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A Case Study to Explore IoT Readiness in Outbound Logistics

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Abstract— **Most of the logistics companies are facing problems with tracking and tracing in their logistics networks that led to poor last-mile service quality. This problem can be solved by improving technology such as the Internet of Things (IoT). Midway through the second decade of the millennium, the rapid development of IoT has influenced the company's outbound logistics operations such as last-mile delivery. Implementation of IoT will help courier companies to optimize their delivery process. Despite its popular perceived benefit in assisting last-mile delivery, IoT remains a new technology and its adoption rate is still low in Malaysia. Thus, the main purpose of this research is to explore the status of IoT readiness among logistics companies in Malaysia. Apart from that, this research also intends to propose the best practice for courier companies to implement IoT. The finding of this research will indicate the factors affecting the readiness of the organizations to adopt IoT and the best practice for the implementation of IoT for the last-mile of a parcel delivery service in Malaysia will be proposed. This research is carried out by making use of qualitative methods with a number of courier companies in Malaysia as case studies. The case study provided is related to a courier company in Malaysia. In the preliminary study phase, results show that IoT helps to improve productivity and enhance the efficiency of the company.**

Keywords— *IoTs, Technology Readiness Index, Outbound Logistics, Last-Mile Delivery, Courier Companies*

1. Introduction

Outbound logistics within the supply chain is responsible for ensuring the overall customer relationship management (CRM) process runs smoothly [1]. External logistics including the "last-mile" are often referred to as one of the keys to making or solving steps in the CRM process which is also the final step of the shipping process. The final mileage of product delivery involves the relationship between retailers and their customers, thus making it important in the supply chain product.

With the development of e-commerce levels, better quality in parcel delivery is one aspect that users want. The success of last-mile delivery can be achieved by looking at the two components which are speed and cost [2]. E-shoppers expect that the predictability of delivery times will be improved. They hope they can estimate their delivery arrival time and agree that track and trace and electronic notifications are very important [3].

Many companies made use of data-driven technologies related to IoT in many ways and one of them is to improve last-mile delivery by providing the real-time tracking of shipments [4]. The Internet of Things (IoT) is a technology that allows objects around us to connect to the internet. It is undeniable that IoT can help in the evolution of the supply chain. Besides, IoT will completely transform the world of delivery operations and Internet-connected physical devices are expected to increase by the year 2020. Hence, how the supply chain works will become different [5].

Thus, under its E-commerce Strategic Roadmap [6], Malaysia has targeted to transform the country's last-mile delivery network. As mentioned earlier, IoT will help to improve the last-mile delivery performance. In line with this, Malaysia has introduced its IoT roadmap knowing that it has the opportunity to raise the country's gross national income from RM9.5billion up to RM42.5 billion starting from 2020 until 2025 [7].

However, the adoption rate of technology in Malaysia is low [8]and this directly contributes to the low adoption rate of IoT [6]. The IoT roadmap in Malaysia that has been introduced in 2015 should have an impact on high IoT usage. This fact triggered the need to try to recheck early readiness of using IoT among the last-mile delivery operations such as in courier companies. The low adoption is mainly due to the lack of successful implementations and budget issues, resulting from an unclear Return on

Investment (ROI) and business case [9]. Thus, there is a tool named the Technology Readiness Index (TRI) to assess the readiness of technology use. TRI is grouped into four dimensions comprising optimism, innovativeness, discomfort, and insecurity. In this study, TRI will be used to measure technology readiness based on interview results [10].

2. Literature Review

First, the overview of Industry 4.0 and how it relates to IoT will be explained. Second, the supply chain management of courier company will be discussed to get an overview of the topics. Next, the dimension of technology readiness was considered to analyze the readiness of IoT implementation.

2.1. Internet of Things

Industry 4.0 can be described as an advanced phase of development in the firm and the whole management of value chain processes included in the manufacturing industry [11] and there are many technologies under the industry 4.0 including IoT. IoT is a concept where equipment, machines, sensors, and devices are connected to the internet and there is data collection and transfer through the network. IoT can give benefits to people's daily life [12].

IoT technology is widely used to utilize successful IOT-based products and services and among the four technologies are radio frequency identification (RFID), middleware, wireless sensor networks (WSN), and cloud computing [13]. Firstly, in general, there are three main components in RFID which are antennas, transponders, and readers. RFID works to send and receive signals from respondents to readers and vice versa with no wireless technology. The communication between this reader and the transponder transfers the data using the electronic field. Secondly, middleware is a device that connects different parts of a series application that helps to solve interoperability problems and interconnections of several applications. Middleware is used to allow software developers to communicate input or output in distributed systems.

Next, WSN is one or more sensors which are equipped with communication system equipment that makes it embedded system equipment. There are a number of types of sensors in the WSN that include temperatures, optics, pressure, position, and others. These sensors will transform the analog data into digital data and this data will be transmitted to a node through the applications like Bluetooth or wifi. Finally, cloud computing is a technology that deals with the use of internet media as a computing resource. There are three types of cloud computing services which are IaaS (Infrastructure as a service), SaaS (Software as a Service), and PaaS (Platform as a Service). Cloud computing allows us to access our data from various locations and through various platforms.

However, there are also some challenges that occur in implementing IoT which includes technological and semantic interoperability, smart things, security and privacy, and resilience and reliability[14].

(a) Technological Interoperability

Interoperability is a connection between people with the device and the devices itself. These devices have different technological capabilities and this make interoperability more challenging for the IoT. Besides, there are hardware and software issues which are involved in this interoperability.

(b) Semantic Interoperability

Semantic problem contains more complex issues when every manufacturer and source of information sources use different terms for the same things. Thus, the semantic device discovery, semantic web or distributed ontologies need to be improved.

(c) Security and Privacy

The data that hold unique identification, personal information, encryption, and data integrity are considered as the challenges for IoT when it is communicated and acquired. Hence, for security and privacy, authentication and identification in IoT systems are very important. There are five dimensions to secure IoT system which are hardware, software, operating system, networking, and data generated, and maintained within the system.

(d) Smart Things

For security and privacy, the fundamental is authentication and identification. There are five dimensions that need to be considered which are hardware, software, operating system, networking and the system that contains maintained and generated data.

(e) Resilience and Reliability

Later, the IoT devices will be produced in large numbers and this will lead to the problem in monitoring and the ultra-large scale system. Meanwhile, availability is a crucial factor that affects reliability. Generally, people want technology to work when they use it but many organizations might not be able to offer full availability in IoT systems and that is why it becomes a challenge.

Despite the challenge, IoT can actually benefit many sectors including supply chains in different industry sectors. Companies can minimize uncertainty and maximize the profit with help the from IoT. The supply chain is known for its ability to track products. Now, the industry tries to bet the competitors with the advancing industrial of IoT.

2.2 Supply Chain Management Of Courier Company

Supply chain management is gaining attention as it has successfully fulfilled the demands of their customers. In general, it is a process for integrating, coordinating and controlling the movement of raw materials into finished products and sending them to consumers. Logistics is an integral part of the supply chain management which comprises inbound and outbound logistic [15].

(a) Inbound Logistics

Inbound logistics is a movement into the company that shows the material flow from the supplier to the factory or the operating department. The buyer is responsible for issuing a purchase order in the purchase of a commodity, to be sent to the supplier, in accordance with the final customer's annual plan. Among the materials requested are the raw materials, parts purchased, machinery, supplies and all other goods and services used in the production system. Once the item is developed, they need to get to the end user. This should ensure cost-effectiveness and meet growing expectations regarding the services and availability of products offered [16].

(b) Outbound Logistics

Outbound logistics is the movement of the product out of the factory or the service operation to customers or consumers that play a vital role in a supplier's overall customer relations within the supply chain relationship management (CRM) process [17]. For instance, Wallmart and Target hold their suppliers to very rigid product delivery standards. If the supplier fails to provide a reliable delivery service to its retail customers, the financial penalties will be imposed. Consequently, the retailer's decision to sell the supplier's product depends on the performance shown by outbound logistics. Given its critical role, a firm's planning and approach towards outbound logistics can benefit greatly from quantitative "firm performance data"-based research, as well as from insights generated by more qualitative perception-based data.

Outbound logistics includes the "last-mile" which is the final step of the delivery process. The term last-mile was borrowed from telecommunications networks [18]. The last mile is the last connection from the service provider communication to customers. Last-mile focuses on the final stage of the delivery process of a parcel when it leaves the warehouse shelf. Delivery of a parcel to the recipient's home or office will be made or it can also be stored until the receiver collects it or it can be readdressed. Last mile delivery is very important in logistics. This is because it refers to the final carriage of goods from the hub to the final destination i.e the customer[15]. Indirectly, it will affect customer satisfaction. Last mile efficiency and customer satisfaction will determine the general perception of the business, which flows into the market in the form of reviews, gossip, and competition. The last-mile contributes up to 75% of the total supply chain, making it one of the most expensive parts of the supply chains [19].

The development of IoT is affecting how supply chain management works. All retailers are now moving forward to implement IoT in their business. The speed of the delivery of the customer's parcels can be improved with the help of IoT. Therefore, this paper will discuss the outbound logistics of a courier company, focusing on last-mile delivery to improve cost-efficiency. In Figure 1, the last mile delivery is the final part in outbound logistics which is the journey of the product from the warehouse to the customer's doorstep.

For courier companies in Malaysia, it consists of a collection center responsible for booking, collection, and delivery of the parcel. Firstly, the process will be at the collection center where the process of handing the parcel to the distribution center is taking place. Next, the distribution center will dispatch the parcel to the delivery center for delivery and it ends with the delivery to the end customer
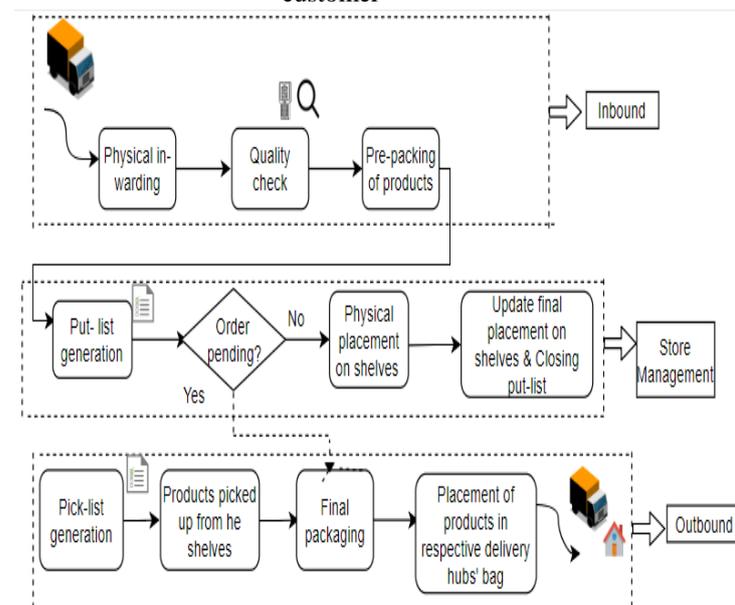

Figure 1. Courier's Warehouse Management

During the delivery process to the end customer, after the courier person handed the parcel to the customer, he/she will take the signature of the customer on the delivery sheet. After the delivery of the parcels, the courier person will go to the delivery center to update the status manually by uploading the data in the system for shipment status update. Then, the system will update the status of the shipment as "delivered" and the customer can see the status by looking at the courier's website by entering the tracking number. This process is referred to as the last mile delivery. The last mile in the supply chain is considered as the last part of the supply chain for the direct-to-consumer market [15].

2.3   Courier Companies in Malaysia

In the courier services industry side, service quality is among the most decisive determinant for customer satisfaction and also can be described as a logistics service providers in supply chain management which serve delivery parcels from retailers directly to consumers. In Malaysia, the logistics operations development in courier industry starts with Pos Malaysia by the government in the 1800s. In the 1980s, Malaysia's logistics industry welcomes two local private companies, namely Nationwide and ABX Express. Later, in the 1990s, the logistics industry in Malaysia became more competitive as more private companies from overseas were added in such as Kangaroo Worldwide Express, Skynet, GD express and so on[20].

Besides, the courier services sector is one of the service sectors that continues to grow. In 2008, global package delivery attained a value of USD 500 million and is expected to continue to increase [21]. Trans-Pacific Partnership Agreement (TPPA) is expected to improve the courier service sector by 20% within the next 5 years. In 2020, the courier services are looking forward to achieving £ 4 billion in value. Nevertheless, this industry faces challenges of managing knowledge and creativity in services as a result of globalization. There are several factors that led to innovation issues in the service innovation of postal and courier in Malaysia and one of them is technology [22]. New technology needs to be developed to support Malaysia economic growth. Thus, Malaysia needs to ensure that its technology is updated since the technology will always be an enabler in implementing innovation.

Nonetheless, postal organizations nowadays have difficulty in dealing with the new technologies and in choosing profitable products, and finally dealing with almost persistent change [23]. Several challenges that affect the development of new technology in industry 4.0 are as follows [24]:

- Lack of awareness on the impact of, and need for Industry 4.0 technologies, both in terms of opportunities and business model.
- Exposure to cyber threats with increased connectivity and new technologies, especially IoT.
- A significant shortage of required talents, skills, and knowledge for Industry 4.0, particularly in the area of IoT, robotics and AI.
- Limited understanding of manufacturing firms of required future skills and expertise, and own readiness to embark on Industry 4.0 transformation.
- Inadequate understanding of 'vs' benefits and ability to conduct Industry 4.0 business case analysis.
- A higher cost of adoption and longer payback period for Industry 4.0 technologies and processes.

- Ownership of Intellectual Properties due to inter-connectivity and information sharing along the supply chain.
- Lack of integrated and digital approach to data gathering along manufacturing and supply chains.
- Lack of a centralized and easily accessible information platform to understand best practices and relevant use cases.

Therefore, this study intends to explore the readiness status of IoT implementation among the courier companies in Malaysia since the government has already provided the initiatives to enhance the manufacturing sector in Malaysia through highly-skilled workers and increased production.

2.4   Technology Readiness Index

Technology readiness has been described as the tendency of people to accept and utilize the new technologies to reach the goals [25]. As shown in Figure 1, TRI (Technology Readiness Index) was developed by Parasuraman [10] to determine people's view and idea about technology in general. There are two positive views in these tools which are optimism and innovativeness which are contributors to technology readiness. The other two negative views in this tool are discomfort and insecurity which are inhibitors to technology readiness.

Optimism means looking at technology positively and agrees that technology can bring benefits to the individual's performance and job satisfaction. Innovativeness can be referred to as a level at which people like to talk, gain knowledge and do an experiment about technology. Next, discomfort is a feeling of not having enough control over technology. Lastly, insecurity dimension indicates a thought that technology can give bad impacts to the user [25].

In addition, there are five technology readiness segments which are explorers, pioneers, skeptics, paranoid, and laggards. Explorers fall under optimistic and innovative with a high score in technology readiness. Pioneers are among the first to explore the technology but are concurrently restrained by insecurity and discomfort. Skeptics are a group of people who are ready with technology but have low motivation and need to be convinced that technology will give the advantage to them. Paranoids think that technology is beneficial to them, but they are also worried about the risk. Laggards are the ones who will not use technology unless they have to use it.
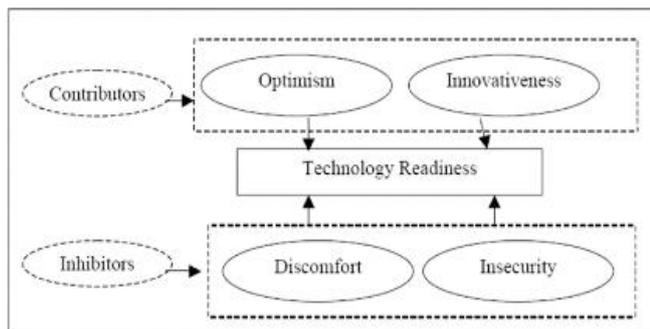
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Figure 2. Technology Readiness [10]

In this research, the technology readiness used shows signs of essential for technology adoption. Even if people have an interest and intention to implement IoT, they need to identify their readiness before they can move to the adoption process. This is why this research intends to explore the readiness among the companies. Hence, the dimension of technology readiness that is mentioned in the interview will be analyzed.

3.   Methodology

Qualitative methods will be utilized to carry out this study by making a courier company in Malaysia as a research case study. There are two main stages in this research which are an extensive literature review and case studies. The paper started by providing an extensive literature review on tools used to measure technology readiness. The tools, then, are used for a guideline for conducting an in-depth interview.

This paper also encompasses the case study of a Malaysian courier company's outbound logistics. The case study approach is used to generate in-depth and exploration of IoT readiness. In this research, an in-depth interview is used to conduct intensive individual interviews with a single respondent or a small number of respondents to explore their perspectives about IoT and get the whole idea of the situation. The company is identified by looking at the courier company that has been registered and has an active status with the Malaysian Communications and Multimedia Commission (MCMC), who is responsible for regulations of the communications and multimedia sector. The interviewees in this study are the IT specialist and senior officers from corporate communication and human resource field.

During the interview, the interviewees were asked whether they have implemented the IoT technology. The interviews also addressed aspects that affect the interviewees' adoption decisions. The interview ended with a question asking how interested the interviewees were in implementing the IoT technology and the best practice for implementing it. The instrument that is founded by Parasuraman [10] is used as a guideline for carrying out in-depth interviews. All the interviews were recorded and transcribed. The transcribed interviews were analyzed utilizing Nvivo software for future work. The flow of
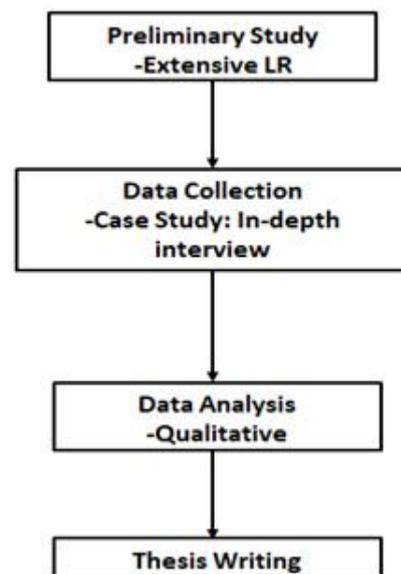
research activities is shown in Figure 3.

Figure 3. Flowchart of Research Activities

4.   Analysis and Result

The results from the interviews are summarized that comprises of the four dimensions of technology readiness developed by Parasuraman [10] and the factors affecting the IoT readiness. The content analysis for exploration of the status of IoT readiness is summarized in Figure 4.

The optimism dimension has become prominent in the interviews. The optimism was demonstrated by telling of the benefits of the technology and their willingness to use most advanced technology:

> "IoT can facilitate our process and increase the efficiency." "With IoT, we can monitor the condition of the parcel, there will be no more damage and loss." "We prefer to use the most advanced technology available if we were given a chance"

Innovativeness, the second dimension of readiness was commonly mentioned by the interviewee who comes out with a new service idea and likes to keep up with the latest of technology. Even the idea is not really advanced, but it is considered as innovativeness since the technology was new to the interviewee.

> "Maybe in future, if we were given a chance to implement IoT, we would like to have a live track on the parcel, we can monitor the movement and also the temperature" "Do you know about company z? They have implemented advanced technology. If you place an order from company z, the order will go to the system, and then the robot will pick up"

Discomfort is viewed as an inhibitor to the technology readiness and it is least discussed in the interview. The

interviewee worried that losing control over task and information will happen:

> *"Because the technology is too advance, we might lose control on how and when they are executed since it is still new, maybe there is no manual yet"*

Insecurity, the phenomenon was discovered that the interviewee suspecting the ability of service to work properly and worried about the security and it is less commonly discussed but almost all of the interviewees have the same opinion:

> *"When something gets automated, we need to check carefully that technology is not making a mistake"*
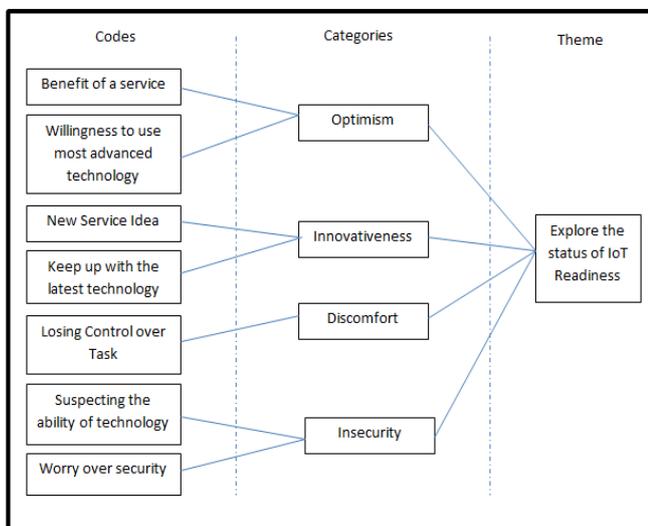> *"With this IoT, is your company information and data is safe?*

Figure 4. Exploration of the status of IoT readiness

The interviewees give emphasis to the factors affecting the readiness of the company. Table 1 summarizes the factors affecting the readiness of the company A and B.

Firstly, they were asked whether they have implemented the IoT technology. All companies that have been interviewed have not yet implemented the IoT. That is why this research intends to explore the reasons behind it. Some of the reasons that the interviewees did commonly mention were infrastructure, cost, and security.

All the interviewees agree that the infrastructure in Malaysia is not ready yet for climate change. The interviewee said, "We are still lacking in coverage. We are now in 4G unlike in other countries, they have reached up to 6G."

In addition, the cost is also highlighted in the interview. The cost of the IoT implementation is too high. One of the interviewees described it: "Some of us know about the IoT and the benefit of it, and realize how expensive it is."

When it comes to new technology, the interviewee stated that security and privacy are one of the factors that might

affect the readiness of adopting it: "Since the crime rate in this country is quite high, there is a high chance of robbery since the information about the parcel is exposed to everyone."

Table 1. Factors affecting the readiness of the company A and B

Factors	Company A	Company B
Infrastructure	✓	✓
Cost	✓	✓
Security & Privacy	✓	✓
Lack of Knowledge	✓	
Unclear ROI		✓

5. Conclusion and Future Work

This research paper is expecting to gather the information on IoT readiness in last mile delivery qualitatively. The findings emphasize that technology readiness helps to determine the status of readiness among the companies. Moreover, this study also indicates the factors affecting the readiness of the companies.

For future work, the number of positive and negative comments of each dimension will be measured by using Nvivo to know the status of readiness. After that, the best practice of the IoT implementation also will be proposed.

Thus, IoT best practice will help to accelerate the readiness level of IoT implementation among courier companies. The best practice will be produced based on the findings from the literature and the interviews that the company can finally use in their company.

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