



RELIABILITY AND USER BEHAVIOR TOWARDS IOT SYSTEM AFFECTING
ORGANIZATIONS' SUPPLY CHAIN PERFORMANCE



BENRONICA JANAM ANAK BENNET BAJA

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

I hereby acknowledge that this project paper has been accepted as part of fulfilment for the degree of Bachelor of Technology Management (Supply Chain Management & Logistics)

SIGNATURE

: 

NAME OF SUPERVISOR : DR. NUSAIBAH MANSOR

DATE

: 20 JANUARY 2023

SIGNATURE

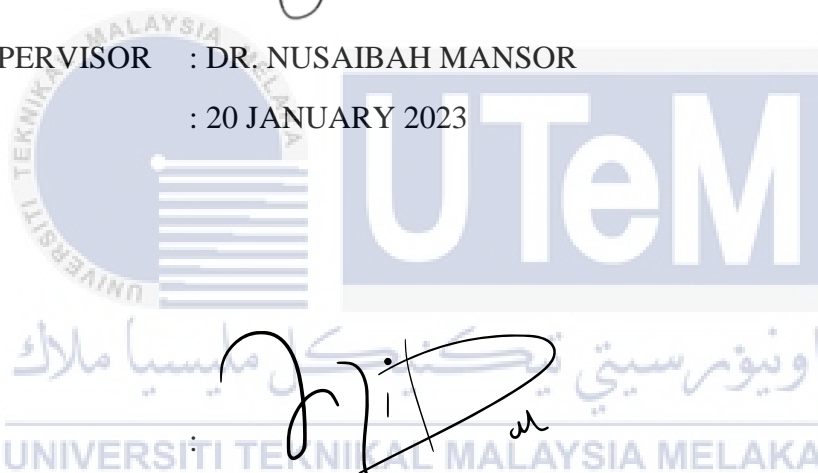
: 

NAME OF PANEL

: DR. MURZIDAH BINTI AHMAD MURAD

DATE

: 20 JANUARY 2023



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BENRONICA JANAM ANAK BENNET BAJA

This thesis is submitted in partial fulfilment of the requirements for the award of

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DECLARATION OF ORIGINAL WORK

I hereby declare that all the work of this thesis entitled reliability and user behaviour towards IoT system affecting on organizations' supply chain performance is originally done by myself and no portion of the work encompassed in this research project proposal has been submitted in support of any application for any other degree or qualification of this or any other institute or university of learning.



SIGNATURE

اوتنوم ستي تیکنیکا ملیسيا ملاک
NAME : BENRONICA JANAM ANAK BENNET BAJA

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
DATE : 20 JANUARY 2023

DEDICATION

I would like to appreciate the dedication to my beloved family members who educated me and motivate me to pursue my studies until degree level. And also, I express a deep sense of gratitude to my lecturer whom also my supervisor for my final year project, DR. Nusaibah binti Mansor and my fellow friends (Aqilah, Anissa, Izyan & Fatini). They have provided me full support and advice throughout this research. Without their blessing and encouragement, this research is impossible to complete within this short period of time.



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ABSTRACT

This research is about the reliability of IoT system and user behaviour towards IoT system that affecting organizations' supply chain performance. IoT is what connect individual identified products, machines and human to provide optimized solutions, through sensor devices, data storage and analysis equipment as well as decision-making tools. It is utilized in the organizations to enable efficient management and applied in the supply chain industry for efficient process. Due to Covid, organizations' explore IoT in which they include it in their supply chain on deeper level in order to counter demand and supply. This research aim to study the organizations supply chain performance after utilizing the IoT frequently in their operation. IoT application are widely used, not only in Malaysia, but in European countries it is a critical high-end solution that ensure efficiency throughout their supply chain processes and managerial activity.

ABSTRAK

Kaji selidik ini adalah mengenai kebolehpercayaan sistem IoT dan tingkah laku pengguna terhadap sistem IoT yang mempengaruhi prestasi rantaian bekalan organisasi. IoT ialah perkara yang menghubungkan produk, mesin dan manusia yang dikenal pasti individu untuk memberikan penyelesaian yang optimum, melalui peranti sensor, penyimpanan data dan peralatan analisis serta alat membuat keputusan. Ia digunakan dalam organisasi untuk membolehkan pengurusan yang cekap dan digunakan dalam industri rantaian bekalan untuk proses yang cekap. Disebabkan Covid, organisasi meneroka IoT di mana menerapkan IoT ke dalam rantaian bekalan mereka pada tahap yang lebih mendalam untuk mengatasi permintaan dan bekalan. Penyelidikan ini bertujuan untuk mengkaji prestasi rantaian bekalan organisasi selepas menerapkan IoT dalam operasi mereka. Aplikasi IoT digunakan secara meluas, bukan sahaja di Malaysia, tetapi di negara-negara Eropah di mana IoT merupakan penyelesaian yang kritikal yang memastikan kecekapan sepanjang proses rantaian bekalan dan aktiviti pengurusan mereka.

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LIST OF ABBREVIATIONS



ABBREVIATION	MEANING
IoT	Internet of Things
RFID	Radio Frequency Identification
WSN	Wireless Sensor Networks

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CHAPTER 1 INTRODUCTION

1.1 Introduction

Organizational supply chain are key to an organization performances. It is one of significant aspect that define the competence of an organization. Reliable supply chain system will enable organization to remain competent and upkeep with the rapid development. The purpose of this research is to study the relationship between the reliability and user behavior of IoT system and how it will affect organization's supply chain. This chapter focuses on the background of study, problem statement, objectives and hypotheses of this research, significance of study, limitation of study and operational definition of terms.

1.2 Background of Study

Supply chain performance is significant for organizations' competitive advantage and utilising IoT system revolutionize many aspects of supply chain from manufacturing to endpoint (Locke, 2020). Previously, supply chain are fragmented into warehousing, forecasting, production and many more and now with the integration of IoT, supply chain are heading and evolving into automation (Rodrigue, 2020). Using IoT, uncertainties are eliminated and allow seamless integration across the supply chain (Locke, 2020). RFID systems, barcodes, and intelligent sensors are some of the technologies that have been deployed in supply chain management in recent decades (Tharaka de Vass, 2018). Implementation of IoT into supply chain allow additional capabilities by IoT technologies to sense supply chain processes, improving visibility, accuracy, traceability, interoperability and collaborative decision (Tharaka de Vass, 2018).

In Malaysia, IoT is still at infancy stage in terms of automating, which puts Malaysia in the back end of line manufacturing although Malaysia has 40 years in the semiconductor segment (Amarthalingam, 2017). The reasons for IoT still being at infancy stage also due to manufacturers refuse to invest in fully automated system as expenditure could cost up to several millions. Currently, it had been predicted that by 2030 and beyond, trillions of sensors and related device in the IoT projected to exist (Sibin Mohan, 2018). Thus, emerging amount of IoT devices and applications will result in emerging variances of vulnerabilities. As other disruptive technologies, reliability of the devices or system will be questioned.

Furthermore, employee or individuals utilization of IoT system in supply chain are impacting the efficiency of IoT system to work with IoT technologies, solutions, device to network and then on its application (Samuel J. Moore, 2020). Reliability and user behaviour towards IoT system which affect organizations' supply chain performance are studied in this research to find out about their relationship. Integration of IoT into an organizations' supply chain will affect organizations' supply chain performance since it has transform conventional supply chain into smart supply chain (Bahar, 2022).

1.3 Problem Statement

IoT system are implemented into supply chain to improve its traceability and visibility which can enhance supply chain performance (Faghihi-Nezhad, 2022). The system generate huge amount of data thus security issues often arises which result into questioning the reliability and of IoT system. Commonly, as any new technology that enters the market, the question about its reliability will surely follow suit (Sibin Mohan, 2018). In addition, the authentication of connected and embedded device within each other and the web services still remain a great challenges (Sibin Mohan, 2018). On top of that, user behavior of IoT system are associated with how employees and organization as a whole interact with the system in order to achieve certain goals set by the companies.

Globalization in supply chain depended heavily on data exchange across its associated organizations despite located geographically apart (Global-Supply Chain Management-Drivers and Activities of Global Supply Chain, n.d.). One of the main aspect that enable supply chain to function efficiently regardless of how broad it is, is visibility within the supply chain (Global-Supply Chain Management-Drivers and Activities of Global Supply Chain, n.d.). An effective supply chain collaboration will allow exchange of information that is accurate and timely which display required information at different point in the supply chain (Global-Supply Chain Management-Drivers and Activities of Global Supply Chain, n.d.). Thus, issues such as inaccurate evaluations, misjudgments and poor decision could affect badly on an organizations and the entire supply chain processes.

Previously, there is also huge case that made the headline, Mirai botnet that infect thousands of IoT devices and then evolving conducting full large-scale attacks (The Mirai Botnet-Threats and Mitigations, n.d.). Mirai botnet which focus on infecting as many device as possible was further encouraged by lack of security embedded into the IoT devices (The

Mirai Botnet-Threats and Mitigations, n.d.). This further result in the gap of security of IoT system with organization adoption of IoT system into supply chain processes which directly impact organizations' supply chain performance.

Moreover, the user behavior of IoT devices also result in vulnerabilities within the devices. It was believed that lack of knowledge, carelessness or malice on employee's part could lead to cyber-attack (Cyber Security Awareness: 7 Ways Your Employees Make Your Business Vulnerable to Cyber Attacks, 2022). This illustrates that user behavior towards IoT system and its reliability result in significant impact on organizations' supply chain performance.

1.4 Research Objectives

1.4.1 General Objective

The research objective of this paper is to determine the relationship between reliability and user behaviour of IoT system and how it will affect the organization's supply chain performance.

1.4.2 Specific Objectives

The specific objectives are:

- a. To identify factors of reliability and user behaviour towards IoT system that is affecting an organization supply chain performance.
- b. To analyse the factors of reliability and user behaviour towards IoT system that is affecting an organization supply chain performance.
- c. To determine the most significant contributing factor of reliability and user behaviour towards IoT system that affect an organization supply chain performance.

1.5 Research Question

- a. What factors of reliability and user behaviour towards IoT system affecting organizations' supply chain performance?
- b. What are the effects of reliability and user behaviour towards IoT system affecting organization's supply chain performance?

- c. What is the most significant contributing factor of reliability and user behaviour towards IoT system that affect an organization's supply chain performance?

1.6 Scope and Limitations of Study

This research study about the reliability and user behavior of IoT system that is affecting organizations' supply chain performance. The scope of the study are focused on utilization of IoT system in Malaysia that will affect supply chain performance of that organizations. This study measures how the reliability aspect of IoT system in organizations and from how the user behavior towards the system affecting organization's supply chain performance. The research are conducted on selected organizations in Ayer Keroh, Malacca, Malaysia where IoT system are utilized in supply chain operations.

The limitation of the study is inaccurate data from the respondents due to some employees does not have a deep and adequate knowledge about IoT system. The researcher also does not focus on every single state in Malaysia and only focuses in three organizations in Melaka that utilized IoT system to manage their supply chain. In addition, researcher also faces time limitation in conducting the study due to study need to be completed in a short amount of time which is in 10 months.

1.7 Significant of study

This study may contribute useful information for other parties as well as for researchers. The findings of the study may contribute to the existing literature today. Through this study, determining the relationship between reliability and user behaviour of IoT system and organization's supply chain performance may enable an extension of current research factors. The findings of the study will benefit organizations who want to improve IoT application within their organization. This will make aware of organizations understand the impact that reliability and user behaviour of IoT system on their supply chain performance. Besides, employees within the IT department can understand and develop more alternatives and solution to build a better IoT system.

1.8 Definition of Terms

In this section, the operational definition of the terms in the research will be explained.

1.8.1 Reliability

Operational: Reliability is the measure of how consistent the system or device respond after certain period of time.

1.8.2 User Behaviour

Operational: User behaviour is defined as how individual act when using the system. The steps and procedure of interacting with the system in order to achieve goal or complete the tasks.

1.8.3 Internet of Things (IoT)

Operational definition: Internet of things consist of smart devices, RFID, sensors, actuators that capture and transmit data that real-time data.

1.8.4 Supply Chain Performance

Operational: Supply chain performance refers to more than just performing the supply chain activities. It is about ensuring the performance delivered comes with good quality and of good service level. For an example, delivery within the time pre-determined time frame, but faster delivery will result in better supply chain improvement.

1.8.5 Security

Operational: Security in the context of reliability refers to the capability of the system to withstand attack of botnets and hackers to prevent leak of data to unauthorized party.

1.8.6 Sensitivity

Operational: Sensitivity under the context of reliability refers to the frequency of the system to produce and transmit accurate data even under non-favourable conditions

1.8.7 Expertise

Operational: Expertise discussed under the context of user behaviour towards IoT system refers to the knowledge and technical skills that employees possess to use IoT system functionality to an optimum level.

1.8.8 Engagement

Operational: Engagement from user behaviour perspective refers to level of involvement of customer in utilizing IoT system in their day to day operations.

1.9 Summary

In conclusion, this chapter discussed about the overview of the study. The discussion in this chapter includes the background of the study, problem statement, research questions and objectives, scope and limitations of the study, significance of the study and the operational definition of terms. In the coming chapter, literature review of this study are discussed and information will be broader and more understandable.



CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

This chapter review literature on reliability, user behaviour and organizations' supply chain performance. The concepts obtained from this literature were used to generate the conceptual framework and the hypotheses for this research. This chapter are segmented into four sections. The first section is about concept which describes the concept of IoT, IoT in supply chain, and the supply chain performance. The second section will describe on the factors of reliability, which are security and sensitivity. For the user behaviour part, factors of user behaviour towards IoT system are described which are engagement and expertise.

2.2 What is IoT?

The term IoT has been circling around during the past two decades and it was first introduced by Kevin Ashton in 1999. It describes the IoT as interconnection among computing devices embedded in physical objects to gather and save information without the requirement of human interaction. The central concept of IoT was described as everyday objects can be equipped with processors and capable of identification, sensing, networking and processing, allowing them to communicate with each other, and with other devices and services, over the internet (Atzori, 2010). Among three main systemic characteristics of IoT were described as well in which it is everything that communicates in the context that wireless communication enable the creation of networks of interconnected things or object. Next, IoT is everything that is identified in which connected things or objects are able to receive a unique identification. Lastly, is that IoT is everything that interacts in which it is possible to sense and interact with the environment when this capacity is present (Miorandi, 2012).

Understanding how IoT work is essential as author needed to strengthen its foundational knowledge about IoT before diving in deeper on IoT in supply chain. Thus further definition of IoT are gathered. According to an article written by Alexandes S. Gilis, 'IoT ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors and communication hardware in order to collect, send and act on data that were collected and acquire from their environments' (Gillis, 2022). This definition detail out that IoT consist of various hardware and software that interacts to carry out various operational functions.

On the other hand, author McLellan defined IoT as 'a fast-growing constellation of Internet-connected sensors attached to a wide variety of things' (Maria Tsourela, 2020). Among

various real world applications of IoT are smart homes (Amazon Alexa), wearable device (smart watch, etc.) smart healthcare (glucose monitoring), smart buildings, smart city, smart farming (CropMetrics), smart appliances and it stretches from consumer IoT and enterprise IoT to manufacturing IoT and industrial IoT (Maria Tsourela, 2020).

Various sectors are adoption IoT into their business process. This is due to the competitive advantage that it gives the companies. IoT importance in businesses can be seen as it enable real-time look into how the company's systems actually works which deliver insights into everything from the performances of machines to supply chain and logistics operations (Gillis, 2022).

Adoption of IoT into business also enable business to 'automate their process and significantly reduce their labour costs' (Gillis, 2022). 'Waste in the business also can be reduced which eliminate additional cost to manage unnecessary waste and improve service delivery that makes it less expensive to manufacture and deliver goods' (Gillis, 2022). The IoT adoption also offer 'transparency into customer transaction which bring business and customer relationship to another level' (Gillis, 2022). Organizations that integrate IoT into its business process could reap benefit such as saving time and money, enhance employee productivity, makes better and well-informed business decisions. It is found as well that IoT is most abundantly applied in manufacturing, transportation and utility organizations with the use of sensors and several other IoT devices (Gillis, 2022).

2.3 IoT in Supply Chain

Shapiro defines a company's supply chain (SC) as "dispersed facilities where raw material, intermediate products, or finished products are acquired, transformed, stored, or sold and transportation links that connect facilities along which products flow" ([Abdallah Jamal Dweekat, 2017](#)). Concept of IoT in supply chain first recognized in 1999 due to its relation to the use of radio-frequency identification (RFID) tags to track product along the supply chain (Ashton, 2010). In association with supply chain, IoT is a network of physical objects that are digitally connected to sense, monitor and interact with a company and between the company and its supply chain, enabling agility, visibility, tracking, information sharing to facilitate timely planning, control and coordination of the supply chain processes (Ben-Daya, 2019). RFID technology, the foundational technology that allow microchips to transmit the identification information to a reader through wireless communication (Elham Ali Shammar,

2019). RFID tags were used to read and identify objects and then transmit the information wirelessly through a network (Mohamed Ben-Daya, 2017).

IoT enabling technologies were developed which enable the IoT to work systemically. The enabling technologies are segmented into four categories, the identification and network technologies, communication and network technologies, service management technologies and cloud computing. Among the identification and tracking technologies commonly used are RFID system, barcodes, and intelligent sensors in which widely used in the retail, logistics and supply chain management over the last few decades (Abdallah Jamal Dweekat, 2017). The RFID can be integrated with wireless sensor networks (WSNs) to ensure better track and trace things in real time. Then, for communication and network technologies, it is described as technology that assist entities to communicate and exchange information. For an example, WAN, MAN, LAN, and WLAN, VPN, communication protocols and standards such as machine-to-machine (Abdallah Jamal Dweekat, 2017). Also, Internet Protocol version 6 (IPv6) and cross layer protocols for wireless networks such as wireless sensor and actuator network to enable or facilitate a diverse communication and computation capabilities (Abdallah Jamal Dweekat, 2017).

Moving on to service management technologies which refers to implementation and management of quality IoT services that meet the need of users or applications and other technologies such as storage space, security management, billing support, and business process management, which were offered through cloud computing (Abdallah Jamal Dweekat, 2017). Cloud computing is described as a promising IoT- enabling technology in the manufacturing industry, virtual enterprises and in supply chain management (Sepehri, 2012). All these technologies which also known as IoT-enabler work together to enable full optimization of IoT function in supply chain.

IoT relate to supply chain in which it authenticate the location of goods at any time. For an example, IoT devices are attached to moving storage container or to raw material or on the product itself. The IoT devices will transmit the goods location in which it will be sensed by GPS satellites that will be used to track the good's movement. Congestion or problematic movement of goods also can be streamlined through IoT device in which IoT devices used are capable to identify where and when goods are delayed during its transit. This enable companies or organization to construct contingency planning and identify alternative routes to ensure

efficiency in the company's supply chain to which significantly improve the company's supply chain performance.

Supply chain can be affected by IoT in various ways and first and foremost, it can develop SC reliability by ensuring or enabling object visibility and real-time information exchange which is information exchange that is up to date and instantaneous (Abdallah Jamal Dweekat, 2017). Next, it can improve SC responsiveness and reduce SC cost, facilitating realtime optimizations for its functions and business process activities (Abdallah Jamal Dweekat, 2017). In addition, IoT enable a better SC asset management by tracking resources in real-time to ensure there is no leftover or waste from negligence (Abdallah Jamal Dweekat, 2017). Last but not least it enhance SC agility as information flow are speed up within few seconds. Based on the content discussed of IoT in supply chain, it is true that IoT affect supply chain performance significantly and the aspect that affect the organizations' supply chain will be discussed accordingly in this research paper.

2.4 Supply Chain Performance

Supply chain performance was describe by (Warren Hausman, 2004) as extended supply chain's activities in meeting end-customer requirements, including product availability, on-time delivery, and all the necessary inventory and capacity in the supply chain to deliver that performance in a responsive manners. The supply chain performance incorporate more than company boundaries as it includes basic materials, components, subassemblies and finished products, and distribution through various channels and finally to the end customer (Supply Chain Performance Measures, n.d.). In order to stay competent in businesses, organizations need to transform their supply chain by implementing and utilizing new technologies such as IoT, big data analytics and other smart solutions.

Commonly, in order to evaluate the effectiveness of the supply chain activities, performance management model and approaches has been develop such as the balance scorecard (BSC) and supply chain operations reference (SCOR) model (Abdallah Jamal Dweekat, 2017). Supply chain performance are broad and can be segregated into two categories. The quantitative measure which includes aspect such as flexibility, resource utilization, delivery performance (SCM - Performance Measure, n.d.). Then, the qualitative measure are based on customer satisfaction and the quality of the product (SCM - Performance Measure, n.d.).