behavioral attributes such as the reason for stay and length of stay.

The instrument Morosan and DeFranco (2016) created was appropriate to the current study. The original survey measured the intentions to adopt NFC mobile payments in hotels; similarly, this study measured the intentions to adopt security strategies in warehouse environments. Additionally, both studies included a security component of protecting information. This study measured factors that impacted the intent to adopt, similar to the original survey instrument.

Morosan and DeFranco (2016) administered their survey instrument online to a sample of participants who had previously used NFC mobile payments. The authors used email and online survey platforms to distribute the survey instrument. Access to participants was obtained through a consumer panel company in which the authors identified participants that recently stayed in hotels and possessed smartphones. The invitation was sent to 25,356 consumers in the United States. After removing records containing missing patterns, the researchers retained 794 participants. The researchers' response rate was 3.1%. This survey instrument was administered by using online questions sent to IT leadership in warehouse environments. The questionnaire was filtered to identify participants in North Texas who were familiar with the use of IoT devices and their implementation.

Morosan and DeFranco (2016) used structural equation modeling (SEM) to analyze the data collected from the survey. Structural equation modeling (SEM) is a statistical method used to test relationships between variables and to examine the relationship between observed and latent variables (Kline, 2011). The researchers used this method to examine the relationships between the independent variables and the dependent variable (intention to use NFC mobile payments). The researchers used descriptive results to display their demographic and behavioral characteristics analysis. The scores were displayed in percentages listed in the tables. The researchers categorized gender, age, income, and education from a demographic perspective. From a behavioral standpoint, frequency of stay, length of stay, and purpose of stay were categorized. The scores showed that 46.4% of the demographic had at least a bachelor's degree, and most participants stayed at hotels for leisure (34.7%). The scores also showed that 53% of the demographic were males and 46.4% were female.

Other researchers have used similar instrumentation for collecting data. Weerakkody & Premarathne (2015) used a similar instrument in their study titled “Adoption of Cloud Computing by small and medium enterprises in Nairobi County, Kenya” to examine the current adoption levels of cloud-based services. Kumar & Taylor (2014) also made use of similar instrumentation in their study titled “Adoption of mobile health technologies (mHealth) by healthcare professionals” to examine the adoption of new technology in mHealth. Lastly, Wang, Li, and Chen (2022) used a similar instrument to measure blockchain adoption in the supply chain in their “Exploring the adoption of blockchain technology in the supply chain: An empirical study.”

The researchers of the original study verified the reliability and validity of the survey instrument through multiple methods. Cronbach's alpha was calculated to assess the internal consistency reliability of the survey items. The authors reported a high level of reliability for their survey, with a Cronbach's alpha of .95 (Morosan & DeFranco, 2016). This finding is in line with prior research that has found that high internal consistency reliability is an essential characteristic of valid and reliable survey instruments (Bello et al., 2019). Test-retest reliability was also conducted to examine the stability of the survey scores over time. The authors administered the survey to a small sample of participants twice and calculated the correlation between the scores from the two administrations. The authors reported a high level of test-retest reliability with a correlation of .86 (Morosan & DeFranco, 2016). This finding suggests that the survey instrument is stable and consistent over time. Lastly, Morosan and DeFranco (2016) conducted a confirmatory factor analysis (CFA) to examine the factor structure of the survey items and assess the measurement model's validity. The results of the CFA indicated that the items loaded on the intended factors and that the measurement model fit the data, providing further evidence of the reliability and validity of the survey. This method is consistent with prior research that has used CFA to verify the validity of survey instruments in information systems research (Chen et al., 2020; Chen & Chen, 2020).

Re-confirming the reliability and validity of the instrument with the changes made was done with factor analysis, sample survey, and Cronbach’s coefficient alpha. Lastly, the raw data will be made available. Including raw data of a quantitative study allows for replication of the study and an examination of data integrity (Carter & Little, 2020).

Data Collection Technique

The technique to collect data was to engage a sponsor within the warehouse environment. By leveraging the resources and networks of these sponsors, researchers can reach a more extensive and diverse population (Bauer et al., 2021). Engaging a sponsor to connect with participants assists in reducing the influence of non-response (Bauer et al., 2021).

Data was collected anonymously using Survey Monkey, an online platform that enables researchers to conduct surveys and collect data through online questionnaires for quantitative research (Smith & Krosnick, 2021). The advantage of using this survey instrument is that collected data can be analyzed to generate statistical data, making

Survey Monkey a valuable tool for quantitative studies (Dillman, 2020). Another advantage of Survey Monkey is that the instrument is cost-effective for researchers conducting online surveys (Kreuter et al., 2020).

On the other hand, the online survey tool presented with some disadvantages. One disadvantage was the potential for low response rates due to the self-administered online nature of the survey resulting in biased samples (Kreuter et al., 2020). Furthermore, participants may also engage in socially desirable responses in which participants answer in ways they believe the researcher or sponsor wants to hear rather than genuine and authentic opinions (Lo et al., 2020).

After IRB approval, the process for conducting a pilot study was to engage sponsors or person of contact in warehouses and provide them with explicit details about the doctoral study, such as the purpose, criteria of participants, informed consent form, and online survey link. Pilot studies are used to assess the feasibility of a study and to identify potential issues with the study design (Leon et al., 2011). I followed up in multiple ways, such as e-mail, letter, and physical. Little and Embretson (2020) states that an effective strategy for reducing non-response bias in quantitative research is to use a multi-mode approach to data collection, such as combining online, mail, and physical interaction.

Data Analysis Technique

The research questions I asked were as follows: What is the relationship between IT leaders perceived ease-of-use of IoT devices and their intent to adopt security strategies for IoT implementation? What is the relationship between IT leaders perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation?

$H1_0$: There is no statistically significant relationship between IT leaders' perceived ease-of-use of IoT devices and their intent to adopt security strategies for IoT implementation.

$H1_1$: There is a statistically significant relationship between IT leaders' perceived ease-of-use of IoT devices and their intent to adopt security strategies for IoT implementation.

$H2_0$: There is no statistically significant relationship between IT leaders' perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation.

$H2_1$: There is a statistically significant relationship between IT leaders' perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation.

Researchers have different tests available to evaluate variables and the relationships between them. Tests that evaluate relationships between variables include analysis of variance (ANOVA), t-tests, and multiple regression. ANOVA is a statistical method utilized to determine significant differences between the means of multiple groups (Maxwell & Delaney, 2020). According to Field (2013), a t-test measures the difference between the means in standard error units, allowing researchers to make inferences about the population means based on the sample data. ANOVA and t-tests are unsuitable for this study as this study aims to evaluate adoption intention. Adoption intention in this study was evaluated using a single participant group and did not include an assessment of causal effects. Multiple linear regression analysis was used in this study to examine the relationship between two independent variables and one dependent variable. The multiple linear regression analysis assessed the relationship between independent and dependent variables or if the relationship exists and is an extension of simple linear regression. In the multiple linear regression formula ($Y = \beta0 + \beta1X1 + \beta2X2 + ... + \beta nXn + \varepsilon$), Y is the dependent variable, β0 is the intercept, β1-βn are the coefficients of the independent variables X1-Xn, and ε is the error term (Habibzadeh & Yadollahie, 2016). In this study, Y represented IT leaderships' intent to adopt security strategies for IoT implementation. The X1 value represented IT leaderships' perceived usefulness IoT devices and the X2 value represented IT leaderships' perceived ease of use of IoT devices ($Intent = \beta0 + \beta1PU1 + \beta2PEOU2 + \varepsilon$). The multiple regression analysis determined if the two independent variables (IT leaderships' perceived ease-of-use of IoT devices and IT leaderships' perceived usefulness of IoT devices.) had a significant relationship with the intent to adopt security strategies for IoT implementations in warehouse environments. Additionally, this model measured any variance in IT leaderships intention to adopt security strategies for IoT implementations in warehouse environments.

While estimating the relationships between the variables, multiple linear regression analysis accounts for the variability in the dependent variable that is not explained by the independent variables (Petersen, 2019). Multiple linear regression analysis is a statistical technique used in quantitative research to examine the relationship between a dependent variable and multiple independent variables using regression coefficients while controlling for the extraneous influences of other variables (Field, 2020). Regression coefficients can be used to identify the most influential variables in predicting the outcome variable (Hox et al., 2020). Multiple linear regression analysis extends linear regression by modeling the relationship between a dependent variable and multiple independent variables rather than a single independent variable (Tabachnick & Fidell, 2021). Multiple linear regression analysis tests for linearity by examining the relationship between each independent variable and the dependent variable through graphical techniques, such as scatterplots, to determine whether the relationship is linear (Chen et al., 2021). Multiple linear regression analysis controls for extraneous variables and provides a comprehensive understanding of each independent variable's unique contribution and the overall relationship (Bryman & Bell, 2015). A simple linear regression, in comparison, only models the relationship between two variables and is unsuitable for complex research (Field, 2020). Simple linear regression was unsuitable for this study as more than one independent variable was examined.

Data cleaning and screening procedures are essential for quantitative data analysis in online survey questionnaires. Data cleaning and screening involve verifying the accuracy and completeness of the data, identifying and addressing outliers, and handling missing values (Gao, Fu, & Liu, 2020). These procedures were appropriate for this study as data was collected using an online survey questionnaire. Handling missing data is a critical component in data cleaning and screening procedures. Missing data may lead to biased or inaccurate results and undermine the reliability and validity of the research findings (Tabachnick & Fidell, 2021). Missing data was addressed by screening the returned questionnaires to ensure complete responses.

This study examined the relationship between IT leadership's perceived ease-of-use of IoT devices, perceived usefulness of IoT devices, and intent to adopt security strategies for IoT implementation in warehouse environments. Inferential results in quantitative research are the conclusions drawn about a population based on sample data and statistical techniques aimed at making predictions or generalizations about the population (Furlan et al., 2020). SPSS statistical analysis software version 27 for PC was used to assess validity and reliability, descriptively generate statistics, and analyze collected data. SPSS was used to evaluate the hypothesis using standard multiple linear regression analysis to determine the significance of any relationships. Primary values were needed to interpret the data. According to Wang et al. (2021), the inclusion of primary values such as R-squared, beta coefficients, standard error of the estimate, and significance levels when interpreting data is vital for accurately assessing the relationship between the dependent variable and the independent variables. These primary values are needed to interpret data and allow researchers to detect potential problems with the model and make informed decisions based on the results (Wang et al., 2021). I used information about the regression coefficients, standard errors, significance levels of the coefficients, and the R-squared value provided by SPSS statistical software for data analysis. SPSS allows for data analysis, statistical modeling, and visualization (Yue & Ma, 2019). Yue & Ma (2019) also identified that this software has capabilities for data preparation, data management, and presentation of results. The results of this study are presented in section 3 of this study.

Interpreting Results

R^2

The R^2 value provided in SPSS in multiple linear regression analysis measures fit or variance in the dependent variable (Vélez-Pareja & García-Suaza, 2021). This tool assesses the strength of the relationship between the dependent and independent variables (Hox et al., 2020). Ranging from 0 to 1, an R^2 value of 0.70 or higher is typically considered strong (Field, 2013). Stronger and higher values represent independent variables that explain more of the dependent variable variance.

Standard Error

The standard error is provided in SPSS to measure the variability of the regression coefficients (Shanmugam, 2019). Smaller standard error values indicate greater precision in estimating the regression coefficients, strengthening the statistical significance of the predictor variable (Shanmugam, 2019).

Significance Level

The significance level, or the alpha level, is a probability value used to determine whether a null hypothesis should be rejected (Schumacker & Lomax, 2016). In SPSS, the default alpha level is set to 0.05, meaning there is a 5% chance of rejecting a true null hypothesis (Derrick et al., 2021). If the p-value associated with a statistical test is lower than the significance level, the null hypothesis is rejected, indicating evidence of a significant effect (Kamkar et al., 2021). However, if the p-value is greater than the significance level, the null hypothesis cannot be rejected, indicating insufficient evidence to support a significant effect (Field et al., 2020).

Regression Coefficients

Regression coefficients, also known as beta coefficients, represent changes in the dependent variable related to a one-unit change in the independent variable, holding all other variables constant (Kenny, 2020). In SPSS, the unstandardized coefficients reflect the raw effect of the independent variable on the dependent variable (Pedhazur & Schmelkin, 2019). Regression coefficients are vital in interpreting the relationship between the independent and dependent variables in multiple regression analysis (Berk et al., 2020).

β Coefficients

β coefficients are standardized coefficients that represent the change in the dependent variable in terms of standard deviations for a one standard deviation increase in the independent variable while holding all other variables constant (Gaskin & Happell, 2014). The β coefficient is calculated in SPSS by dividing the unstandardized coefficient by the standard deviation of the predictor variable (Derrick et al., 2021). β coefficients are used in comparing the relative strength of the effects of different predictors on the dependent variable, as they are on the same scale (Field et al., 2020).

Study Validity

Validity

In quantitative studies, validity is defined as an accurate measure of a concept (Heale & Twycross, 2015). Concerning validity, reliability is associated with the accuracy of an instrument used within a study (Heale & Twycross, 2015). Validity in quantitative research involves understanding if the instrumentation covers the intended content and if there is the ability to have consistent results if used in a similar situation on multiple occasions. Threats to validity may impact both internal and external validity. The following sections explain and define the threats and possible mitigation steps to eliminate the threats from the study.

Threats to External Validity

Haegele & Hodge (2015) states that external validity refers to the degree to which results are generalizable. Similarly, Cook & Campbell (1979) identifies external validity as the extent to which the results of a study can be generalized to other populations and settings beyond the specific sample and context in which the study was conducted. A threat to external validity was the introduction of bias concerning sampling. Sampling strategies directly correlate with external validity (McEwan, 2020). Threats to external validity include effects of testing (both reactive and interactive), multiple treatment interference, and selection bias. Sampling strategies such as selecting a sample of participants representing the greater population can control the threats to external validity (Haegele & Hodge, 2015).

A potential threat to external validity was convenience sampling, in which participants are selected based on their accessibility and willingness to participate, which can introduce bias into the sample and limit the generalizability of the results (Shadish et al., 2002). This threat was mitigated by using an online survey to decrease participant influence. Online surveys can reach a larger and more diverse sample, including those who may not be easily accessible through traditional sampling methods (Kim et al., 2021). By increasing the sample's representativeness, online surveys can help enhance the generalizability of the results and reduce the potential for bias (Kim et al., 2021). It was important to identify the external threats to ensure a robust study. Bhandari (2022) identified that introducing replication to the study to mitigate threats to external validity will enhance generalizability to the population and the study conditions. Other ways to mitigate threats to external validity include reprocessing to counter selection bias and using natural contexts (Bhandari, 2022).

Threats to Internal Validity

Effects observed within a study related to the independent variable rather than outside factors are referred to as internal validity (McLeod, 2013). Internal validity examines the relationships between independent and dependent variables. According to O'Neil et al. (2022), internal validity is a critical factor in evaluating the quality of a study, as it determines the strength of the causal relationships that can be inferred from the results. By introducing high internal validity, studies may properly show the relationship between two variables (Bhandari, 2022). Threats to internal validity include history, maturation, instrumentation, and testing. Kim and Cho (2021) identify that experimental studies correlate with causal relationships. Internal validity did not apply to this study as this study did not establish causal relationships.

Threats to Statistical Conclusion Validity

Threats to statistical conclusion validity, also known as Type I error rate, can significantly impact the credibility and interpretability of research findings (Simons, 2018). I addressed Type I errors by using G* Power software. Faul et al. (2019) identified that G* Power analysis addresses threats of Type I error by calculating the required sample size needed to detect an effect of a certain size with a specified level of statistical power. In addition to using G* Power software, researchers can also address the threat of Type I error by adjusting the significance level of their results (Simons, 2018; Hsu, 2015). By setting a stringent significance level, researchers can reduce the probability of accepting a false positive result and increase the reliability of their results (Hsu, 2015). This approach is commonly used to increase the validity of research findings and minimize the impact of Type I errors (Simons, 2018). Additionally, adjusting the significance level can help increase the precision and accuracy of the results, which is important for ensuring the validity and generalizability of research findings (Hsu, 2015).

Data Assumptions

Researchers should understand the underlying assumptions about statistical analyses as these assumptions play an essential role in the validity of the results (Kline (2020). Normality, independence, outliers, multicollinearity, autocorrelation, homoscedasticity, and linearity are the assumptions that will be tested in this study.

Normality

Normality assumptions involve the normally distributed dependent variable and are assessed through a histogram or normal probability plot (Kline, 2020). Normality is an important assumption in quantitative research when performing statistical hypothesis testing (Bandalos & Finney, 2018). Normality refers to the normal or bell-shaped data distribution, with a symmetrical distribution and a mean and median that are equal (Field et al., 2020). The normal distribution is a central concept in statistics characterized by its mean and standard deviation (Ghasemi & Zahediasl, 2012). Failure to meet the normality assumption can lead to biased estimates, incorrect standard errors, and inaccurate p-values (Kim & Kim, 2020). To assess this assumption, I used a probability plot to visually inspect the normal probability plot of the regression standardized residual and a scatterplot of the residuals.

Independence of Residuals

The independence of residuals refers to the assumption that the residuals or errors of a regression model are not correlated (Gujarati & Porter, 2021). Additionally, independence assumptions refer to the observations in the sample must be independent and free of any correlations between each other (Bollen, 2019). Bollen (2019) also states that the presence of interdependence can lead to biased results. Furthermore, violations of the independence assumption can lead to incorrect standard errors and an inaccurate test of the hypothesis (Kuhfeld & Tobias, 2020). This assumption was tested with visual inspection of the normal probability plot of the regression standardized residual and scatterplot of the residuals. Visual inspection of the residuals can reveal patterns or trends that might violate the independence assumption (Hawkins & Basak, 2022). According to Kuhfeld & Tobias (2020), when the independence assumption holds, the residuals should be randomly scattered around zero with no discernible patterns in the plot.

Outliers

Outliers may impact quantitative data interpretation by potentially distorting results and reducing statistical power (Alimohamadi et al., 2021). Outliers can affect statistical analyses and inference, leading to erroneous conclusions (Kharroubi et al., 2020). To mitigate outliers and the distortion of data, techniques such as box plots, scatter plots, and Cook's distance may be used (Kabir, 2021). I visually examined the normal probability plot of the regression standardized residual and scatterplot of the residuals. According to Wang et al. (2020), addressing outliers can enhance the validity and reliability of research findings while minimizing the influence of false observations on conclusions.

Homoscedasticity

According to Smith (2020), the homoscedasticity assumption refers to the dependent variable's remaining constant variance across all independent variable levels. Violations of homoscedasticity may lead to biased and inefficient parameter estimates and affect the validity of statistical inference (Cribbie & Jamieson, 2022). Homoscedasticity was assessed by visually examining the normal probability plot of the regression standardized residual and scatterplot of the residuals.

Linearity

Linearity refers to the relationship between the dependent and independent variables being linear or approximately linear (Xu et al., 2020). Nonlinearity can lead to biased estimates and incorrect inferences (Westfall et al., 2020). Linearity may be examined through scatterplots, visually depicting the relationship between variables (Neteret al., 2020). I assessed nonlinearity by visually inspecting the normal probability plot of the regression standardized residual and scatterplot of the residuals.

Multicollinearity

The multicollinearity assumption is where independent variables in a regression model are highly correlated, leading to unreliable coefficient estimates and difficulties in interpretation (O'Brien, 2007). Multicollinearity can be identified using statistical measures such as the variance inflation factor (Li, 2020). According to Kim et al. (2020), multicollinearity in regression analysis can be quantified using the variance inflation factor, which measures the degree to which the variance regression coefficient is increased due to the correlation between the independent variables. The formula for the variance inflation factor is $1/(1-R^2)$, where R^2 is the coefficient of determination from a regression of one independent variable on all the other independent variables in the model (Kim et al., 2020). Multicollinearity is suggested if the variance inflation factor exceeds 10 (Kim et al., 2020).

Autocorrelation

Autocorrelation assumptions refer to the correlation of a variable with itself over time, resulting in non-independent errors and biased coefficient estimates (Kim, 2021). One way to deal with autocorrelation violation quantitatively is to use time-series analysis techniques, such as autoregressive integrated moving average (ARIMA) models, that account for the temporal dependencies in the data (Enders, 2010). This is done quantitatively by forecasting future values to improve accuracy (Edens, 2010). Another approach is to use generalized estimating equations (g(E(Y_i)) = X_i * beta) to account for the correlation between observations within the same cluster (Ivanescu et al., 2018).

Alternatively, researchers can include lagged variables as independent variables in the regression model to capture the temporal effects (Kim, 2021).

Distribution

In quantitative research, distribution analysis enables researchers to assess the normality of data and select appropriate statistical tests for hypothesis testing (Hair et al., 2018). Researchers use visual aids such as histograms and QQ plots to supplement statistical tests and better understand data distribution (Pilarski & Bar, 2021). Before conducting statistical analyses, researchers must verify the quality of the data by examining distribution characteristics such as skewness and kurtosis (Kim, 2021). Additionally, measures of central tendency, such as mean and median, are used to describe the typical value of a variable (Ivanescu et al., 2018).

If assumptions are violated, researchers should take the appropriate action. According to Zhang and Chen (2020), transforming the variables, such as using a logarithmic transformation for positively skewed variables, is an action to take if assumptions are violated. This action is used when the relationship between dependent and independent variables is not linear. Additionally, bootstrapping is a process that addresses violations of assumptions. Bootstrapping involves generating multiple samples with replacements from the original data and then fitting a regression model to ensure more accurate standard errors and confidence intervals (Liu et al., 2021).

Transition and Summary

The purpose of this quantitative, correlational study was to examine the relationship between IT leaderships' perceived ease-of-use and perceived usefulness of

IoT devices and their intent to adopt security strategies for IoT implementation in warehouse environments. Section 2 addressed the roles of the researcher, participants, research methodology, research design, population, and sampling. This section also covered data analysis, data collection methods, and instrumentation. This section concluded with a discussion on research validity and the threats to validity while also touching on ethics in research.

In Section 3, I present the reader with an overview of the study's findings. In addition to the findings, I discuss the application to professional practice by providing a detailed overview of the applicability of the findings concerning IT professional practice. Section 3 will then touch on social change, recommendations for action, recommendations for further research, and reflect as the researcher of this study. This section will also include all appendices and the table of contents.

Section 3: Application to Professional Practice and Implications for Change

In this study, I used a correlational quantitative research method to examine the relationship between IT leaderships' perceptions as it relates to adoption of security strategies. Drawing on the TAM as theoretical framework, I specifically analyzed the relationship between IT leadership's perceived ease-of-use of IoT devices, perceived usefulness of IoT devices, and intent to adopt security strategies for IoT implementation in warehouse environments. In this section, I present the results of the analysis of the data collected through the online surveys completed by the participants of the study over a 2-month period.

Overview of Study

The purpose of this quantitative correlational study was to examine the relationship between IT leaders' perceived ease-of-use and perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation in warehouse environments. Data were collected from a sample of 69 IT leaders via SurveyMonkey, which satisfied the sample size requirement. Standard multiple linear regression analysis was conducted to assess the relationship between the independent and dependent variables.

The results of the multiple regression analysis revealed nonsignificant findings and the two predictors explained 50% of the variance ($R^2 = 0.50$, $F(2, 66) = 1.721$, $p > .05$). It was found that IT leaderships' PEOU is not a statistically significant predictor of intent to adopt security strategies for IoT implementation in warehouse environments ($\beta = -.044$, $p > .05$), as did IT leaderships' PU ($\beta = .233$, $p > .05$). Additionally, based on the results, both null hypotheses failed to be rejected, and there is not enough evidence to support a statistically significant relationship between the independent and dependent variables. In other words, the null hypotheses were accepted, and the others rejected.

Presentation of Findings

In this section, I describe the statistical tests, the variables, the purpose of the tests, and how they relate to the hypothesis. Descriptive statistics and results of inferential statistics are presented. Additionally, the evaluation of statistical assumptions is provided. Lastly, this section concludes with a summary of the findings. The research questions for this study are as follows:

1. What is the relationship between IT leaders' perceived ease-of-use of IoT devices and their intent to adopt security strategies for IoT implementation?

2. What is the relationship between IT leaders' perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation?

The null and alternative hypothesis addressed in this study were as follows:

$H1_0$: There is no statistically significant relationship between IT leaders' perceived ease-of-use of IoT devices and their intent to adopt security strategies for IoT implementation.

$H1_1$: There is a statistically significant relationship between IT leaders' perceived ease-of-use of IoT devices and their intent to adopt security strategies for IoT implementation.

H2_0: There is no statistically significant relationship between IT leaders' perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation.

H2_1: There is a statistically significant relationship between IT leaders' perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation.

Logic and filters were implemented to mitigate missing, incomplete, and invalid data by ending the survey for individuals who did not respond with *yes* to all qualifier questions related to Tables 1 to 4. Before data analysis, I assessed normality, outliers, multicollinearity, and homoscedasticity. To examine the relationship between independent and dependent variables, a multiple linear regression analysis was conducted, and descriptive statistics were provided.

Descriptive Statistics

Data were collected from a convenient sample of 69 IT leaders in warehouse environments who were knowledgeable from an IoT perspective and were local to North Texas ($N = 69$). I relied on participants and contacts who were readily available and willing to participate. Haegele and Hodge (2015) stated that convenience sampling methodology uses individuals based on their availability for the study. Logic was used in the survey tool to auto-filter and end the survey for individuals who did not meet the criteria for the study and did not respond with *yes* to all qualifying questions. The page logic provided in SurveyMonkey ended the survey if the participants did not answer *yes* or meet the study criteria. Tables 1 to 4 include the descriptive statistics of the IT professionals who took the survey. Displayed in Table 5 are the descriptive statistics of the means and standard deviations for the study variables.

Table 1

Frequency and Percent Statistics of Participants Considered IT Leaders

Variable	Frequency	%
IT leader	82	79.61
Non-IT leader	21	20.39

Note. IT = Information Technology.

Table 2

Frequency and Percent Statistics of Participants Knowledgeable of IoT Devices

Variable	Frequency	%
Participants with IoT device knowledge	93	90.29
Participants without IoT device knowledge	10	9.71

Note. IoT= Internet of Things.

Table 3

Frequency and Percent Statistics of Participants in Warehouse Environment

Variable	Frequency	%
Participants with experience in warehouse environments	91	88.35
Participants without experience in warehouse environments	12	11.65

Table 4

Frequency and Percent Statistics of Participants in North Texas

Variable	Frequency	%
Participants in North Texas	87	84.47

Participants outside of North Texas	16	15.53

Table 5

Means and Standard Deviations for Study Variables

Variable	Minimum	Maximum	Mean	Std. Deviation
IT leaderships' PEOU of IoT devices	2	5	3.89	.69
IT leaderships' PU of IoT devices	3	5	4.18	.54
IT leaderships' intent to adopt security strategies for IoT implementation	3	5	4.23	.48

Note. IT = Information Technology; PEOU = Perceived Ease of Use; IoT = Internet of Things; PU = Perceived Usefulness.

Data Cleaning

Data were cleaned to mitigate missing data, invalid entries, incomplete responses, and outliers. A frequency count analysis was conducted to address missing data. I compared the frequency counts of cases imported into SPSS with data obtained from both Microsoft Excel and Survey Monkey. After careful examination, I concluded that all cases contained complete and relevant data that contributed to the analysis. Outliers were addressed by visually examining the scatterplot of the residuals. According to Wang et al. (2020), addressing outliers can enhance the validity and reliability of research findings while minimizing the influence of false observations on conclusions. After examining the visual inspection of the residual scatterplot for observations greater than three standard deviations, no outliers were identified. Additionally, *z* scores were calculated in SPSS to ensure values were within the +/- 3.29 range standard deviation. Tabachnick and Fidell (2007) stated that an outlier is a data point that significantly deviates from the mean by

+/-3.29 standard deviations or more, signifying a divergence from the assumed normal distribution. Based on the *z* scores, no outliers were identified in the data.

Reliability Assessment

I assessed each variable in this study using Cronbach's alpha. Ebenehi et al. (2019) identified that the acceptable recommended minimum threshold for Cronbach's alpha is 0.7 and if $\geq .70$, scale reliability is assumed. As shown in Table 6, the items for IT leaderships' PEOU of IoT devices, IT leaderships' PU of IoT devices, and IT leaderships' intent to adopt security strategies for IoT Implementation indicated acceptable reliability.

Table 6

Reliability Statistics

Variable	Cronbach's Alpha	Number of items
IT leaderships' PEOU of IoT devices	.740	4
IT leaderships' PU of IoT devices	.735	4
IT leaderships' intent to adopt security strategies for IoT implementation	.718	4

Note. IT = Information Technology; PEOU = Perceived Ease of Use; IoT = Internet of Things; PU = Perceived Usefulness.

Evaluation of Statistical Assumptions

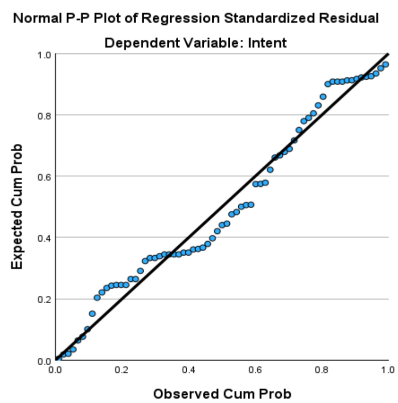
An evaluation of the assumptions of normality, independence of residuals, homoscedasticity, linearity, and multicollinearity occurred in this study.

Normality

Normality was assessed evaluating the P-P plot of the standardized residual. Graphically checking for normality is conducted by plotting data points on a straight line to observe normal distribution (Asuero & Bueno, 2011). No significant deviations from normality were observed (see Figure 11).

Figure 11

P-P Scatterplot of Regression Standardized Residual Testing Normality

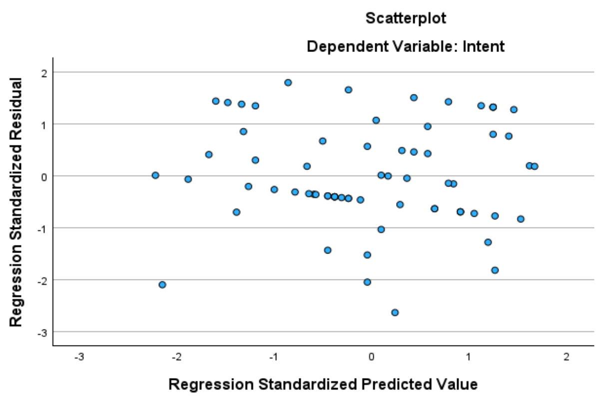


Independence of Residuals

This assumption was tested using the Durbin-Watson value and visual inspection of the scatterplot of the residuals. This value should be equal to 2 or closer to 2 (Perera & Wijesundara, 2020). With a visual inspection of the scatterplot and a 2.6 Durbin-Watson value, there is no evidence of suggesting a violation of the independence assumption (see Figure 12).

Figure 12

Residuals Standardized Predicted Value Testing for Independence and Homoscedasticity



Homoscedasticity

Violations of homoscedasticity may lead to biased and inefficient parameter estimates and affect the validity of statistical inference (Cribbie & Jamieson, 2022). This assumption was tested with visual inspection of the scatterplot of residuals standardized predicted value and the Durbin-Watson test. The assumption of homoscedasticity was met (see Figure 12).

Multicollinearity

The violation of multicollinearity was determined absent in the independent variables with the variance inflation factor values. The calculated variance inflation factor values were below 2.5 and does not indicate cause for concern as it relates to the violation of multicollinearity assumption (see Table 7).

Table 7

Variance Inflation Factor for Independent Variables

Variable	VIF
IT leaderships' PEOU of IoT devices	1.112
IT leaderships' PU of IoT devices	1.112

Note. VIF = Variance Inflation Factor; IT = Information Technology; PEOU = Perceived Ease of Use; IoT = Internet of Things; PU = Perceived Usefulness.

The evaluation of assumptions for multiple linear regression revealed no significant violations, affirming the normality of the collected data and obviating the necessity for data transformation. As a result, inferential statistics were employed using multiple linear regression.

Inferential Statistics

Multiple linear regression analysis was used to examine the relationship between the independent variables: (a) IT leadership's perceived ease-of-use of IoT devices, (b) IT leadership's perceived usefulness of IoT devices, and the dependent variable, (c) IT leadership's intent to adopt security strategies for IoT implementation in warehouse environments.

The research questions were as follows:

1. What is the relationship between IT leaders' perceived ease-of-use of IoT devices and their intent to adopt security strategies for IoT implementation?
2. What is the relationship between IT leaders' perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation?

The null and alternative hypothesis addressed in this study were as follows:

($H1_0$): There is no statistically significant relationship between IT leaders perceived ease-of-use of IoT devices and their intent to adopt security strategies for IoT implementation.

($H1_1$): There is a statistically significant relationship between IT leaders perceived ease-of-use of IoT devices and their intent to adopt security strategies for IoT implementation.

($H2_0$): There is no statistically significant relationship between IT leaders perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation.

($H2_1$): There is a statistically significant relationship between IT leaders perceived usefulness of IoT devices and their intent to adopt security strategies for IoT implementation.

The multiple regression analysis was used to test if IT leaderships PEOU and PU of IoT devices significantly predicted participants' intent to adopt security strategies for IoT implementation in warehouse environments. The results of the regression indicated the two predictors explained 50% of the variance ($R^2 = 0.50$, $F(2, 66) = 1.721$, $p > .05$). It was found that IT leaderships PEOU is not a statistically significant predictor of intent to adopt security strategies for IoT implementation in warehouse environments ($\beta = -.044$, $p > .05$), as did IT leaderships PU($\beta = .233$, $p > .05$). The results of the multiple linear regression supported the null hypothesis, and p-values are greater than .05. Table 8 displays the multiple regression analysis among the study predictors. Table 9 displays the Pearson correlation matrix of the independent and dependent variables.

Table 8

Multiple Linear Regression Analysis Among Study Predictors

Variable	*B*	*SE*	95%CI lower bound	95%CI upper bound	β	t	*p*
IT leaderships' PEOU of IoT devices	-.030	.088	-.205	.145	-.044	-.348	.729
IT leaderships' PU of IoT devices	.205	.112	-.018	.428	.233	1.839	.070

Note. Results: $F(2, 66) = 1.721$, $p > .05$, $R^2 = 0.50$

Table 9

Pearson Correlation Matrix

Variable	IT leaderships' intent to adopt security strategies for IoT implementation	IT leaderships' PEOU of IoT devices	IT leaderships' PU of IoT devices
IT leaderships' intent to adopt security strategies for IoT implementation	-	.030	.219
IT leaderships' PEOU of IoT devices	.030	-	.317
IT leaderships' PU of IoT devices	.219	.317	-

Note. IT = Information Technology; PEOU = Perceived Ease of Use; IoT = Internet of Things; PU = Perceived Usefulness.

Analysis Summary

In this study, I examined the relationship between IT leadership's perceived usefulness and ease of use of IoT devices and their intent to adopt security strategies for IoT implementation in warehouse environments. I conducted a standard multiple linear regression analysis to assess the relationship between the independent and dependent variables. Model diagnostic tests such as residual analysis and VIF for multicollinearity violation was used for a model validation. Figure 12 and Table 7 indicate no violation of the assumptions. Data was cleaned before the standard multiple linear regression and descriptive statistics were generated. Next, I conducted a reliability assessment for the composite scores using Cronbach's alpha. All scale items of the study survey instrument had a Cronbach's alpha value above .7, which indicated that the instrument was acceptable and reliable for all the scales. Additionally, the assumptions of multiple linear regression were tested to ensure that the study did not violate the assumptions. The multiple linear regression analysis result indicated a statistically nonsignificant relationship between the independent and dependent variables, $F(2, 66) = 1.721$, $p > .05$, $R^2 = 0.50$. Considering the results of the multiple linear regression analysis, there is not enough evidence to reject the study's null hypothesis.

Theoretical Conversation on Findings

The literature review indicated a need for more research regarding IoT security strategies in warehouse environments. Using TAM as the theoretical framework, a quantitative instrument was used to survey IT leadership in North Texas in warehouse environments to understand their perspective on what factors impact intentions to adopt security strategies for IoT implementation. The constructs adapted from TAM were (a) IT leadership's perceived usefulness of IoT devices, (b) IT leadership's perceived ease of use of IoT devices, and (c) IT leadership's intent to adopt security strategies for IoT implementation in warehouse environments.

The findings of this study indicated the two predictors explained 50% of the variance (R^2 = 0.50, F(2, 66) = 1.721, p > .05). It was found that IT leaderships PEOU is not a statistically significant predictor of intent to adopt security strategies for IoT implementation in warehouse environments (β = -.044, p > .05), as did IT leaderships PU (β = .233, p > .05). There was not enough evidence to reject the null hypotheses.

The findings of this study partially align with Kumar et al. (2011) who examined the factors that impact behavioral intention to use internet banking. Kumar et al. identified that a statistically significant relationship did not exist between PEOU (p = .499) and intention to use internet banking. PU (p<0.01) was identified to have a significant relationship with the intention to use internet banking. Similarly, Chong (2013) examined determinants for adoption and identified PEOU to have no significant relationship with adoption of new technology. The findings of this study also supported the finding in the study by Bhardwaj et al. (2021) who examined IoT technology adoption in the supply chain. Bhardwaj et al. found that users perceive IoT technology to be complex. The findings of this study supported the studies conducted by Kumar et al., Chong, and Bhardwaj et al. from a perceived ease of use perspective.

The findings of this study are contrary to previous studies conducted by researchers, in which perceived usefulness and ease of use are important factors in determining behavioral intention (Yildirim & Ali-Eldin, 2019). In a previous study titled "The effect factors in the adoption of Internet of Things (IoT) technology in the SME in KSA: An empirical study", Jaafreh (2018) examined both perceived ease of use and perceived usefulness as predictors to predict intention to use IoT technology. This study also used TAM as the framework to ground the research. In contrast to this study, Jaafreh (2018), perceived ease of use and usefulness were influential predictors of the dependent variable. However, Yildirim & Ali-Eldin (2019) identified nonsignificant results when examining the variables risk ($p = 0.196$), improper access ($p = 0.718$), and collection ($p = 0.187$) with their relationship with behavioral intention in the study titled "A model for predicting user intention to use wearable IoT devices at the workplace". The authors stated different opportunities for further research of the nonsignificant results, such as conducting the study with a different population, including a greater number of respondents, and identifying different cultural perspectives (Yildirim & Ali-Eldin, 2019).

This study indicated that there is no evidence that IT leaders in warehouse environments perceive IoT devices as useful and easy to use, and they are willing to adopt IoT security strategies due to these factors. A possible explanation for this is that IT leadership in warehouse environments may be dealing with other factors that indirectly impact the relationship, such as limited knowledge of security best practices and legacy system integrations.

Applications to Professional Practice

The standard multiple regression analysis results in this quantitative correlational study were used to determine the significance of the relationship between (a) IT leadership's perceived usefulness of IoT devices, (b) IT leadership's perceived ease of use of IoT devices and (c) IT leaderships intent to adopt security strategies for IoT implementation in warehouse environments. This research used the TAM framework to assess the variables impacting the intent to adopt security strategies. Few studies in the literature examined the effects of IT leadership's perceived usefulness of IoT devices and IT leadership's perceived ease of use of IoT devices on IT leadership's intent to adopt security strategies for IoT implementation in warehouse environments. This study is significant to IT practice because it may provide practical knowledge of the factors influencing IoT security strategy adoption for IT leaders in warehouse environments.

The results of this study provide a starting point for IT leaders to reduce further the knowledge gap surrounding IoT security and warehousing. Additionally, the results of this study address the need for more substantial research related to IoT security strategy adoption, specifically in logistics and supply chains. The addition to the body of knowledge increases the understanding of security as it relates to IoT in warehouse environments.

This study revealed no statistically significant relationship between the independent and dependent variables. Based on the results of this study, there is not enough evidence to state that IT leadership's intent to adopt security strategies for IoT implementation in warehouse environments is positively influenced by IT leadership's perceived usefulness and perceived ease of use of IoT devices. Comparing this study to another scholarly article titled: “Factors Affecting Adoption of Information Security Management Systems: A Theoretical Review,” the authors also identified adoption of security is a challenge for organizations (Kiilu & Nzuki, 2016). In reviewing the literature further, there was a lack of research that would confirm the findings of a statistically nonsignificant relationship between the independent and dependent variables. Therefore, a major contribution in terms of this research, despite nonsignificant findings, is that the knowledge provided in this study allows IT leaders to explore other influencing factors as IT professionals in warehouse environments explore maturing from a security perspective. Hsu & Lin (2018) identified in the study "Exploring Factors Affecting the Adoption of Internet of Things Services" factors such as perceived benefit and perceived sacrifice that could be used in future research.

Implications for Social Change

This study examined the relationship between independent variables (a) IT leadership's perceived usefulness of IoT devices, (b) IT leadership's perceived ease of use of IoT devices, and (c) IT leadership's intent to adopt security strategies for IoT implementation in warehouse environments. The results showed that the independent variables lacked a significant relationship with the dependent variable. Warehouse organizations may use the knowledge gained from the results to understand better the influencing factors for security strategy adoption related to IoT devices.

The implications for positive social change include the potential for a better understanding, by IT professionals, of the importance of IoT security in warehouse environments. IoT security in warehouse environments creates the opportunity for a more efficient warehouse and supply channel. The efficiencies impact consumers and citizens positively at the terminal end of the supply chain. As a result of the positive impacts, consumers and citizens can contribute further to spending, leading to increased profits for organizations and an improved economy.

Recommendations for Action

The results of this study revealed that IT leadership's perceived usefulness of IoT devices and IT leadership's perceived ease of use of IoT devices did not have a significant relationship with IT leadership's intent to adopt security strategies for IoT implementations in warehouse environments. This knowledge can be used to refine the model and factors used for evaluating the intent to adopt security strategies for IoT implementations in warehouse environments in the future.

The literature review revealed a need for more research on studies providing strategies for security related to IoT implementations in supply chain warehouses. It is recommended that further studies be conducted in the supply chain warehousing industry due to the limited studies that examine influencing factors of security strategies for IoT implementations. A deep understanding of security strategies will assist IT leadership in warehouse environments when implementing IoT devices on the warehouse floor.

I will share the findings of this study with IT project managers, IT managers, and technical architects within the supply chain and logistics industry through conferences and pieces of training. My focus will be to help IT leaders mature their security from an IoT perspective and reduce network breaches in warehouse environments when possible.

Recommendations for Further Study

There were several limitations identified in this study. The first limitation of this study was that it was conducted in North Texas and targeted only IT leaders in warehouse environments. A second limitation was the sample size of the study (69). The final limitation is the use of convenience sampling methodology. This limitation limited the participation of all qualified IT leaders within the targeted population. Additionally, this limitation may have reduced the generalizability of the study results to the target population. The scope of the sample population for further research could expand to include other IT leaders in warehouse environments located in other regions or parts of the country. This recommendation may increase the accuracy and generalizability of the result of the study to the target population. Additionally, this recommendation may help increase the knowledge surrounding IoT security strategy adoption among IT leaders from a broader perspective.

Further research on security strategies for IoT implementation in warehouse environments could include the following recommendations. Researchers could include more independent variables to measure other factors that may impact the intention to adopt security strategies for IoT implementation in warehouse environments. This approach directly addresses the statistically nonsignificant results and assists in identifying other predictors. This recommendation would also expand the literature on IT leadership's intent to adopt security strategies for IoT implementations. Secondly, researchers should maintain the same independent and dependent variable and alter the location of the targeted population from North Texas to South Texas, East Texas, or West Texas. In doing so, future research may contradict or support the results of this study.

Reflections

The IT Doctoral Study process was very challenging. The DIT program at Walden University was one of the most challenging times academically. Although challenging, the program was also rewarding. This program allowed me to grow from a time management standpoint. I had to balance work, the program, and a new growing family. The resources I was provided during the program allowed me to be successful and see it through to the end.

I started this journey needing help understanding the concepts of TAM. In working with my chair and utilizing all available resources through Walden, my knowledge developed, and I could relate the framework in the context of security strategy adoption for IoT implementation in warehouse environments. I have expanded my knowledge of conducting research in a scholarly manner. Another change in thinking after completing this study includes how I will approach IT leadership roles as my career progresses.

There were no preconceived ideas or personal biases when starting this research in examining the relationship between (a) IT leadership's perceived usefulness of IoT devices, (b) IT leadership's perceived ease of use of IoT devices, and (c) IT leaderships intent to adopt security strategies for IoT implementation in warehouse environments. The effects on the participants due to this study include an increased understanding of IoT devices and how useful and easy they are perceived. With this knowledge, IT leaders in warehouse environments can implement IoT devices more securely to increase efficiency in the supply chain. Secure IoT implementations should result in increased reliability in the supply channel and the distribution of goods and products needed by consumers.

Conclusion

The purpose of this quantitative correlation study was to examine the relationship between independent variables, that is, IT leadership's perceived usefulness of IoT devices, IT leadership's perceived ease of use of IoT devices, and the dependent variable, IT leadership’s intent to adopt security strategies for IoT implementation in warehouse environments. I collected data from 69 IT leaders in warehouse environments; this sample size fell within the G*Power software recommendation. I generated descriptive statistics from the data collected. Additionally, I conducted instrument reliability, assessed assumptions related to standard multiple linear regression, and tested the hypotheses generated from the research questions using a standard multiple linear regression.

The result from the multiple linear regression did not provide enough evidence to support the rejection of the null hypothesis. The results indicated the two predictors explained 50% of the variance ($R^2 = 0.50$, $F(2, 66) = 1.721$, $p > .05$). It was found that IT leaderships PEOU is not a statistically significant predictor of intent to adopt security strategies for IoT implementation in warehouse environments ($\beta = -.044$, $p > .05$), as did IT leaderships PU ($\beta = .233$, $p > .05$). In other words, the results revealed a statistically nonsignificant relationship between IT leadership's perceived usefulness of IoT devices, IT leadership's perceived ease of use of IoT devices, and the dependent variable IT leadership's intent to adopt security strategies for IoT implementation in warehouse environments. Despite the study limitations and statistical results, IT leaders in warehouse environments can leverage these findings to make informed decisions on factors that may or may not influence IT leaders' intention to adopt security strategies for IoT implementations. This study contributes significantly to the body of research on IoT security strategies in warehouse environments.

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Appendix A: PHRP Protecting Human Research Participants Certificate of Completion

CERTIFICATE

OF COMPLETION

PHRP Online Training, Inc. certifies that

Opegbemi Oladapo

has successfully completed the web-based course "Protecting Human Research Participants Online Training."

Date Completed: **2023-02-01** Certification Number: **2986555**

PHRP
Protecting Human
Research Participants
Online Training

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

COMPLETION REPORT - PART 2 OF 2
COURSEWORK TRANSCRIPT**

** NOTE: Scores on this Transcript Report reflect the most current quiz completions, including quizzes on optional (supplemental) elements of the course. See list below for details. See separate Requirements Report for the reported scores at the time all requirements for the course were met.

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- **Curriculum Group:** Student's
- **Course Learner Group:** Doctoral Student Researchers
- **Stage:** Stage 1 - Basic Course

- **Record ID:** 43613854
- **Report Date:** 22-Feb-2023
- **Current Score**:** 100

REQUIRED, ELECTIVE, AND SUPPLEMENTAL MODULES	MOST RECENT	SCORE
Students in Research (ID: 1321)	15-Jul-2021	5/5 (100%)
Consent in the 21st Century (ID: 17060)	15-Jul-2021	5/5 (100%)
Assessing Risk - SBE (ID: 503)	15-Jul-2021	5/5 (100%)
Informed Consent - SBE (ID: 504)	15-Jul-2021	5/5 (100%)
Privacy and Confidentiality - SBE (ID: 505)	15-Jul-2021	5/5 (100%)
Unanticipated Problems and Reporting Requirements in Social and Behavioral Research (ID: 14928)	15-Jul-2021	5/5 (100%)
History and Ethical Principles - SBE (ID: 490)	15-Jul-2021	5/5 (100%)

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Appendix B: Permission for Reprinted Figures

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The Internet of Things (IoT) is a term that relates the connection of material devices to the internet – as diverse as domestic appliances to health monitoring equipment to

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Re: Reprint Permission for Dissertation

SP Sunyoung Park <spark65@lsu.edu>
To Oladapo Opegbemi
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Sunyoung Park, PhD

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RE: Reprint Permission for Dissertation

W wahaishi@gmail.com
To Oladapo Opegbemi; vaclav.snasel@vsb.cz
Wed 4:52 PM

Dear Oaldapo,

Thank you for your email and interest in reprinting some material of our publication titled "Modeling the Determinants Affecting Consumers' Acceptance and Use of Information and Communications Technology". I have no objection to re-use any of our published material given that the proper citation and credit will be given.

I wish you all the best in your doctoral work and should you need any further information or assistance, please let me know.

Best,
Saleh

From: Oladapo Opegbemi <oladapo.opegbemi@waldenu.edu>
Sent: Wednesday, 1 February 2023 8:09 pm
To: wahaishi@gmail.com; vaclav.snasel@vsb.cz
Subject: Reprint Permission for Dissertation
Importance: High

Dear Sir/Ma'am,

Hope all is well. My name is Oladapo Opegbemi and I attend Walden University's Doctor of Information Technology program working to conduct research. I am working on my doctoral study titled "Secure Strategies for IoT Implementation in Warehouse Environments". I hope to obtain permission to reprint your Theory of Reasoned Action diagram in the article "Modeling the

Appendix C: Permission for Survey Instrument

PsycTESTS®

Information Systems Adoption Survey

Note: Test name created by PsycTESTS

PsycTESTS Citation:
Morosan, C., & DeFranco, A. (2016). Information Systems Adoption Survey [Database record]. Retrieved from PsycTESTS. doi: https://dx.doi.org/10.1037/t49008-000

Instrument Type:
Survey

Test Format:
The Information Systems Adoption Survey is comprised of 47 items, which are rated for agreement with 5-point, Likert-type scales.

Source:
Morosan, Cristian, & DeFranco, Agnes. (2016). It's about time: Revisiting UTAUT2 to examine consumers' intentions to use NFC mobile payments in hotels. International Journal of Hospitality Management, Vol 53, 17-29. doi: https://dx.doi.org/10.1016/j.ijhm.2015.11.003, © 2016 by Elsevier. Reproduced by Permission of Elsevier.

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Appendix D: Original Survey Instrument

PsycTESTS®

doi: http://dx.doi.org/10.1037/t49008-000

Information Systems Adoption Survey

Constructs and items

Performance expectancy (adapted from Venkatesh et al., 2012)
PE1: Using NFC mobile payments in hotels would enhance the effectiveness of my interactions with the hotel (for example, purchasing products/services, making reservations)
PE2: Using NFC mobile payments would increase the efficiency of my hotel stay
PE3: Using NFC mobile payments in hotels would improve the quality of my hotel stay
PE4: Using NFC mobile payments would allow me to access products/reservations faster in hotels)
PE5: Using NFC mobile payments would allow me to make more accurate purchases/reservations in hotels
PE6: Using NFC mobile payments would allow me to purchase/reserve products with an overall better value in hotels
PE7: Using NFC mobile payments would allow me to better manage my money when staying in hotels
PE8: Using NFC mobile payments would allow me to have better control over my expenses in hotels
PE9: Using NFC mobile payments would allow me to have a better view of my purchasing history in hotels
PE10: Using NFC mobile payments would provide me with a more secure method of payment in hotels
PE11: Using NFC mobile payments would lower the need to carry multiple methods of payment with me when staying in hotels
PE12: Using NFC mobile payments would allow me to choose more effectively among my methods of payment
PE13: Using NFC mobile payments would allow me to obtain benefits beyond the hotel stay (for example, using a preferred credit card).
PE14: Overall, I believe that NFC mobile payments are useful when staying in hotels
Effort expectancy (adapted from Venkatesh et al., 2012)
EE1: Learning how to use NFC mobile payments for my purchases in hotels is easy for me
EE2: My interactions with my mobile phone and transaction terminals when using NFC mobile payments in hotels are clear and understandable
EE3: I find it easy to use NFC mobile payments in hotels
EE4: It is easy for me to become skillful at using NFC mobile payments in hotels
Social influence (adapted from Venkatesh et al., 2012)
SI1: People who are important to me think that I should use NFC mobile payments in hotels
Si2: People who influence my behavior think that I should use NFC mobile payments in hotels
Si3: People whose opinions that I value prefer that I use NFC mobile payments in hotels
Facilitating conditions (adapted from Venkatesh et al., 2012) .842
FC1: I have the resources necessary to use NFC mobile payments in hotels
FC2: I have the knowledge necessary to use NFC mobile payments in hotels
FC3: NFC mobile payments are compatible with other technologies I use
FC4: I can get help from others when I have difficulties using NFC mobile payments in hotels
Hedonic motivation (adapted from Venkatesh et al., 2012)
HM1: Using NFC mobile payments in hotels is fun
HM2: Using NFC mobile payments in hotels is enjoyable

PsycTESTS

doi: http://dx.doi.org/10.1037/t49008-000

Information Systems Adoption Survey

Constructs and items
HM3: Using NFC mobile payments in hotels is entertaining
HM4: Using NFC mobile payments in hotels is pleasant
Habit (adapted from Venkatesh et al., 2012)
HA1: Generally, the use of mobile phones for payment has become a habit for me
HA2: I am addicted to using mobile phones for general payment
HA3: I must use mobile phones for payment
HA4: Using mobile phones for payment has become natural to me
General privacy (adapted from Li et al., 2011)
GP1: Compared to others, I am more sensitive about the way companies handle my personal information
GP2: To me, it is most important to keep my privacy intact from companies
GP3: I am concerned about threats to my personal privacy today
System-related privacy (adapted from Kim et al., 2008b)
SP1: Using NFC mobile payments makes me concerned about my personal privacy
SP2: Using NFC mobile payments would make me personally uncomfortable
SP3: Using NFC mobile payments would make me have privacy concerns
Perceived security (adapted from Vatanasombut et al., 2008)
PS1: NFC mobile payment systems are secure systems through which to send sensitive information in hotels
PS2: I would feel secure providing personal information when using NFC mobile payments in hotels
PS3: I am not worried that information I provide when using NFC mobile payments could be used by other people
PS4: Overall, NFC mobile payment systems are safe to transmit sensitive information
Intentions (adapted from Venkatesh et al., 2012)
IN1: I intend to use NFC mobile payments in hotels in the future
IN2: I will always try to use NFC mobile payments in my hotel stays
IN3: I will recommend to others using NFC mobile payments in hotels
IN4: NFC mobile payments would be one of my favorite technologies for payment