ANTEDECENTS AND OUTCOME OF INTERNET OF THINGS ADOPTION: A PERSPECTIVE OF PUBLIC LISTED COMPANIES ON MAIN MARKET BOARD OF BURSA MALAYSIA

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DEDICATION

This work is dedicated to my parents, my fiancée and finally my course mates and colleagues who are always in my thoughts and recognition.

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LIST OF ABBREVIATIONS

Abbreviation	Description
APAC	Asia Pacific
APeJ	Asia Pacific excluding Japan
AVE	Average Variance Extracted
BPM	Business Process Modelling
BSC	Balanced Scorecard
CAGR	Compound Annual Growth Rate
CEO	Chief Executive Officer
CFA	Confirmatory Factor Analysis
CIO	Chief Information Officer
CR	Composite Reliability
CRM	Customer Relationship Management
DOI	Diffusion of Innovation
EC	Electronic Commerce
EDI	Electronic Data Interchange
EFA	Exploratory Factor Analysis
ERP	Enterprise Resource Planning
EU	European Union
GDP	Gross Domestic Product
GE	General Electric
GoF	Goodness-of-Fit
ICT	Information & Communication Technology
IOS	Interorganizational System
IoT	Internet of Things
IP	Internet Protocol
IS	Information System
IT	Information Technology
M2M	Machine to Machine
MEMS	Micro-electromechanical System
MNC	Multi National Company
NFC	Near Field Communication
PC	Personal Computer
PLC	Public Listed Company
PLS	Partial Least Square
REST	Representational State Transfer
RFID	Radio Frequency Identification
ROI	Return on Investment
SEM	Structured Equation Modeling
SME	Small Medium Enterprise
TOE	Technology-Organization-Environment
Wi-Fi	Wireless Fidelity
WSN	Wireless Sensor Networks

ABSTRAK (MALAY)

Kemajuan and perkembangan dalam sensor teknologi pengumpulan data telah membawa kepada sebilangan besar peranti pintar seperti Pengenalan Frekuensi Radio (RFID) yang disambungkan ke Internet dan penghantaraan data secara berterusan. Internet Perkara (IoT) berniat untuk merapatkan jurang antara Sistem Maklumat (IS) dan process perniagaan, melengkapi peranti dengan keupayaan untuk menangkap data konteks and menyiapkan system maklumat dengan perwakilan "perkara" yang membolehkan system maklumat untuk memantau process perniagaan, pertukaran data and membuat keputusan berdasarkan logic perniagaan. Kebanyakan peryelidikan terdahulu berkaitan dengan IoT hanya memberi tumpuan kepada aspek teknologi dan operasi teknologi sahaja. Terdapat kajian yang terhad yang menekankan faktor-faktor lain dalam pandangan menyeluruh and tekanan terhadap kesan yang dibawa IoT dari segi prestasi organisasi. Kajian ini berusaha untuk menentukan peramal and hasil pelaksanaan IoT kepada prestasi organisasi dari perspektif syarikat awam (PLC) yang disenaraikan di papan pasaran utama Bursa Malaysia berdasarkan rangka kerja teknologi, organisasi and alam sekitar (TOE) Iacovou et al. (1995) dan Penyebaran Inovasi (DOI) teori. Data akan dikumpulkan melalui soal selidik daripada PLCs dan Partial Least Square (PLS) dari Structured Equation Modeling (SEM) digunakan untuk memeriksa dan menganalisis data yang dikumpul berdasarkan hipotesis yang diperolehi daripada kerangka penyelidikan. Keputusan akhir menunjukkan bahawa kelebihan, kos, tekanan daya saing dan intensiti maklumat adalah peramal penting yang mempengaruhi penggunaan IoT di kalangan syarikat tersenarai awam. Di samping itu, ketangkasan strategik telah terbukti sebagai moderator yang penting ke atas hubungan antara penggunaan IoT dan prestasi organisasi. Akhir sekali, penggunaan IoT menunjukkan kesan yang ketara ke atas prestasi organisasi berdasarkan analisis data.

ABSTRACT

Advances and proliferation in sensor data collection technology have led to a substantial number of smart devices such as Radio Frequency Identification (RFID) that are connected to the Internet and continuously transmitting data over time. The Internet of Things (IoT) intents to bridge the gap between Information Systems (IS) and real-world business processes, equipping devices with the capability to capture context data and render information systems with a representation of "things" which allows information systems to monitor business processes, exchange data and make decisions based on business logic. Majority of prior researchers pertaining to IoT focused on the technological and operational aspects of the technology per se. There are limited studies that emphasize on other factors in a holistic view and stress on the impact that IoT could exert on organizational performance. Therefore, this study strives to determine the antecedents and outcome of IoT adoption on organizational performance from perspective of public listed companies (PLC) on the main market board of Bursa Malaysia by applying the Technological, Organizational and Environmental (TOE) framework, Diffusion of Innovation (DOI) theory and Iacovou et al. (1995) model. Data were collected via questionnaires from PLCs and subsequently, Partial Least Square (PLS) of Structured Equation Modeling (SEM) was utilized to examine and analyze collected data based on hypotheses derived from the research framework. Final results indicated that relative advantage, cost, competitive pressure and information intensity are important predictors influencing IoT adoption among public listed companies. In addition, strategic agility was proven to be a significant moderator on the relationship between IoT adoption and organizational performance. Finally, IoT adoption showed significant impact on organizational performance based on data analysis.

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter introduces the research outline of the study. It begins with the highlight on the associated background of study, ensued by problem statement and subsequently outlining the research objectives and research question. Definition of key terms will also be outlined for better comprehension. Chapter 1 wraps up with significance of study and provides a brief overview on the organization of remaining chapters in this dissertation.

1.2 Background of Study

At present times, approximately two billion individual around the globe utilizes the Internet for Web browsing, exchanging email, accessing multimedia services and content, playing games, using social networking applications and a myriad of other tasks (M. Daniele, 2012). With an increase in the number of people gaining access to such a global information and communication infrastructure, another big leap forward is in the making, which is relatively related to the utilization of the Internet as a global rostrum for permitting communication, computation, dialogue and coordination between machines and smart objects (S. Sabrina, 2012). It was foretold that the Internet will persist as a seamless fabric of networked objects and classic networks. Content and services will be always available all around us, paving the road to novel applications, fostering new fashions of working; new methods of interacting; novel ways of entertainment and even new fashion of living (D. P. Francesco, 2012).

In correspondence to such a perspective, the conventional conception of the Internet as an infrastructure network attaining to end-users' terminals will eventually fade, relinquishing space to a notion of "smart" objects interconnected to form pervasive computing environments (M. Weiser, 1991). Nonetheless, the Internet infrastructure will not entirely disappear. Instead, it will preserve its vital role as a global fortitude for worldwide information diffusion and sharing, interconnecting physical objects equipped with communication / computing capacity across a broad spectrum of technologies and services (C. Imrich, 2012).

J. Zheng and H. Mouftah (2011) reported that the Internet has evolved tremendously over the last few years, globally connecting billions of things. These "things" came in varying sizes, capabilities, processing and computational power as well as supporting different kind of applications (Y. Huang and G. Li, 2010). Thus, the conventional Internet consolidates into smart future Internet known as Internet of Things (IoT) (J. Zheng and H. Mouftah, 2011). A generic scenario of IoT is illustrated in Figure 1.1 below. The IoT connects and links physical world objects and embed intelligence into the system to adeptly process object specific information and assimilate useful autonomous decisions (Y. Huang and G. Li, 2010). As such, IoT can be considered as a future evaluation of the Internet, giving birth to vast beneficial applications and services that the world never imagined before (D. Simplot-Ryl and C. Bisdikian, 2011).

Figure 1.1. A Generic Scenario of IoT

Source: (10th International Conference on Frontiers of Information Technology Journal, 2012)

IoT refers to a novel paradigm that is swiftly gaining momentum in the field of modern wireless telecommunications (A. Luigi, 2009). The underlying idea of this concept refers to the pervasive presence of a variety of "things" or "objects" all around us, for instance Radio-Frequency Identification (RFID) tags, actuators, sensors and mobile phones to name a few. All of which are able to interact with one another through usage of unique addressing schemes, further cooperating with their neighbors to achieve common goals (D. Giusto and A. Iera, 2010). The IoT has garnered world-wide attention, both in the field of research as well as media (S. Haller and C. Schroth, 2009). Considered as one aspect of a Future Internet, a number of application areas have been conjectured, not limited only in industrial domains like logistics, manufacturing, retail, service management and energy, but also for the life of every citizen, whereby IoT is

able to present significant improvements, resulting even in new business models and market opportunities (O. Vermesan and M. Harrison, 2009).

By referring to the IoT paradigm above, it is somehow not astonishing that IoT was enlisted by the US National Intelligence Council in the list of six "Disruptive Civil Technologies" with latent impacts on US national power (US National Intelligence Council, 2008). Auto insurers in the United States and Europe have started pilot testing with IoT by offering to install sensors in customers' vehicles to devise new pricing models based upon risk of driving behavior instead of driver's demographic characteristics (L. Peter, 1999). In addition, global luxury-auto manufacturers have initialized production to equip vehicles with networked sensors that could perform evasive actions automatically in the likelihood of accidents (B. Bernhard and K. Joe, 1999). German giant SAP dominates the enterprise software market. But the company is betting that with the Internet of Things that market is going to change drastically. SAP is positioning their HANA database as "the secret sauce to make Internet of Things run simple".

Nowadays, service-oriented architectures served as a foundation for contemporary enterprise systems and business processes in such systems are designed as a composition of underlying services (D. Guinard, 2009). Integration of the IoT into business process systems necessitates the requirement for service-enable IoT resources such as actuators and sensors that are generally used to interact with the physical environments which can be achieved through utilization of full-blown Web Services or in more likelihood using REST (Representational State Transfer)-based approaches (Web Services Architecture, 2011).

However, usage of service-based approach presents additional advantage of concealing the heterogeneity of IoT devices and data protocols associated with the business application (E. Wilde, 2010). Additionally, Business Process Modelling (BPM) refers to an established technique in which enterprises may rely on for modelling and executing complex processes in respective enterprises alongside deployment of IoT technologies in business processes (S. Haller and C. Magerkurth, 2010).

Till-date, there aren't any generally accepted definitions regarding the Internet of Things as well as IoT. The terminology of "Internet of Things" (IoT) was first used by Kevin Ashton in a presentation in 1998 to describe an emerging global Internet-based information service architecture (R. H. Weber, 2009). Approximately over a decade ago, the late Mark Weiser developed an innovative vision of future technological ubiquity, which dictates that an increase in the "availability" of processing power would be accompanied by a decrease in "visibility" (ITU, 2005). He observed that "the most profound technologies are those that disappear…they weave themselves into the fabric of everyday life until they are indistinguishable from it" (M. Weiser, 1991). On contrary to the unclear definitions of IoT, the IoT architecture is generally accepted. The prominent 3-layer construct consists of the Application Layer, Network Layer and finally the Perception layer, as depicted in Figure 1.2 below.

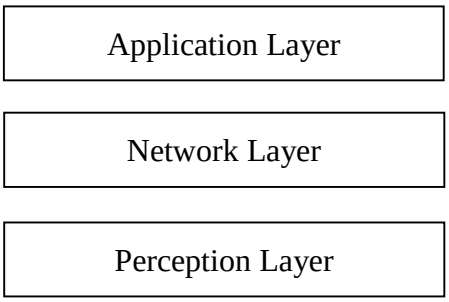

Figure 1.2. 3-Layer Architecture of the Internet of Things

Source: (3rd International Conference on Advanced Computer Theory and Engineering (ICACTE) Journal, 2010)

The IoT refers to a technological revolution that served as a representation of future computing and communications, with its development dependent on dynamic innovation across a number of crucial fields, from wireless sensors to nanotechnology (ITU, 2005). From a technical point of view, the IoT architecture is founded on data communication tools, primarily items tagged with RFID. One of the primitive purposes of IoT include facilitating information exchanges among goods in global supply chain network, i.e. the related IT infrastructure ought to provide information about "things" in a reliable and secure manner (W. Miao and J.L. Ting, 2010). Extending beyond the initial application scope, IoT can be considered as a backbone for ubiquitous computing, empowering smart environments to recognize and distinguish objects and subsequently retrieve information from the Internet to assist their adaptive functionality (R. H. Weber, 2009).

This current shift in technology is generating and presenting unprecedented opportunities for both the public and private sectors to develop and offer new services, enhance productivity and efficiency, improve real-time decision making, solve critical societal problems, and develop new and innovative user experiences (Intel, 2013).

McKinsey & Co. reported that IoT is already spear-heading transformation across a number of industries, and is expected to lead to even more significant changes in the future. IoT offers innumerable opportunities that can assist organizations in utilizing their business infrastructure and assets in innovative fashions to proffer novel services and serve up additional revenue. Most importantly, deriving meaningful information from the vast amount of data generated by IoT can foster better decision-making and facilitate proactive, predictive insights (Cognizant Reports, 2014). These aforementioned opportunities will bring upon widespread impact to the entire marketplace across numerous sectors ranging from manufacturing and transportation to utilities and healthcare - fueling Gross Domestic Product (GDP), creating new job opportunities, and bolstering the global economy (M. Royer, 2013).

1.2.1 Malaysia IT Context

Ericsson revealed a 2003 data showing that were an estimated 6.3 billion humans on the face of the Earth and about 500 million Internet connected devices (mostly PCs and a few smartphones). By 2011 there were approximately 7 billion human beings on the face of the earth, and 12.5 billion Internet connected devices including nearly every PC in the world and well over a billion smartphones (R. James, 2014). This is equivalent to nearly 2 connected devices for every human on the face of the earth. By 2020, Ericsson expects the human population to grow to 7.6 billion with 50 billion devices connected to the Internet (R. James, 2014).

"The Internet's Impact on Aspiring Countries", a study by McKinsey revealed that the Internet contributed 4.1% or USD9.75 billion in equivalence to Malaysia's reported GDP of USD238 billion in 2010 (McKinsey Global Institute, 2011). This ranks

Malaysia among the highest of the purported 30 fast-growing countries where the Internet showed great potential in economy transformation. As of end-2012, the number of Internet users in Malaysia has grown rampantly to 18 million and is expected to reach the 25 million mark by 2015 (Economic Report Malaysia, 2013/2014). This data represents approximately 23% increase over the 18 million estimated subscribers for year 2012 (Economic Report Malaysia, 2013/2014). In addition, household broadband penetration rate was recorded to be 66.8% as at end-June 2013 and currently there are 42.6 million mobile subscribers with a penetration rate exceeding 100%, exhibited in Figure 1.3 (Economic Report Malaysia, 2013/2014).

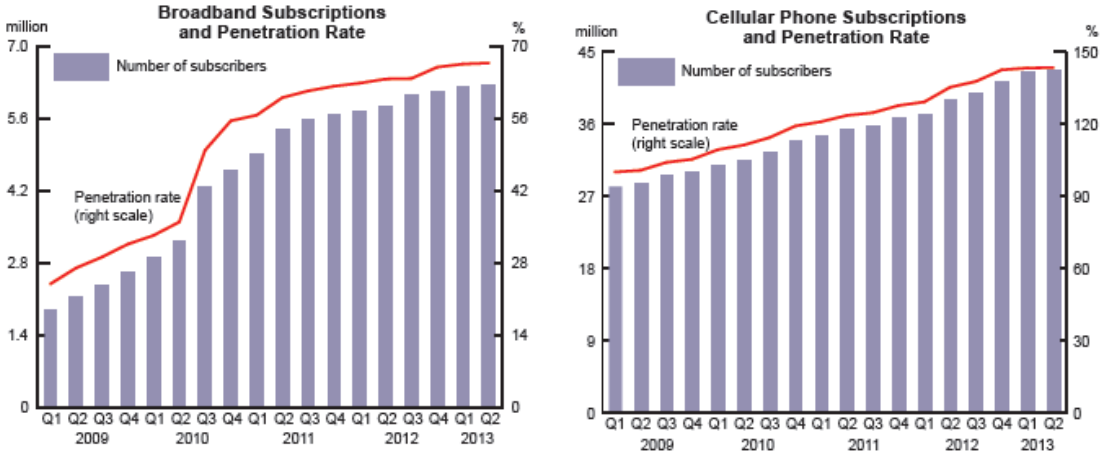

Figure 1.3. Selected Indicators and Penetration Rate

Source: (Economic Report Malaysia, 2013/2014)

This Internet penetration rate growth has created opportunities and interest for Malaysian businesses to integrate online presence as part of their marketing strategy. In 2004, the number of subscribers was 2.9 million, increased to 3.5 million subscribers in 2005 and subsequently increased to close 5 million of subscribers in 2006 (Economic Report Malaysia, 2013/2014). This encouraging growth trend has continued ever since.

For instance, the retail industry has experienced such changes, whereby some retailers now having established an online presence to reach out to a wider market and sell more products at both the domestic and international scale (Economic Report Malaysia, 2013/2014).

Increased usage of information and communication technology (ICT) in businesses have led to improved productivity and efficiency in almost every aspects of the value chain (McKinsey, 2011). Certain global technology giants such as Google, Facebook, Twitter and Instagram have leveraged on the Internet to foster business growth. Malaysia in specific has witnessed the multiplying importance of online business, distinctively in the industries such as budget airline travel, retail apparel, fast food and deal-of-the-day business. For instance, particular small local entrepreneurs established in rural areas have managed to achieve success when their conventional business was transformed into online business (Nielson, 2011).

McKinsey Global Institute identified the IoT as one of the most under-hyped technologies with great economic impact – on the scale of $2.7 to $6.2 trillion of estimated global economic impact by 2025 (Mckinsey Global Institute, 2013). Similarly, Cisco predicted that there will be $14.4 trillion "value at stake" over the next decade in the IoT economy, driven by "connecting the unconnected" (people-to-people, people-to-machines, machines-to-machines, etc) (Cisco IBSG, 2011). General Electric (GE) further estimated that the IoT could add from $10 from $15 trillion to global GDP over the next twenty years (GE Report, 2013). GE is among the leading Industrial Internet of Things companies. It actually coined the term Industrial Internet (of Things).

GE is rolling-out solutions in a number of industries such as aviation, manufacturing, or power generation.

According to a recent IDC report (dated February 2015), the Internet of Things market size in Asia Pacific excluding Japan (APeJ) will grow from USD 408 billion in 2013 to USD 862 billion in 2020, reporting a Compound Annual Growth Rate (CAGR) of 11.3% (International Data Corporation Report, 2015). Significant growth is also forecasted in the number of autonomous intelligent/embedded systems, or "things" that will connect to the Internet in APeJ, with the number growing from 2.59 billion in 2013 to 8.98 billion in 2020. The total Machine to Machine (M2M) connections in the Asia-Pacific (APAC) region were recorded to be 20.8 million in 2010 and is expected to reach the mark of 116.6 million by 2015 (International Data Corporation Report, 2015) as illustrated in Figure 1.4.

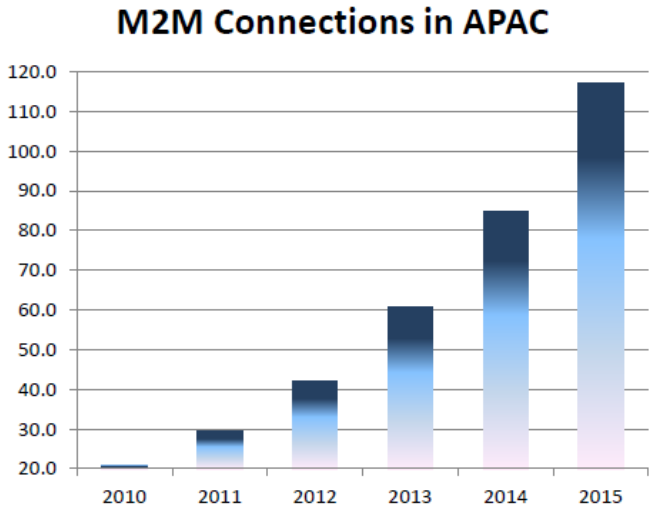

Figure 1.4. M2M Connections in APAC

Source: (International Data Corporation Report, 2015)

IDC Asia predicted that Malaysia is to grow faster at average growth rate at CAGR of 50% compared to other countries in the region (International Data Corporation Report, 2015), shown in Figure 1.5 below.

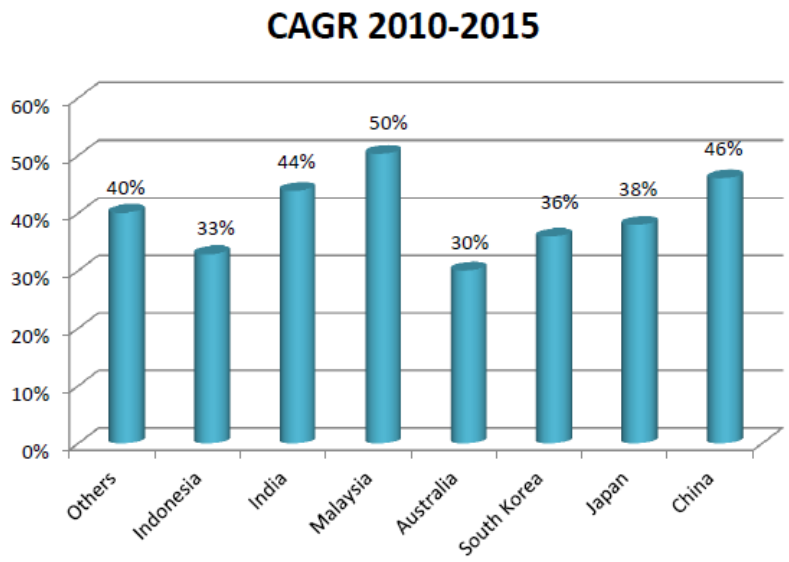

Figure 1.5. CAGR 2010-2015

Source: (International Data Corporation Report, 2015)

1.3 Problem Statement

Backdating to approximately two-and-a-half years ago, Mckinsey Quarterly (2010) described eight technology-enabled business trends that were found to be profoundly remolding strategy across a wide array of industries (M.M. James, P.R. Roberts and L.S. Kara, 2007). Mckinsey Quarterly (2007) additionally asserted the combined effects exhibited by emerging Internet technologies, extended computing power, and swift, pervasive digital communications were generating new manners to contrive talent and assets as well as new reflection regarding organizational structures.

Since then, the technology landscape has rapidly and continuously evolved especially the Internet. Facebook has quintupled in size in just over a short span of two years to a network that connects more than 500 million users (B. Jacques, 2010). Advancing technologies alongside with their swift adoption are upending conventional business models with necessitates the need for businesses to strategically consider about how to prepare the organizations for the dynamic yet challenging new environment and to capitalize the transformations that are under way (C. Michael, 2010). Internet of Things (IoT) is redefining enterprise information technology (IT) by altering the business playing field, offering opportunities for novel stream of revenues, immense efficiencies and smarter interactions with customers (SAP, 2014).

In recent years, the world has entered a new era of connectedness beyond the human realm whereby more and more objects in our physical world are now fit to communicate with each other or even with us (SAP, 2014). Interactions have been made possible through usage of embedded sensors, tags and actuators without human involvement (M. James, 2010). These intelligence embedded "smart objects" generates huge amounts of valuable data that can be gathered, networked and analyzed for a wide range of purposes such as business, societal and personal advances (Z. Rifaqat, 2012). Adopting IoT can foster more efficient processes, equip products with new capabilities and introduce novel business models (V. Hal, 2010). As the cost of technologies continues to drop and the ecosystem matures, the IoT will open up new sources of efficiencies, facilitate reallocation of resources for better operational effectiveness, improve decision macking and enable proactive, predictive insights (R. James, 2014). A recent report considered IoT to be one of the most disruptive technology trends of the next decade, with wide implications for businesses and policymakers (Mckinsey

Global Institute, 2010). In short, if IoT solutions are effectively adopted, it will greatly enhance the overall organizational performance. However, there still exists a literature gap with regards to IoT innovation adoptions and their respective determinant factors.

Nonetheless, adopting technology to obtain better organizational performance is never a smooth and simple process albeit the profound repayment that may come along with the technology per se. In the Malaysia context alone, many studies have found that there were failures and difficulties in implementing new innovations among enterprises regardless of industry background. For instance, Shahawai and Idrus (2010) identified that one of the international top vendors for ERP system failed to establish and bridge the gap between the requirements and characteristics of SME due to incompatibility of varying organizational needs. The electronic business application adoption rate of Malaysian companies is relatively slower compared to other countries due to cautions and skeptical on benefits in the new technology (Ang and Husain, 2012).

Likewise, adopting and implementing IoT system / solutions is not an easy process entailing solely the procurement of software and hardware; instead it is deemed a complicated task demanding proper system, technology and infrastructure integration and also resources over certain period of time (Yeoh and Koronios, 2009). As the IoT budge forward to the mainstream, businesses must be prepared to enclose increasingly intelligent assets into the IT landscape. Businesses must be equipped with technology infrastructures that are able to capture data securely, affordably handle Big Data and capable of performing powerful real-time analytics (C. Imrich and M. Daniele, 2012). Grandhi and Chugh (2013) pointed out that IT / IS system implementation failures may

result in financial instability and loss of competitive advantage. Therefore, various innovation adoption factors at the technology, organization and environment level extracted from past researches will be used to examine its influence on IoT adoption in this study.

Hence, this research strives to distinguish the various antecedents that were established, i.e. technology, organization and environment factors which exerted influence on IoT adoption and its impact on organizational performance among public listed companies on the main market board of Bursa Malaysia.

1.4 Research Objectives

This study attempts to achieve the following primary objectives:

(1) To examine the relationship between relative advantage and IoT adoption among public listed companies on main market board of Bursa Malaysia.

(2) To examine the relationship between cost and IoT adoption among public listed companies on main market board of Bursa Malaysia.

(3) To examine the relationship between compatibility and IoT adoption among public listed companies on main market board of Bursa Malaysia.

(4) To examine the relationship between competitive pressure and IoT adoption among public listed companies on main market board of Bursa Malaysia.

(5) To examine the relationship between information intensity and IoT adoption among public listed companies on main market board of Bursa Malaysia.

(6) To examine the relationship between IoT adoption and organizational performance among public listed companies on main market board of Bursa Malaysia.

(7) To study the moderating effect of CIO innovativeness on the relationship between relative advantage and IoT adoption among public listed companies on main market board of Bursa Malaysia.

(8) To study the moderating effect of information distribution on the relationship between information intensity and IoT adoption among public listed companies on main market board of Bursa Malaysia.

(9) To study the moderating effect of strategic agility on the relationship between IoT adoption and organizational performance among public listed companies on main market board of Bursa Malaysia.

1.5 Research Question

To accomplish the primitive objectives, the study strives to answer the following research questions:

(1) What is the relationship between relative advantage and IoT adoption among public listed companies on main market board of Bursa Malaysia?

(2) What is the relationship between cost and IoT adoption among public listed companies on main market board of Bursa Malaysia?

(3) What is the relationship between compatibility and IoT adoption among public listed companies on main market board of Bursa Malaysia?

(4) What is the relationship between competitive pressure and IoT adoption among public listed companies on main market board of Bursa Malaysia?

(5) What is the relationship between information intensity and IoT adoption among public listed companies on main market board of Bursa Malaysia?

(6) What is the relationship between IoT adoption and organizational performance among public listed companies on main market board of Bursa Malaysia?

(7) Does CIO innovativeness moderates the relationship between relative advantage and IoT adoption among public listed companies on main market board of Bursa Malaysia?

(8) Does information distribution moderates the relationship between information intensity and IoT adoption among public listed companies on main market board of Bursa Malaysia?

(9) Does strategic agility moderates the relationship between IoT adoption and organizational performance among public listed companies on main market board of Bursa Malaysia?

1.6 Definition of Key Terms

1.6.1 Internet of Things (IoT)

Internet of Things (IoT) can be defined as a world in which physical objects are seamlessly unified into the information network and whereby the physical objects can be turned into active participants in business processes. Services will be able to interact with these 'smart objects' over the Internet network, have their associated state and associated information with them queried, with security and privacy constrains taken into consideration (Haller & Karnouskos, 2008).

In addition, IoT could also act as a backbone for ubiquitous computing, permitting smart environments to acknowledge and distinguish objects, and further

retrieving information from the Internet to assist in their progress of adaptive functionality.

1.6.2 Relative Advantage

Relative advantage is referred to as the usefulness or degree to which an innovation is perceived to provide greater organizational benefits than its antecedents rather than maintaining status quo. It is fairly reasonable for organizations to take into consideration the associated advantages that stem from adopting innovations. Relative advantage of an innovation was defined by Rogers as "the degree to which an innovation is perceived as being better than the idea it supersedes" (Rogers, 1995). Some of the underlying determinants of innovation adoption are economics, savings in time and rapid information access.

1.6.3 Compatibility

Rogers defines compatibility of an innovation as "the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of the potential adopters" (Rogers, 1995). It was purported that a new technological innovation will be more likely to be adopted if it is perceived to be consistent with present value systems and procedures of the potential adopter (Ettlie, 1986). Higher compatibility with existing beliefs, IT infrastructure and value systems promises less resistance to adoption and lesser risk to adopters (Teo et al., 1997-1998).

1.6.4 Cost

Cost is usually defined in the business world as a monetary valuation of effort, material, time and resources consumed and finally opportunity forgone in production and delivery of a good or a service. In conventional adoption research, cost is typically incorporated in the construe of relative advantage (Rogers, 1995). This study however treats cost as a separate factor to clearly distinguish it from the relative advantage of time and place independence. Kim et al. (2007) reported that cost was considered as a significant determinant for the intention to adopt innovations (Kim et al., 2007).

1.6.5 Information Intensity

Information is crucial and necessary for any establishment that exists in a dynamic business environment. Glazer (1991) conceptualized information intensity as the density of information along the value chain and is suggested to be closely related to the value of information. Information intensity is defined as the magnitude to which the presence of information in the product or service of a business reflects the information intensity level of that particular product or service (Glazer, 1991). Businesses in varying sectors normally present different information processing needs with those in more information-intensive sectors have higher likelihood to adopt IT innovations than those in less information-intensive sectors.

1.6.6 Organizational Performance

Organizational performance is defined as how efficient and effective an organization manages business strategies that leads to synergy (Olson, Slater and Hult, 2005). Researches further explained organizational performance as an indicator to

measure how well and organization achieves goals through evaluation of the organization's efficiency, achievement of mission, activities and finally objectives influence (Pebrianto, Suhadak, Kertahadi and Djamhur, 2013). Performance of an organization can be measured with the use of balanced scorecard based on the organization's vision and strategy. The balanced scorecard encompasses four aspects known as financial, internal business process, learning and growth and customer (Kaplan and Norton, 1992).

1.6.7 Competitive Pressure

Competitive pressure is often taken as a driver of innovation adoption, operates on the basis of retaliatory and endless vicious circle and refers to the perceptions about competitors' uses of potential innovations. Porter and Millar (1985) suggested that innovation changes the rules of competitive games, restructures industry make-ups and further unravels novelty in outperforming rivals. Innovation adoption are normally predicted to transform usual industry practices, ushers in new cast of competitors and repositions competitive grounds to reflect in an effort for prime movers to hold and sustain market pace against rivals (Porter and Millar, 1985).

1.6.8 Chief Information Officer (CIO) Innovativeness

Chief Information Officer (CIO) or sometimes known as Information Technology (IT) Director refers to a job title conventionally bestowed to the most senior executive or figure in an enterprise that holds the responsibilities regarding information technology and computer systems that supports enterprise goals (E. Simson, 2014). Personal innovativeness is defined as the speed with which a person accepts and adopts

new, fresh ideas relative to other members in the same system (Rogers, 1995). CIO plays an important role in the adoption decision process as the CIO will exert a positive attitude toward the adoption of new IT application if he/she can plainly accept and conform to an innovative technology.

1.6.9 Information Distribution

Information distribution is attributed as the process in which individuals, groups or diverse units of an organization share data and information among themselves (Flores et al., 2012). Information distribution is also sometimes referred to the process for making required information readily available to project stakeholders in a timely manner (W. Hansen, 2003).

The information distribution construct is typically used to assess whether an organization possess the necessary information sharing attributes that contributes to the overall readiness towards adopting IT innovation in the business.

1.6.10 Strategic Agility

Strategic agility is defined as the ability of an organization to continuously adjust and adapt the nature of business's strategic direction to cope with the dynamic circumstances and to introduce not just new product or services to the market but as well as develop new business models and innovative measures to create business value (Doz, 2014). Strategic agility is also otherwise stated as the ability of an organization to adequately accommodate and adapt core business's strategic direction in a timely

manner corresponding to changing circumstances identified and judged by sensitivity to the environment (Ofoegbu and Akanbi, 2012).

1.7 Significance of Study

This research investigates and identifies the antecedents for Internet of Things (IoT) adoption among public listed companies on the main market board of Bursa Malaysia as well as its impact on organizational performance. Based on empirical evidences from prior studies and literature reviews, it is strongly believed that there exists significant benefits of IoT adoption from the perspective of organizational performance and business sustainability. For instance, in a paper analyzing the drivers for IT and business services to adopt IoT, S.K. Vuppala and HS. Kiran (2014) revealed that development of solutions through IoT exploitation offers tangible and quantifiable business benefits which further emphasizes the imminent need for a generic IoT accelerator. Business benefits stemming from IoT solutions or applications are noticeable from several aspects namely reduction of operation costs, productivity, efficiency and improvement of revenue (S. Haller and C. Magerkurth, 2011). Commercial deployments of IoT solutions have been proven to effectively addressing business problems, offer attractive business benefits and most importantly the solution provided is economically viable (Ericsson, 2010).

Undeniably, the main strength of IoT refers to the significant impact it will exert on several aspects of behavior and every-day life of potential users. From the point of view of a private end-user, the most noticeable effects of IoT would be evident in both domestic and working fields. In the end-user context, smart homes and offices, assisted living, enhanced learning and e-health are only minor examples of feasible application

schemes in which the new paradigm will assume a leading role in the near future (L. Atzori, a. Lera and G. Morabito, 2010). In resemblance, from the perspective of business users, the most discernible outcomes would be proportionately perceptible in business fields such as business process management, intelligent transportation of people and goods, automation, logistics and industrial manufacturing (L. Heuser, Z. Nochta and N.C. Trunk, 2008).

In a nutshell, the term "Internet-of-Things" refers to an umbrella keyword for enwrapping diverse aspects associated to the extension of the Internet and the Web into the physical realm, indicated by the extensive deployment of spatially distributed devices with actuation capabilities and/or embedded identification, sensing (M. Daniele, S. Sabrina, D.P. Fancesco and C. Imrich, 2012). Most importantly, IoT proffer great potentials in various different application areas for improving enterprise applications – from efficiency gains to unimpaired new business processes and to some extend novel business models (S. Haller and C. Magerkuth, 2011).

This research essentially employed certain factors that have been adapted from previous studies pertaining to Information Technology (IT) / Information System (IS) adoption and implementation. All of the aforementioned factors are categorized as independent variables that influence the adoption of IoT among public listed companies on the main market board of Bursa Malaysia. Relative advantage was adapted from research conducted by Delone and McLean (2003), while cost and compatibility was taken from C. Shapiro (1999) and Wu and Subramaniam (2009) correspondingly. Besides that, competitive pressure was adapted from Pang and Jang (2008) while information intensity was adapted from Thong and Yap (1995) and IoT adoption was

adapted from research performed by S. Haller (1995). Moderators namely Chief Information Officer (CIO) innovativeness, information distribution and strategic agility was separately adapted from discussion and studies conducted by Thong and Yap (1995), G. Huber (1991) and Sambamurthy et al. (2003) respectively.

An overview of literature about IoT revealed that majority of the papers generally discussed about the critical success factors of IoT adoption and values brought by IoT along with its impact. There are limited articles elaborating about the determinants of adoption as well as its impact on organizational performance. In fact, there is even limited research that attempts to examine the associated pre and post implementation of IoT system with the TOE framework. Therefore, the result of this particular learning will serve as a benchmark for public listed companies on the main market board of Bursa Malaysia especially businesses that illustrate tendency to acquire and adopt IoT system solutions. The identified factors will contribute as an awareness platform to practitioners with regards to fostering a strong yet reliable business process while ensuring business sustainability and ideal organizational performance. The model is anticipated to be consistent with DOI theory and TOE model to examine the independent factors influencing IoT adoption.

1.8 Organization of the Remaining Chapters

This study is systematically organized into five chapters. Chapter 1 provides an introduction as well as a brief overview of the study. Chapter 2 presents the review of literature that outlines previous studies undertaken in relation to Internet of Things and business, theoretical framework and hypotheses development. Chapter 3 illustrates the data and variables in terms of research design, sample collection, measurement of

variables, method of data analysis and the corresponding expected outcome. Chapter 4 analyzes the results of finding, focusing on statistical analysis, descriptive statistics, correlation analysis and regression analysis. Finally, chapter 5 sums up and conclude the overall findings alongside with the discussion of implications of the research. Limitation and suggestion in concern of the study are examined for future research and conclusions.