



Faculty of Technology Management and Technopreneurship



**A FRAMEWORK FOR ADOPTING GREEN INFORMATION
TECHNOLOGY IN MALAYSIA: CASE STUDIES FROM
GOVERNMENT AGENCIES, INTERNATIONAL BUSINESS
MACHINES SDN. BHD. AND HEWLETT-PACKARD ENTERPRISE**

Siti Aishah binti Ramli

Master of Science in Technology Management

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INTERNATIONAL BUSINESS MACHINES SDN. BHD. AND HEWLETT-
PACKARD ENTERPRISE**

SITI AISHAH BINTI RAMLI

**A thesis submitted
in fulfillment of the requirements for the degree of Master of Science
in Technology Management**



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this thesis entitled “A Framework for Adopting Green Information Technology in Malaysia: Case Studies from Government Agencies, International Business Machines Sdn. Bhd. and Hewlett-Packard Enterprise” is the result of my own research except as cited in the reference. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Name : SITI AISHAH BINTI RAMLI
اونيور سيتي بيكييكل بليسيا ملاك

Date : 22/09/2022

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPROVAL

I hereby declare that I have read this thesis and in my opinion, this thesis is sufficient in terms of scope and quality for the award of Master of Science in Technology Management.

Signature

: *BCCheW*

Supervisor Name

: PROFESOR MADYA TS. DR. CHEW BOON CHEONG

Date

: 29/09/2022



DEDICATION

This thesis is specially dedicated to:

My beloved mother and father,

Mdm. Sariah Binti Yusak and Mr. Ramli Bin Mohamad Noor



ABSTRACT

Green IT has been widely reviewed by technical and administrative areas. Green IT as green and sustainable practices are practices in designing, manufacturing, using and disposing of IT technologies in order to reduce the energy consumption, carbon emission and electronic waste. A major gap that exists in the Green IT literature today is the lack of a propose framework. Such framework is actually able to be used to assist policy maker, organization such as public and private sector and other researcher in order to support Malaysia's pledge towards global carbon emission reduction by the year 2020. As IT industry is one of the sectors that recognized as a constituent player in supporting a sustainable development, this study attempts to bridge the gap by proposing the framework which focus on factors rendered Green IT adoption and process involved in Green IT adoption by the public sector and the private sector. In this study, the researcher depicts the major factors rendered Green IT adoption, which consists of technological, organizational, environmental, regulatory support, competitive pressure, business opportunity, responsible business ecosystem, and cost. Besides, the researcher illustrates the process involved in Green IT adoption, which consists of plan phase, design phase, implement phase, and measure of the performance phase. At the end of the study, the researcher determined which factors drive the adoption of Green IT in Malaysia and the list of activities included in each process between public and private sector. In order to achieve the research objectives, qualitative method was applied through semi-structured interview with 23 respondents by using open-ended questions as a guideline. Furthermore, in realizing the objective of the propose framework, five organizations were chosen that comes from public sector and private sector, which are Ministry of Energy, Green Technology and Water (KeTTHA), Unit Pemodenan Tadbiran dan Perancangan Pengurusan Malaysia (MAMPU), GreenTech Malaysia, International-Business-Machines Sdn Bhd, and Hewlett-Packard Enterprise. Therefore, the researcher believed by using the proposed framework, Green IT will widely spread to nationwide of Malaysia that start from public sectors which can be applied by the other public sector and the producers which will be able to produce Green IT products with purely Green.

**KERANGKA BAGI MENERIMA PAKAI TEKNOLOGI MAKLUMAT HIJAU DI
MALAYSIA: KAJIAN-KAJIAN KES DARI AGENSI-AGENCI KERAJAAN,
INTERNATIONAL BUSINESS MACHINES SDN. BHD. DAN HEWLETT-PACKARD
ENTERPRISE**

ABSTRAK

IT Hijau telah dikaji secara meluas dalam bidang teknikal dan pentadbiran. IT Hijau sebagai amalan hijau dan mampan merupakan amalan dalam merekabentuk, pembuatan, penggunaan dan pelupusan teknologi IT dalam rangka untuk mengurangkan penggunaan tenaga, pengeluaran carbon, dan sisa elektronik. Jurang utama yang terdapat dalam kesusasteraan IT Hijau hari ini adalah kekurangan rangka kerja yang dicadangkan. Rangka kerja yang dicadangkan sebenarnya dapat digunakan untuk membantu pembuat dasar, organisasi seperti sektor awam dan sektor swasta, dan penyelidik lain dalam menyokong janji Malaysia terhadap pengurangan pelepasan karbon secara global menjelang tahun 2020. Sebagai industri IT yang merupakan salah satu sektor yang diiktiraf berperanan dalam menyokong pembangunan mampan, kajian ini cuba untuk merapatkan jurang dengan mencadangkan rangka kerja yang memberi tumpuan kepada faktor-faktor yang membawa kepada pengambilan IT Hijau dan proses yang terlibat dalam pengambilan IT Hijau. Dalam kajian ini, penyelidik telah menggambarkan faktor utama yang membawa kepada pengambilan IT Hijau yang terdiri daripada teknologi, organisasi, persekitaran, sokongan peraturan, tekanan persaingan, peluang perniagaan, tanggungjawab ekosistem, dan kos. Selain itu, penyelidik menjelaskan proses yang terlibat dalam pengambilan IT Hijau dimana ia termasuk fasa perancangan, fasa mereka bentuk, fasa pelaksanaan, dan fasa menganalisis prestasi. Diakhir kajian, penyelidik telah mengenalpasti faktor-faktor utama yang membawa kepada pengambilan IT Hijau di Malaysia dan senarai aktiviti yang terlibat di dalam setiap proses diantara sektor awam dan sektor swasta. Bagi mencapai objektif-objektif kajian, kaedah kualitatif telah digunakan melalui temubual separuh berstruktur dengan 23 responden dengan menggunakan soalan terbuka sebagai panduan. Selain itu, dalam merealisasikan objektif untuk mencadangkan rangka kerja, lima organisasi telah dipilih yang terdiri daripada sektor awam dan sektor swasta iaitu Kementerian Tenaga, Teknologi Hijau dan Air (KeTTHA), Unit Pemodenan Tadbiran dan Perancangan Pengurusan Malaysia (MAMPU), GreenTech Malaysia, International-Business-Machines Sdn Bhd, Hewlett-Packard Enterprise. Oleh itu, penyelidik percaya bahawa dengan menggunakan rangka kerja yang dicadangkan, IT Hijau akan tersebar secara meluas diseluruh Malaysia bermula dari sektor awam untuk diaplikasikan kepada sektor awam yang lain dan pengeluar-pengeluar produk IT yang mana dapat mengeluarkan produk IT Hijau yang benar-benar hijau.

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LIST OF ABBREVIATIONS, SYMBOL AND NOMENCLATURE

AI	= Artificial Intelligence
CAPEX	= Capital Expenditure
CD	= Compact Disc
CIDB	= Construction Industry Development Board Malaysia
	Conference Malaysia
CPU	= Central Processing Unit
DAHLIA	= Data Hijau Lestari Program
DOE	= Department of Environment اونيورسيٲي ٲيڪنيڪل ٲليسياء ٲاراڪ
DOI	= Diffusion of Innovation UNIVERSITI TEKNIKAL MALAYSIA MELAKA
DRC	= Disaster Recovery Centre
EPEAT	= Electronic Product Environmental Tool
ETP	= Economic Transformation Program
FMA	= Factory and Machinery Act
GDP	= Gross Domestic Product
GreenTech	= Green Technology Corporation
GTFS	= Green Technology Financial Scheme

HP	= Hewlett-Packard
IBM	= International Business Machines
IBS	= Industrialized Building Systems
ICT	= Information Communication and Technology
IGEM	= International GreenTech and Eco Products Exhibition and
IoT	= Internet of Things
IT	= Information Technology
JKR	= Jabatan Kerja Raya
KeTTHA	= Ministry of Energy, Green Technology and Water
MAMPU	= Malaysian Administrative Modernisation and Management
MDeC	= Multimedia Development Corporation
MIMOS	= Malaysian Institute of Microelectronics Systems
MNC	= Multinational Corporation
MOF	= Ministry of Finance
MOSTI	= Ministry of Science, Technology and Innovation
MSC	= Multimedia Super Corridor
OSHA	= Occupational Safety and Health Act
PC	= Personal Computer
PERM	= Perceived e-readiness model
	Planning Unit

PUE	= Power Usage Effectiveness
RoHS	= Restriction of Hazardous Substance
ROI	= Return of Investment
SME	= Small-Medium Enterprise
TAM	= Technology Acceptance Model
TBP	= Theory of Planned Behaviour
TOE	= Technology-Organization-Environment
UTAUT	= Unified Theory of Acceptance and use of Technology
VCD	= Video Compact Disc
WEEE	= Waste Electrical and Electronic Equipment



LIST OF PUBLICATIONS

NO.	TITLE	STATUS
1	Ramli, S.A., Chew, B.C and Saptari, A., 2021. Factors in Adopting Green Information Technology: A Qualitative Study in Malaysia. <i>Pertanika Journal of Science & Technology</i> , 29(3), pp. 1431 – 1450.	Published
2	Ramli, S.A., Chew, B.C and Saptari, A., 2022. A Process of Adopting Green Information Technology In Malaysia. <i>Suranaree Journal of Science & Technology</i> , 29(4), pp.1-11.	Published



CHAPTER 1

INTRODUCTION

1.0 Background of Study

Today, Information Technology (IT) development is witnessing a rapid innovation, transformation and change. As IT magnifies into the developing world, it delivers the positive and negative impact on the environment. In terms of positive impact, Nuruddin and Yusoff (2016) indicate that ICT can reduce administration costs and improve access to key areas such as in healthcare, education and banking as well as providing a platform for presence. However, since the community has begun to emphasize the need for a speedy transition to a green growth; Lee, Park and Trimi (2013) claim that at least 3% of global carbon emission is produced by IT products and the more trouble is IT power consumption is rising constantly at a speedy rate.

Consequences from that, Taruna, Singh and Joshi (2014) illustrate that developed countries such as Ministry of Science, Technology and Innovation of Denmark's efforts for the establishment of Green IT whereas the Ministry of Economy, Trade and Industry of Japan established Green IT initiative, which provides a strong model of green innovation policy. Through the development of sustainable and green in developed countries, A National Green Technology Policy was established in Malaysia in 2009 where 6th Malaysian Prime Minister indicated that *“Green Technology is a blue ocean strategy as it transcends across all sectors of the economy. It provides vast opportunities for government and business to innovate and grow as well as developing new parts of competitiveness”*

(Kasbun et al., 2016). In National Green Technology Policy also pointed out five strategic thrusts and one of them is strengthen efforts in promotion and improve the awareness of people in ICT technology (KeTTHA, 2009). Therefore, ICT sector was recognized as one of the sectors in supporting National Green Technology Policy (GreenTech, 2013). From there, Green IT was developed as one of the new green ideas for ICT sector (GreenTech, 2011) since ICT are manufactured using toxic chemicals (Bello, Ahmad and Nordin, 2013), and government's annual electricity consumption in Malaysia for IT facilities at an alarming rate in 2020 that will amount 465,000,000 kWh with costing some RM619,000,000 whilst generating 418,000 metric tons of carbon emission (KeTTHA and Green Computing Initiative, 2012). Besides that, Alias, Ishak and Zulkifli (2014) affirm that generation of electronic waste (E-waste) has been estimated to be about 652,909 tons in 2006 and was extrapolated to reach around 706,000 tons in 2011 and about 1.2 million tons in 2020 in Malaysia. Extending the views, the researcher posits that ICT sector is one of the main contributions of carbon emission and electronic waste, and Green IT is the best solution to support the National Green Technology Policy.

Nuruddin and Yusoff (2016) emphasize that ICT are increasingly recognized as an integral part of the Sustainable Development Goal process which in 2030 Agenda notes that the spread of ICT and global interconnectedness has great potential to accelerate human progress, to bridge the digital divide and to develop knowledge societies. Besides, KeTTHA and Green Computing Initiative (2012) state that Green IT was implemented to support the vision of the previous Prime Minister of Malaysia which is to reduce by up 40% of carbon emission by the year 2020. Therefore, Green IT should play an important role to support the vision in 2020 at the same time will be able to achieve 2030 Agenda. Green IT is clarified as practices in designing, manufacturing, using and disposing of IT technologies in order to reduce the energy consumption, carbon emission and electronic

waste. Furthermore, Zoysa and Wijayanayake (2013) highlight that Green IT can be described as two categories which is minimizing the harmful effect of IT to the environment where the power consumption of IT equipment, waste disposal and associate utilities and the other categories is utilizing IT resources to reduce the environmental harmful effect from another process. Thus, Green IT handles the carbon emission of the whole IT life-cycle, extending from designing an IT device, to its use and its end-of-life management. Green IT also brings positive effects in the reducing of carbon footprint on the environment, help to create a more sustainable environment, growing the consumer interest in environmentally friendly products and services where organizations with the technology and vision to produce products and services (Murugesan and Gangadharan, 2012).

Nonetheless, to make the aspiration, goal and vision become reality, the full adoption of Green IT throughout the Malaysia should be happen as previous Prime Minister Dato' Sri Najib Tun Razak mentioned that *"...it is becoming my aspiration to develop the Putrajaya and Cyberjaya as example for urban cities that ecological friendly and be able to be applied in other cities throughout Malaysia"* (Elias, Bakar and Nadarajan, 2012). Therefore, the researcher believed that for full adoption of Green IT throughout the Malaysia, the organization should recognize the factors and process involved in Green IT adoption. Thus, this research in need to examine the factor rendered Green IT adoption and investigate the process involved in Green IT adoption in Malaysia.

1.1 Problem Statement

In implementation of Green IT in Malaysia, there are many studies have been conducted regarding Green IT (Elias, Bakar and Nadarajah, 2012; Ramachandiran, 2012; Bello, Ahmad and Nordin, 2013; Din, Haron and Ahmad, 2013; Rahim and Rahman, 2013;

Aghasian, Pourtaheri and Ahmadizadeh, 2013; Franklin and Ismail, 2014; Selyamani and Ahmad, 2015; Kasbun et al., 2016; and Esfahani, Ramayah and Nilashi, 2017). However, there are only some of the studies that been conducted regarding the adoption of Green IT in Malaysia (Esfahani, Rahman and Zakaria, 2015; Esfahani, Ramayah and Nilashi, 2017). Following the past studies of Green IT that have been held in Malaysia, there are still has a gap between Malaysian studies and other country studies regarding Green IT adoption, which other country studies have been discussed more on Green IT adoption (Zoysa and Wijayanayake, 2013; Chen and Chang, 2014; Deng and Ji, 2015). Therefore, the researcher considered that this is the reason why Green IT is still not widely adopted in Malaysia. This is supported by Din, Haron and Ahmad (2013) illustrate that Green IT engagement in the taking care of the environment is still a long way off and Malaysia are in the 'snail' phase and intermittent in a "Green" practice. The researcher posits that for the comprehensive adoption, fully study about Green IT adoption should be conducted to disclose the reasons, process, challenges, impact and others so that organizations, especially public and private sector gained full exposure about Green IT and attracted to adopt as initiative.

Furthermore, current studies are more towards the impact or current situation of practices on using IT (Aghasian, Pourtaheri and Ahmadizadeh, 2013; Selyamani and Ahmad, 2015; Alla and Chen, 2016), disposing of IT (Bello, Ahmad and Nordin, 2013; Kasbun et al., 2016) and the findings are more toward practices of using in the education sector (Aghasian, Pourtaheri and Ahmadizadeh, 2013; Bello, Ahmad and Nordin, 2013; Din, Haron and Ahmad, 2013; Selyamani and Ahmad, 2015; Alla and Chen, 2016) which lead to the low and the average level of knowledge about Green IT results from the studies at the same time it shows that the adoption of Green IT in Malaysia is still at a nascent stage. Moreover, only some studies conducted in organizations sides (Uddin et al., 2012;

Rahim and Rahman, 2013; Kasbun et al., 2016; Esfahani, Rahman and Zakaria, 2015; Esfahani, Ramayah and Nilashi, 2017). Therefore, the researcher intends to back to the first step of the adoption where the researcher aim to examine the factors of Green IT adoption and process of adoption so that it can fill the gap as other countries have been studying thoroughly about the factor and process of Green IT adoption (Zoysa and Wijayanayake, 2013; Bose and Luo, 2012; Mittal and Kaur, 2013; Letlonkane and Mavetera, 2014; Radu, 2016)

A study of factor and process of Green IT, there are several past studies in Malaysia have been briefly discuss about the factor (Rahim and Rahman, 2013; Esfahani, Rahman and Zakaria, 2015; Esfahani, Ramayah and Nilashi, 2017). However, it is only briefly discussed about organizational factor, environmental factor, and competitive factor, and slightly discussed on the cost factor, regulatory factor and technological factor. Meanwhile, other country studies have been discussed more on the technological factor, environmental factor, organizational factor, regulatory support factor, competitive pressure factor, business opportunity factor, responsible business ecosystem factor and cost factor which have their own benefits for each factor. Therefore, the researcher desiderates to identify the factors rendered in the Green IT adoption and examine which factors that drive the adoption of Green IT in Malaysia at the same time able to fill the gap between factors in Malaysia and other countries. Moreover, the researcher also aims to study about the process of Green IT adoption. This is because there is only one study that has been conducted about the Green IT process in Malaysia (Uddin et al., 2012). However, the study is more towards the implementation process of green data centre and its infrastructure whereas Green IT scopes are comprised of manufacturing, using and disposing. Hence, the researcher desiderate to investigate the process involved in Green IT adoption, including

the designing side, manufacturing side, using side, disposing side between public and private sector.

The researcher wants to conduct the study about the factor and process of Green IT adoption due to the researcher wishes to propose framework at the end of the study as the contribution of the study. This is because Rahim and Rahman (2013) demonstrate that a major gap that exists in the Green IT literature today is the absence of a theoretical framework. Therefore, the proposed framework can be used by the policy maker, organization such as public and private sector and other researcher as a guideline for them. This will further explain in the significance of the study section. The research objective of this study is important due to past studies only touched the several factors about the Green IT adoption and lack of discussion in the process of Green IT between public and private sector. The researcher was chosen to conduct the study in public and private sector due to the researcher able to understand in-depth regarding Green IT adoption in the public sector context and the private sector context especially the innovator of ICT products. Hence, from that, the researcher will be able to propose a framework which it is not only can be used by the public sector, but it also can be used by the private sector including the innovators of the products and services of IT.

1.2 Research question

Based on the problem arises through Green IT, there are three research questions that concerned with this research. The research questions are shown as below:

- i. What are the factors rendered the Green IT adoption by MAMPU, KeTTHA, GreenTech Malaysia, IBM Malaysia and HP Malaysia?
- ii. What are the process involved in Green IT adoption by MAMPU, KeTTHA, GreenTech Malaysia, IBM Malaysia and HP Malaysia?