INVESTIGATING THE RELATIONSHIP BETWEEN INFORMATION TECHNOLOGY CAPABILITIES AND ENVIRONMENTAL PERFORMANCE IN THE INDONESIAN INFORMATION AND COMMUNICATION TECHNOLOGY INDUSTRY

Darius Antoni

S3308096

A thesis submitted for the degree of Doctor of Philosophy

School of Business Information Technology and Logistics

Business College

RMIT University

October 2014

Abstract

Information technology (IT) capability can be adopted by organisations to improve their environmental performance in order to meet environmental regulations, improve their profitability and enhance their competitive position in the market place. The purpose of this research is to develop a IT capability model that incorporates IT infrastructure quality and the competence of IT human resources, which can be used by organisations to support the digitalisation of their business processes and develop their environmental IT competencies in order to improve their environmental performance in the Indonesian Information and Communication Technology (ICT) industry.

The study begins by establishing a definition of the relationship between IT capability and environmental performance, based on previous studies associated with IT capabilities and environmental performance, to develop a proposed framework. The resource-based view (RBV) and natural RBV are used in this study as theoretical foundations for understanding how IT capabilities can influence the improvement of environmental performance in organisations. The results of the literature review show that there are five variables used in developing the model. These are: IT infrastructure quality; IT human resources competence; the digitalisation of business processes; environmental IT competence; and environmental performance.

This is followed by an analysis of employee survey data that was collected through a drop-and-collect method in a number of Indonesian ICT organisations. The data obtained from the survey was screened for missing values, normality, outliers, linearity, common method bias and non-response bias. The objective was to avoid the failure of the model estimation and the crashing of fitting programs. Furthermore, the validity of the model was tested by exploratory

factor analysis, confirmatory factor analysis including congeneric factor analysis, multifactor analysis and full model measurement, and structural equation modelling.

The survey findings reveal that IT capability is a critical ability of an organisation to be used for developing business process digitisation and environmental IT competence. The results also indicate that business process digitisation and environmental IT competence are positively associated with the environmental performance of organisations. A new model of IT capability constitutes an original contribution to the information systems (IS) literature, especially in the area of the relationship between IT capability, business process digitisation, environmental IT competence and environmental performance.

These findings show that this study makes an original contribution to the IS literature through its development and validation of the research model and its accompanying measurement instrument. The conception, hypotheses, analysis and statistical findings of this study represent an important improvement of the theoretical foundations, IS and IT capabilities, and the use of IT capabilities in developing country. The research also makes recommendations to the IT managers of Indonesian ICT organisations about how to improve environmental performance successfully.

Declaration of originality

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed: _____ On: _____/____/_____

Publications

Darius Antoni and Ferry Jie (2012). “The relationship between Information Technology and organisational environment performance: A conceptual framework.” Third Annual International Infocomm Technologies in Competitive Strategies (ICT) Conference Proceedings.

Darius Antoni (2013). “Conceptual framework of Information Technology capability on improvement of organisational environment performance”. Paper presented at Information Technology and Business Application (ICIBA) conference, 2013, Palembang, Indonesia.

Darius Antoni and Ferry Jie (2013). “Investigating the critical capabilities of information technology for developing ecological competencies of organisations”. Eleventh ANZAM operations, Supply Chain and Service Management Symposium.

Darius Antoni (2013). “Critical success factors of IT capability for improving environmental performance in the Indonesian ICT Industry”. Presented at HDR panel discussion, Research day program, 11 October 2013, organised by School of Business IT and Logistics, College of Business, RMIT University, Melbourne.

Working Papers

Darius Antoni, Ferry Jie and Ahmad Abareshi (2014). “Antecedents of IT infrastructure quality for enhancing environmental competence of organisations". Has been submitted in Australian Journal of Information systems (ABDC-A ranked journal) (under review).

Darius Antoni, Ferry Jie and Ahmad Abareshi (2015). “Investigating the role of IT human resources competencies in developing environmental competence of an organisation. To be submitted at Information Technology and Business Application (ICIBA) conference, 2015, Palembang, Indonesia.

Darius Antoni, Ferry Jie and Ahmad Abareshi (2015). “Antecedents of information technology capability for enhancing environmental competence of organisations through business process digitisation". To be submitted in European Conference on Information System (ECIS) 2015 in Germany

Acknowledgements

Alhamdulillah, Glory and great thanks to ALLAH S.W.T for giving me the strength to complete this study and also granting me pursuit of the degree of Doctor of Philosophy. I am most grateful to HIM for granting me wisdom to undertake this research. The successful completion of this thesis is with HIS blessings. This journey of knowledge has been filled with triumph, excitement, frustration and satisfaction. I also thank HIM for HIS peace in a time of frustration; for HIS joy in a time of sorrow; for HIS strength in a time of weaknesses; for HIS faithfulness when I stray; and for HIS unfailing mercies.

I also extend my appreciation and thanks to the Ministry of Education and Culture of the Republic of Indonesia, especially the Directorate General of Higher Education (DIKTI) and Private Higher Education Coordinating II (KOPERTIS II) for awarding me a scholarship and opportunity to pursue this study at RMIT University, Melbourne. Furthermore, my sincere thanks go to Bina Darma University and its administration staff for much help during this study, particularly the Rector of Bina Darma University, Prof. Bochori Rachman MSc and the Vice Rector of Bina Darma University, Dr Sunda Ariana, who always supported and encouraged me to complete this study.

I would also to like to express my deepest gratitude to my senior supervisor, Dr Ferry Jie, for his invaluable and unfailing support, advice, guidelines and encouragement in bringing this research work to a successful completion. I am also grateful to my second supervisor, Dr Ahmad Abareshi, for providing me with his valuable advice, guidelines and support at various stages of my research. My two supervisors are not only my respected supervisors for inspiring me in conducting my research, but also good friends and big brothers for offering me generous help and guidance in life. They have always given me great motivation and encouragement during the PhD journey.

I am extremely thankful to my family, particularly my wife, Nur Ikasari Gumayna, for always supporting and understanding me from the beginning of my PhD journey to the end. I am greatly indebted to you. Your unwavering love, support and encouragement have allowed me to complete this long journey. I feel most blessed and lucky to find you always on my side. I also thank my children, Rizky Ainayah Santi Putri Antoni (Ayuk Pingki), Muhammad Zidane Attallah (Pito) and Muhammad Fazzle Gerinemo (Pibi), who also been understanding of me as a father with deficiencies during this study. All they need to know is that they have contributed to my emotional strength in pursuing this challenging journey of mine.

I thank my beloved mother, Yanti Mala, for everything she is, for her continuous prayer and words of wisdom; my father, Saipul Jamaluding, for a good education and support. I am grateful to my sisters, brothers, brothers– and sisters-in-law, nieces and nephews for bringing joy to my life. Their unconditional love and constant support over the years is something that I cannot thank them enough for. Not a single day passes by that I do not think of them.

The road to a PhD is often a solitary journey, but it could not be accomplished without the support of friends. I would like to express my appreciation and thanks to all of them. However, the following names are worth mentioning specifically for their support and assistance: Rabin Ibnu Zanial, Mohammad Solikin, Bayu Khresna, Arie Wardhono, Dr Dedi Rianto Rahadi, Dedy Syamsuar, Rindang Widuri and Ayu Chairina Laksmi. Last but not least, this thesis is also expressly dedicated to a number of friends and colleagues who have consistently given me support and unfailing encouragement, for lending their ears and listening to my grudges, and sharing the good and bad moments throughout the journey.

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List of Abbreviations

AGFI	Adjusted Goodness-of-Fit Index
AMOS	Analysis of Moment Structural
ANZ	Australian New Zealand
APJII	Internet Service Providers Association
ASEAN	South East Asia Assosiation
ASV	Average Shared Variances
AVE	Average Variance Extracted
BDV	Bandung Digital Valley
BPD	Business Process Digitisation
BTOS	Bartlett's test of sphericity
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CR	Construct Reliability
Cronbach's Alpha	The Coefficient of Internal Consistency
DC	Digital Communication
DETIKNAS	The National Technology Council
DF	Degree of Freedom
DIKTI	Directorate General of Higher Education
DT	Didital Business Transaction
EDI	Electronic Data Interchange
EFA	Exploratory Factor Analysis
EIT	Environmental Competence of IT
EM	Emission Management

EM	Expectation-Maximisation
EMS	Environmental Management System Standards
EP	Environmental Performance
E-procurement	Electronic Procurement
ERP	Enterprise Resource Planning
GDP	National Gross Domestic Product
GOF	Goodness of Fit
HREC	RMIT Human Research Ethics Committee
ICT	Information Communication Technology
IFI	Incremental Fit Indices
IS	Information System
ISO	Management System Standard
ISP	Internet Service Providers
IT	Information Technology
ITH	Human Resources Competencies
ITQ	Information Technology Quality
KMOMSA	Kaiser-Meyer-Olkin measure of sampling adequacy
KOPERTIS	Private Higher Education Coordinating
MI	Modification Index
MSV	maximum shared variances
NFI	Normed Fit Index
PCA	Principal Component Analysis
PCFI	Parsimony Comparative Fit Index
PNFI	Parsimony Normed Fit Index
PSTN	Basic Wired Telephone Services

RBV	Resources-Based View Theory
RFID	Radio Frequency Identification
RICE	Regional IT Centres of Excellence
RMSEA	Root Mean Square Error of Approximation
RMSR	Root Mean Square Residual
RS	Resources Stewardship
SB	Sustainability Behaviour
SEM	Structural Equation Modelling
SFL	Standardised Factor Loadings
SISFONAS	National Information System
SMC	Squared Multiple Correlation
SME	Small Medium Enterprises
SRMR	Standardised Root Mean Residual
TLI	Tucker-Lewis Index
X2	Chi-Square

Chapter 1
Introduction

This thesis is an investigation of the relationship between Information Technology (IT) and organisational environment performance to better understand the critical factors of IT capability that influence the improvement of environmental performance based on the perceptions of IT users. The context of this study is IT capability in information technology and communication (ICT) organisations within Indonesia. This study utilises a survey as the research methodology. The respondents to the survey consisted of IT managers from Indonesian ICT organisations.

1.1 Background

Organisations are increasingly concerned about the environmental performance of their operations in today's competitive environment. This is because effectively improving their environmental performance can help the organisation to meet environmental regulation and compliance standards, improve organisational profitability, provide the organisation with business opportunities and improve the competitive position of the organisation in the marketplace (Adela, Marie-Claude & Richard 2008; Bansal & Roth 2000). As a result, organisations have been implementing specific policies and strategies for improving their environmental performance.

There are many approaches and techniques that an organisation can use to improve their environmental performance, including the adoption of information technology (IT) (Boudreau, MC, Chen & Huber 2008; Mingay 2007; Speshock 2010; Tippins & Sohi 2003; Tornatzky, Fleischer & Chakrabarti 1990; Xiaoxia, Hepu & Brian 2012). Mingay (2007), for example, shows that organisations can use IT to significantly reduce the carbon dioxide emissions from their business operations. Sayeed and Gill (2008) argue that organisations can

improve their environmental performance through effectively managing their IT resources. Dao et al. (2011) state that organisations can reduce their energy consumption through using digitised documents and automating different business activities. These studies show that IT is being developed and used as a capability in organisations for improving their environmental performance (Melville 2010; Molla 2008).

IT capability is the ability of an organisation to effectively and efficiently utilise its IT resources for improving its organisational performance, including its environmental performance (Boudreau, MC, Chen & Huber 2008). It can be approached from different perspectives including IT infrastructure, IT human resources and IT management (Bharadwaj 2000; Kettinger et al. 1994; Lee, Trauth & Farwell 1995; Molla, Cooper & Pittayachawan 2009). Kettinger et al. (1994), for example, argue that IT capability is the ability of an organisation to use IT infrastructure for achieving competitive advantages. Lee, Trauth and Farwell (1995) state that IT capability is the organisational ability to effectively manage organisational operations through effective use of IT human resources. Bharadwaj (2000) shows that IT capability is the organisational ability that is created by the interaction between IT infrastructure, IT human resources and IT intangible assets in an organisation for improving its organisational performance. Tippins and Sohi (2003) argue that IT capability is the ability of an organisation to use IT resources for improving its performance. Jiao, Chang and Lu (2008) state that IT capability determined by IT infrastructure, IT human resources and IT management can be used for improving organisational performance. In this study, IT capability is defined as the ability of an organisation to utilise its IT resources for enhancing its performance, including its environmental performance.

There is much research on the role of IT in improving environmental performance (Adela, Marie-Claude & Richard 2008; Daly & Butler 2009; Mann, Grant & Singh 2009; Sayeed & Gill 2008). Sayeed and Gill (2008), for example, explore the use of the ‘green’ capability of

IT infrastructure in organisations for reducing their energy consumption and meeting environmental regulations. Adela, Marie-Claude and Richard (2008) argue that the use of IT infrastructure in an organisation can facilitate environmentally friendly operations through informing, automating and transforming business operations. Molla (2008) examines the role of IT including infrastructure, IT human resources and IT management in organisations for improving their environment performance. Daly and Butler (2009) state that the design of IT infrastructure in an organisation, which is usually influenced by regulative, normative and cultural-cognitive forces, can affect organisational energy efficiency. Benitez-Amado, Perez-Arostegui and Tamayo-Torres (2010) argue that utilising IT human resources can improve organisational environmental performance. These studies show that the use of IT in organisations as an organisational capability can improve their environmental performance.

The ICT industry is one of the main industries in Indonesia. It provides the Indonesian people and society with various IT-related services including computer, internet and communication services. The ICT industry has made a significant contribution to the Indonesian economy, exemplified by its contribution to the National Gross Domestic Product (GDP) at 30.41% in 2008 (Ministry of Telecommunication and Informatics 2009). With stimulating policy and strategy from the Indonesian government, the ICT industry is being developed rapidly. This can be demonstrated by the growth of ICT organisations in Indonesia from one organisation to thirteen organisations in 2008. Overall, the Indonesia ICT industry is playing a significant role in the development of the Indonesian economy.

With the rapid development of the ICT industry in Indonesia, there is an increasing need for improving the environmental performance of ICT organisations (Ministry of Communication and Informatics 2010). In fact, many Indonesian ICT organisations have started to use IT for mitigating the impact of their business operations on the environment. For example, PT Indosat Indonesia, one of the leading ICT organisations, has implemented a ‘green office’

strategy in an effort to reduce its energy consumption through IT, such as video conferencing technologies, and mobile networks and devices (PT Indosat 2010). PT Telkom Indonesia.tbk (Telkom Indonesia) has also adopted green organisation strategies for addressing the environmental concerns of its stakeholders (Dwi Utari 2010). For example, 'greening office' is one of the Go Green programs which are being adopted to encourage internal and external stakeholders to replace paper-based documents with digital documents. While Indonesian ICT organisations have started to implement strategy and policy to improve their environmental performance, how effectively these organisations organise their IT for improving their environmental performance is not clear. To address this issue, this study attempts to investigate the relationship between IT capability and environmental performance in the Indonesian ICT industry.

1.2 Significance of the research

There are four reasons to investigate the relationship between IT capability and environmental performance. First, there is increasing recognition of the importance of improving the environmental performance of an organisation to the success and even survival of the organisation in today's competitive market. This is because effectively improving environmental performance not only helps organisations to meet environmental regulations, stakeholder requirements and compliance standards, but also helps organisations to improve their profitability, provide business opportunities and improve their competitive position in the market environment (Adela, Marie-Claude & Richard 2008; Bansal & Roth 2000).

Second, Indonesia is the fourth largest country in the world, with a population of 260 million distributed across 3667 islands, 33 provinces, 6 major religions and more than 300 ethnic groups. The ICT industry in Indonesia makes a significant contribution to connecting the Indonesian people together. It is playing a critical role in the development of the Indonesian economy. It has a huge potential market in Indonesia. This can be demonstrated by the

number of customers of the communication industry, which has reached more than 190 million subscribers in 13 telecommunication organisations. The ICT industry provides many facilities to support various activities including government and business operations based on telecommunications technology.

Third, the Indonesian government through the Indonesia Ministry of Communication and Informatics has created a policy to encourage Indonesian organisations to use IT for improving their environmental performance (Ministry of Communication and Informatics 2010). Many ICT organisations have implemented this policy in their business practices. For instance, PT. Indosat, a state-owned telecommunications company, has an e-procurement strategy to support the procurement process in the organisation (PT Indosat 2010). PT. Excelkomindo employs email as an alternative to replace billing statements for its customers for cost saving as well as creating a cleaner, greener and more sustainable environment (PT XL Axiata Tbk 2010). PT. Bakrie Telecom has a 'green office' strategy which focuses on the use of IT for reducing paper usage, encouraging employees to recycle paper, recycling paper and printer cartridges and saving electricity. Telkom Indonesia, one of the government-owned companies, has implemented some programs and policies to support government programs in order to improve its environmental performance (PT Telekomunikasi 2010). For instance, Telkom Indonesia provides cloud computing services for their customers as well as their business operations. The other program is 'green building', which is used as a solution in the efficient use of resources and energy for improving environmental performance. Such buildings use IT for automated operation of the building, and defining rule and tasks for using energy building to realise efficient energy consumption.

Fourth, while there has been an increase in the use of IT capability for improving environmental performance in the Indonesian ICT industry, how effective the use of IT has been for improving the environmental performance of these organisations is unclear. In

particular, how and to what extent IT is used in the industry for improving environmental performance have not been studied so far. This because there is little research that investigates the role of IT in improving environmental performance in the Indonesian telecommunications industry. To address this issue, this study attempts to investigate how IT capability is used for improving environmental performance in the Indonesian telecommunications industry. To facilitate investigating the relationship between IT capability and organisational environmental performance in the Indonesian ICT industry, several research objectives and questions are formulated in the following.

1.3 Research aims and objectives

Given the need to develop a better theoretical framework to understand how IT capability is used to improve environmental performance, the main purpose of this study is to develop a research framework that can serve as a basis to understand the relationship between IT capability and environmental performance in the Indonesian ICT industry. Furthermore, the framework is utilised to understand how IT capability leads to the improvement of environmental performance and the critical IT capabilities for improving environmental performance in an organisation. Drawing from past research, the development of the research framework is based on the resource-based view (Bharadwaj 2000; Molla et al. 2008; Molla, Cooper & Pittayachawan 2009). The resource-based view considers organisations to be heterogeneous packages of the resources that have capabilities and characteristics to predict organisational success (Barney 1991; Bharadwaj 2000). From this perspective, resources can be seen as the basis of the capabilities to gain and maintain competitive advantage in the competitive business environment. Extending these views to the use of IT capability in improving environmental performance, IT capabilities represent the ability of an organisation to effectively and efficiently use IT resources for improving environmental performance.

Based on these premises, the specific objectives of this research are defined as follows:

- To examine the factors of **IT infrastructure quality** which affect **business process digitisation** and **environmental IT competence**
- To examine the factors of **IT human resources competence** which affect **business process digitisation** and **environmental IT competence**
- To examine the factors of **business process digitisation** which affect **environmental performance** and **environmental IT competence**
- To examine the factors of **environmental IT competence** which affect **environmental performance.**

1.4 Research questions

To achieve the objectives of the study as given above, the main research question in this study is formulated as follows:

What are the **critical factors of IT capabilities** for improving environmental performance in the Indonesian ICT industry?

To answer this question, several subsidiary questions are as follows:

- What are the factors of **IT infrastructure quality** which affect **business process digitisation** and **environmental IT competence** in the Indonesian ICT industry?
- What are the factors of **IT human resources competence** which affect **business process digitisation** and **environmental IT competence** in the Indonesian ICT industry?
- What are the factors of **business process digitisation** on **environmental performance** and **environmental IT competence** in the Indonesian ICT industry?
- What are the factors of **environmental IT competence** which affect **environmental performance** in the Indonesian ICT industry?

1.5 Research methodology

To adequately answer the research questions above, a quantitative method is adopted to investigate the relationship between IT capability and organisational environmental performance in the Indonesian ICT industry.

The quantitative method in this study involves using a survey of the targeted population in the Indonesian ICT industry. To ensure the validity and reliability of the research findings, three steps are followed in this study. First, an initial questionnaire was developed based on the

conceptual model developed from a comprehensive review of the related literature. The developed questionnaire was reviewed by senior academics at the university. The reviewed questionnaire was further pilot-tested by several managers from the Indonesian ICT industry to ensure that it was understandable and answerable. Finally, the questionnaire was distributed to selected managers in Indonesian ICT organisations.

The participants in the survey were selected from Indonesian ICT organisations. In determining the size of the sample population, two specific rationales were followed, including (a) the size of the sample should be greater than or equal to 50+8m (m is the number of independent variables) in the proposed conceptual model (Green 1991); and (b) the research findings should be generalisable with respect to the ratio between the number of observations and the number of independent variables (Hair 1995). With these guidelines, the sample size of this study was determined at around 378 participants.

The participants were selected from Indonesian ICT organisations by the adoption of a clustering approach. Clustering was based on the regions where the ICT organisations are located and meant that the region with the largest number of ICT organisations received the greatest number of questionnaires. Specifically, the province that had the most ICT organisations had more participants in the survey.

There are currently 1265 ICT organisations in Indonesia. The distribution of the questionnaire to individual ICT organisations was carried out under the guidance of the Ministry of Telecommunication and Informatics and the Ministry of Trade of the Republic of Indonesia.

1.6 Outline of the thesis

This thesis is structured into seven chapters. Chapter 1 is divided into seven sections, namely, background, motivation for the research, research objectives and research questions, research methodology and outline of the thesis. The background of the research is a comprehensive

overview of this study. The motivation is focused on the rationale for the study. The research objectives and questions are about the scope and boundaries in the study. The research methodology explains how the data was gathered and explores the hypotheses in the research. The thesis outline provides the structure of the study.

Chapter 2 briefly describes an overall view of the Indonesian ICT industry. Furthermore, this chapter reviews the Indonesian ICT industry scenario, specifically the development issues and involvement of computer and communication technology. This chapter consists of five sections. The first section is the introduction. Section 2.2 discusses the development of Indonesian telecommunications organisations. Section 2.3 provides information about IT organisations and their development in the business environment. Section 2.4 presents a discussion of internet service providers. Section 2.5 covers Indonesian government plans for the ICT industry. Section 2.6 provides a summary of this chapter.

Chapter 3 provides a comprehensive review of the related literature, covering both theoretical and empirical research pertinent to the study objectives, drawing from resource-based view theories, IT capability for improving environmental performance and empirical research. This chapter provides a strong foundation for facilitating the development of conceptual models and methodologies for this study. Relevant theories and model identified from the literature review provided guidelines for developing this chapter.

Chapter 4 presents the conceptual framework and hypothesis development used to describe the critical factors for the improvement of environmental performance in the Indonesian ICT industry. The chapter covers a discussion regarding how the conceptual framework has been developed based on the literature review. It also provides the theoretical background that is adopted as the lens for investigating the relationship between IT capability and environmental performance. The last section presents a summary of the chapter.

In Chapter 5, the methodology used to gather the data and explore the research hypotheses is discussed. The chapter covers arguments and decisions regarding epistemological choice, the research basic approach, sample design, instrument development, and data collection and analysis procedures.

Following this, Chapter 6 discusses the data examination and preparation. It examines the data for missing values, outliers, departure from normality, and non-respondents and common method bias, and discusses the remedial steps taken in accordance with recommended procedures. The chapter also provides a brief description of the respondent demographics.

Chapter 7 provides the data analysis and the discussion of the statistical findings with the purpose of interpreting the statistical results. It makes a significant contribution by presenting an analysis of the descriptive data and examining the unidimensionality of the model through a confirmatory factor analysis approach. This chapter further presents the analysis of the structural model using structural equation modelling (SEM). It is aimed at answering the research questions and validating the hypotheses.

Chapter 8 presents the interpretations and discussion of the findings from the statistical analysis in the previous chapter. The discussion is structured to acknowledge the research objectives and hypotheses developed in Chapter 3. This chapter explains the creation of IT capability for this study and reports the impact of the use of each IT capability for improving environmental performance in organisations. The last section summarises the use of IT capability for improving organisational environmental performance in the Indonesian ICT industry.

Chapter 9 gives a final summary of the thesis with conclusions, implications, limitations and recommendation for further research. The conclusions of the research are based on the research findings explained in the previous chapter. This chapter also discusses the

conclusions based on the research hypotheses, the research model and the research questions. The theoretical and practical implications of the research findings are described in the last section of this chapter.

1.7 Summary

This chapter has argued that the use of IT capability is significant for the Indonesian ICT industry in order to improve its environmental performance. This is because effective environmental performance improvement can assist organisations to meet environmental regulation and compliance standards, improve profitability, provide organisations with business opportunities and improve their competitive position in the marketplace. Following this, the approach and assumptions, significance of the study and expected contributions were outlined. The next chapter presents a literature review concerning the use of IT capability and environmental performance.

Chapter 2
The Indonesian information communication technology industry

2.1 Introduction

The information and communication technology (ICT) industry is one of the important industrial sectors in Indonesia. It consists of IT hardware and peripheral IT, telecommunications and internet service providers (Ministry of Industry 2014). This chapter describes an overall view of the Indonesian ICT industry. Furthermore, this chapter reviews the Indonesian ICT industry scenario, specifically the development issues and involvement of computer and communication technology.

This chapter consists of five sections. The first section is the introduction. Section 2.2 discusses the development of Indonesian telecommunication organisations. Section 2.3 provides information about IT organisations and their development in the business environment. Section 2.4 presents a discussion of internet service providers. Section 2.5 covers Indonesian government plans for the ICT industry. Section 2.6 provides a summary of this chapter.

2.2 The telecommunications organisations

Indonesia is one of the largest countries in the world, with a great potential market for the ICT industry (Ministry of Industry 2014). This can be demonstrated from geographic and business viewpoints. From the geographic perspective, Indonesia has 17,508 islands, 5400 square kilometres and a population of 237 million. This means that ICT organisations have a significant role as facilitators in providing telecommunications and internet services, IT products (e.g. software and hardware) and IT services for business operations. For example, IT infrastructure has a role linking locations or areas in order to reduce transportation and logistics costs. The use of IT infrastructure can improve organisational profitability and the

competitive position of organisations in the marketplace (Ministry of Telecommunication and Informatics 2011). As a result, the ICT industry is one of the important industries for business operations as well as Indonesia's economic growth.

The ICT industry is one of the main industries in Indonesia and the fastest growing industry in the world, and can help the Indonesian government to provide communication services as well as IT infrastructure (Ministry of Industry 2012). Based on the Ministry of Communication and Informatics of Indonesia, this industry consists of communications organisations and IT organisations. The communications organisations are a group of organisations that provide communications and internet services to connect people together. The IT organisations are a group of organisations that provide and sell IT products, including hardware, software and computer networking, to the Indonesian people and society.

From the business viewpoint, the ICT industry has made a significant contribution to the Indonesian economy at 30.41% in 2008. It can be described by (1) the number of customers of telecommunications organisations having reached more than 200 million subscribers in eight organisations; (2) the number of internet users having reached more than 45 million; and (3) the volume of ICT business (including communication and IT equipment) having reached $30 billion in 2009.

The ICT industry also has a significant role in assisting the different types of Indonesian organisations to improve their performance. For example, Wardina (2002) argues that the ICT industry can help the education sector to improve its transfer of knowledge through providing internet access and e-learning systems. The Ministry of Telecommunication and Informatics (2011) investigated the role of ICT organisations in improving the performance of local government. Their study showed that ICT organisations have a significant role in developing e-government by providing 24-hour services to the Indonesian people. Furthermore, ICT can

be used for monitoring and guiding implementation of government policies, such as public service policies that are assisted by the National Information System (SISFONAS) in order to improve public services performance. Fathoni (2010) argues that ICT organisations provide technology and information that can help to improve the quality of life in rural areas in Indonesia; this finding shows that there is a significant role for ICT organisations as a third party in facilitating e-commerce, life tools services, and training of trainers for people who live in rural areas in order to improve the quality of their lives. Based on the findings of the prior research above, ICT organisations have a significant role in helping other businesses to improve their business performance. Therefore, there is a need for the Indonesian government to develop and provide telecommunications services to all Indonesian people.

The Indonesian ICT industry was started by providing telecommunications services dominated by PT. Telekomukasi Indonesia (PT.Telkom) as one of the state government organisations in the ICT industry. The dominance of PT. Telkom in telecommunications services has existed since the independence of Indonesia. It encompasses many telecommunications services including basic wired telephone services (PSTN), internet, wireless telephone, satellite, multimedia, international telephony, etc. Furthermore, PT. Telkom also has subsidiary organisations that provide cellular communications and products (Arif & David 2010).

In 1998, the Indonesian government established a new telecommunications organisation called PT. Indosat, which was based on the Telecommunication Act No. 3/1989. Therefore, there was a deal regarding the allocation of services between both telecommunications organisations. The international telecommunications services which were previously dominated by PT Indosat then became a duoply business service between PT. Indosat and PT. Satelindo, a subsidiary organisation of PT. Indosat. Domestic telecommunications services

that were dominated by PT. Telkom were then categorised into seven areas, five operated by private telecommunication organisations that collaborated with PT. Telkom.

In 1999, Indonesia introduced a requirement for natural competition between telecommunication organisations. Therefore, the Indonesian government passed the Telecommunication Act No. 36/1999, which gives additional three points of telecommunications services, including network provision, telecommunications service provision and special telecommunications services. Based on this law scheme, national telecommunications services are operated by Telkom and international telecommunications services are operated by PT. Indosat. Private telecommunications organisations may operate non-basic telecommunications service and telecommunications services in collaboration with PT. TELKOM and PT. Indosat, based on Rule No. 8/1993.

The Telecommunication Act No. 36/1999 system is known as the ICT blueprint of 1999. Briefly, the blueprint was expected to encourage good market competition in the telecommunications business environment. Furthermore, this law facilitates private telecommunications organisations to have the opportunity to compete not only in the telecommunications business but also in business providing internet, multimedia and information products. Through the years, many regulations, laws and rule have also been created to revise and complete the whole system, in order to bring many advantages for people and society and to improve the services, quality and competitive prices.

With support by government through the Act No. 36/1999, the number of Indonesian telecommunications organisations is increasing, as can be seen from the many investments in the telecommunications sector. Table 2.1 provides the number and list of telecommunications providers based on their services. It shows that there has been an increase in the number of telecommunications organisations from 79 in 2008 to 111 providers in 2011.

Table 2.1 The number of telecommunications service providers

No.	The numbers of service providers	2008	2009	2010	2011
1	Fixed-line service providers	64	86	91	94
2	Mobile communications service providers	15	17	17	17

Source: ICT white paper (2012)

Based on Table 2.1, the dramatic increase of the number of telecommunications organisations is in the fixed-line service providers from 64 in 2008 to 94 in 2011. This number can be divided into four services including local fixed lines, closed fixed lines, long-distance connection fixed lines and international connection fixed lines. The highest increase was for closed fixed-line operators, which rose by 6.9% in 2010 after the previous year increasing by 31.8%. Local fixed-line operators increased by 4.3%. For fixed lines of long-distance connection and international connections, this has not increased since 2008.

The number of mobile communications service providers increased from 15 to 17 providers. This number is predicted to increase further based on market trends for using mobile phones in Indonesia. There are 15 telecommunications providers in Indonesia and 8 of them operate in mobile communications services. Based on Table 2.2, there has been an increase in the number of telecommunications providers in the past several years. Furthermore, PT. Telkom and PT. Indosat are still dominating by existing in three of the four communications services.

Table 2.2 The number of telecommunications organisations

No.	The numbers of service providers	Providers	Quantity
1	Fixed-line service providers	• PT. Telekomunikasi Indonesia • PT. Indosat • PT. Batam Bintan Telekomunikasi	

			3
2	Wire-line service providers	• PT. Telekomunikasi Indonesia • PT. Indosat • PT. Bakrie Telecom • PT. Mobile-8	4
2	Mobile communications service providers	• PT. Telekomunikasi Indonesia • PT. Indosat • PT. Excelkomindo • PT. Mobile-8 • PT. Sampoerna telekomunikasi Indonesia • PT. Natrindo Telepon Seluler • PT. Hutchison CP Telecommunication • PT. Smart Telecom	8

Source: Statistic data of Directorate General of Post and Telecommunication (2009)

For mobile network organisations, there has been no increase in the number of organisations since 2009, after increased significantly by 13.3% in previous years. This is because the implementation of mobile networks needs a significant investment. Furthermore, there are currently 8 telecommunication organisations of this mobile cellular network, quite a high number. With intense competition allegedly for mobile network operators, there may not be many more additions.

In their role in the Indonesian economy, telecommunications organisations make a significant contribution to GDP. According to Table 2.3, although the percentage of the development of the telecommunications sector has declines, the growth of the communication sector has been higher rather for than the other sectors.

Table 2.3 The growth of business sectors (%)

No.	**Business sectors**	**2009**	**2010**	**2011**	**2012**	**2013**
1	Agriculture	3.98%	2.97%	3.38%	4.20%	3.54%
2	Mining	4.44%	3.59%	1.68%	1.77%	1.34%
3	Manufacturing	2.16%	4.80%	6.14%	5.74%	5.56%

4	Electricity, gas and water	14.29%	5.33%	4.82%	6.13%	5.58%
5	Construction	7.07%	6.95%	6.65%	6.81%	6.57%
5	Hospitality	1.30%	8.66%	9.17%	8.21%	5.93%
6	Communications	23.61%	17.81%	12.64%	12.08%	12.02%
	a. Post and communication	23.61%	17.81%	12.73%	12.17%	12.02%
	b. Communication support services	23.61%	17.81%	12.73%	12.17%	12.02%

Source: Statistical data of Directorate General of Post and Telecommunication (2013)

From the tables above, it is very clear that the development of the telecommunications sector has been higher rather than for the other sectors. While GDP declined in 2012, the communications sector grew the most and also reached two digits in 2013 at 12.8%. To summarise, the telecommunications industry is an important industry in assisting government services and the business operations of organisations and has also made a significant contribution to the GDP.

2.3 The IT organisations

Indonesia is the largest country and population in South East Asia (ASEAN group). Indonesia demand for IT products and services was worth up to US$22.768 bn in 2012 and are forecasted to increase to US$20.44 bn in 2015 (International 2014). This is because there are some fundamental drivers including low computer penetration and growing affordability that ensure the market remains firmly in positive growth territory. Furthermore, growth in data centres and other ICT infrastructure drives the demand for IT services as well.

The growth of IT product demand also within the Indonesian government means that IT has started to be utilised to develop e-government for improving services to the society and people. For example, in 2010 the Indonesian government started to introduce e-passports, following in the footsteps of other South East Asian countries including Singapore, Malaysia and Thailand. The Law and Immigration Department plans to distribute 10,000 e-passports in

the first stage in three main cities including Jakarta, Semarang and Surabaya. Another Indonesian government initiative is e-learning. This program is aimed at education's share of local IT. It means that there is a need for IT products such as personal computers, which are used to support the Indonesian school system (International 2011).

To describe the contribution of the IT sector to the Indonesian economy, this research needs to compare it with the other sectors including agriculture, financial services etc. Data and information about the IT sector has been obtained from government institutions, the Ministry of Trade, Ministry of Telecommunication and Informatics, and Central Bureau of Statistics. Figure 2.1 shows the percentage of IT organisations in the manufacturing sector. In 2006, there were 444 IT organisations or 1.14% of the manufacturing sector. In 2007, the number of IT organisations decreased slightly, but the percentage of the total manufacturing organisations increased by 1.18%. Similarly, in 2008 there was a decline in the number of IT organisations to 409 organisations, but the percentage increased to 1.20%. In 2009, the number of IT organisations increased to 415 or 1.26% of the total manufacturing organisations (Ministry of Telecommunication and Informatics 2011).

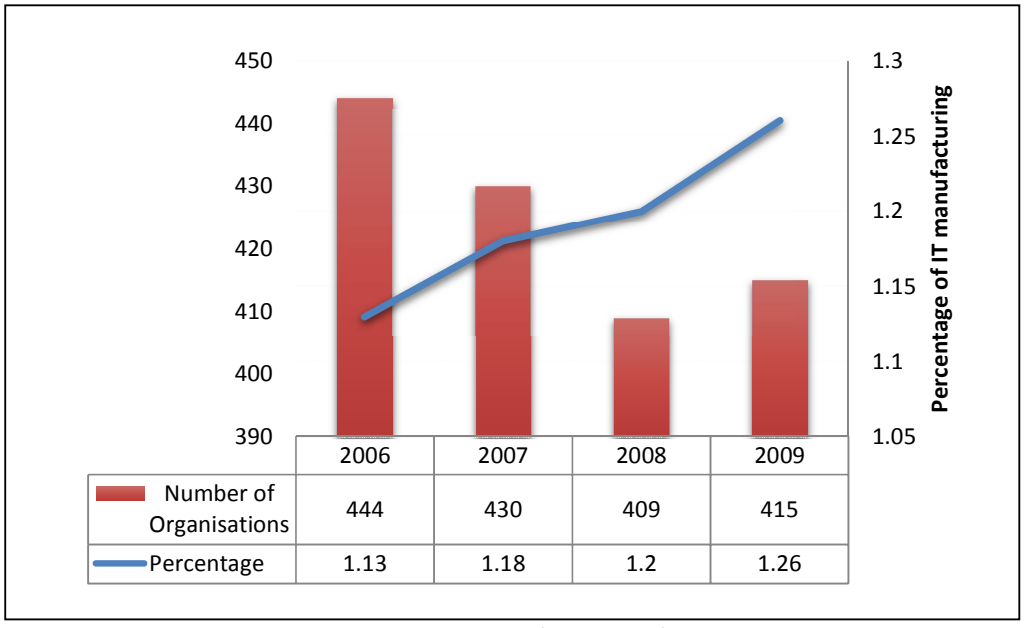


Figure 2.1 The proportions of IT manufacturing sector

2.4 Internet service providers

Internet service providers (ISP) are organisations that provide services for persons and businesses in accessing, using and participating in the internet. These services include internet access, internet transit, domain name registration, web hosting and collocation. Internet access is defined as the connection of personal computers, mobile devices and computer networks to the internet, enabling users to access internet services including email and the World Wide Web through various technologies that offer a wide range of data signalling rates (speed). Internet transit is the service of allowing networks to cross or 'transit' a computer network, usually to connect a smaller ISP to the larger internet. A domain name is an identification string that defines a realm and administrative autonomy, authority or control on the internet. It is formed by the rules and procedures of the domain name system. A collocation centre is a type of data centre where equipment, space and bandwidth are available for rental to retail customers. This service provides space, power, cooling and physical security for the server, storage and network equipment of other organisations, and connects them to a variety of telecommunications and network ISPs with the minimum of cost and complexity. Therefore, ISPs play a significant role in connecting organisations to the world.

In Indonesia, the internet was developed in mid-1990 by academics and scientists who were interested in computer technology and radio. They conducted experiments and research in university and government institutes related to telecommunication technology, especially computers and network. Therefore, the internet exists as part of process learning that aims to share data and information effectively and efficiently.

To provide the internet to the people and society, the Indonesian government through the Directorate General of Post and Telecommunication released a permit to IndoNet, the first

ISP in Indonesia. The dial-up technique was used by IndoNet to connect to the internet through the telephone line. Based on a report released by Directorate General of Post and Telecommunication, there are now 146 licenced ISPs. These ISPs help organisations to interact and communicate with their stakeholders for providing training to employees, e-recruitment, customer services, internet banking, e-procurement, news, government information, video conferencing, VOIP, and accessing social media and email.

Table 2.4 below shows the number of ISPs in Indonesia. Based on the Directorate General of Informatic Applications, there are 101 ISPs or 69.18% located in Jakarta. Yogyakarta and Bali are in second place with 8 ISPs or 5.48% respectively. With 4.79% or 7 ISPs, Bandung is positioned in fourth place followed by Surabaya with 2.74% of the total ISPs in Indonesia. Palembang and Tangerang are placed in positions six and seven with 3 ISPs or 2.05% of the total.

Table 2.4 The number of ISPs in Indonesia

No.	**City**	**Number**	**Percentage**
1	Jakarta	101	69.18
2	Yogyakarta	8	5.48
3	Bali	8	5.48
4	Bandung	7	4.79
5	Surabaya	4	2.74
6	Palembang	3	2.05
7	Tangerang	3	2.05
8	Malang	2	1.37
9	Solo	2	1.37
10	Balikpapan	1	0.68
11	Bekasi	1	0.68
12	Makasar	1	0.68
13	Medan	1	0.68
14	Padang	1	0.68
15	Pontianak	1	0.68
16	Riau	1	0.68
17	Semarang	1	0.68
	Total	146	100%

In positions eight and nine, there are Malang and Solo with 2 ISPs or 1.37%. The rest of the cities have one ISP, namely Balikpapan, Bekasi, Makassar, Medan, Padang, Pontianak, Riau and Semarang.

According to Table 2.4, most ISPs, nearly 70%, have invested their business in Jakarta. This is because Jakarta is not only the capital city of Indonesia but also has a better infrastructure for internet networks. Furthermore, based on research conducted by the Indonesia Internet Service Providers Association (APJII) in Indonesia in 2012, Jakarta is a significant market for ISPs with penetration of internet users of 3.5 million users from 9.5 million people or 36.9% (APJII 2013). Meanwhile, in Sumatra, internet user penetration averages only 25.53% from nine main cities. In Borneo and Sulawesi, the penetration averages 20.06% and 26% respectively. Furthermore, Ternate and Sorong are the cities with the fewest internet users due to their inadequate infrastructure and inappropriate internet networks. Therefore, Jakarta with an adequate internet infrastructure network, people with large incomes and technology lifestyle trend, is the city with the largest number of internet users in Indonesia.

Based on Arif and David (2010), in Indonesia there are three techniques for people or organisations to connect to the internet: (1) narrowband; (2) fixed broadband; and (3) mobile broadband. Narrowband is described as an internet connection with low bandwidth, such as a dial-up connection. Fixed broadband is the internet network that utilises digital subscriber lines technology, fibre to the home, fibreoptic, leased lines, satellites, Wireless Area Networks and Wimax technology, which has high speed bandwidth in transferring data. Mobile broadband is the internet network that uses mobile technologies including code division multiple access, high-speed download access and evolution-data optimised.

Based on the Ministry of Telecommunication and Informatics (2011), most organisations in Indonesia have adopt fixed broadband as their internet connection for business activities. This

shows that internet connection in Indonesia has improved to support business operations. Almost 97% of these are the organisations that have revenue of more than US$100,000. The second group of organisations that use the internet for business operations is those that have revenue from US$50,000 to US$100,000. The last group is the organisations that have revenue under US$50,000 with 7.06% of the total organisations in Indonesia. Therefore, this clearly indicates that organisations with the highest revenue are commonly associated with a large base of internet users.

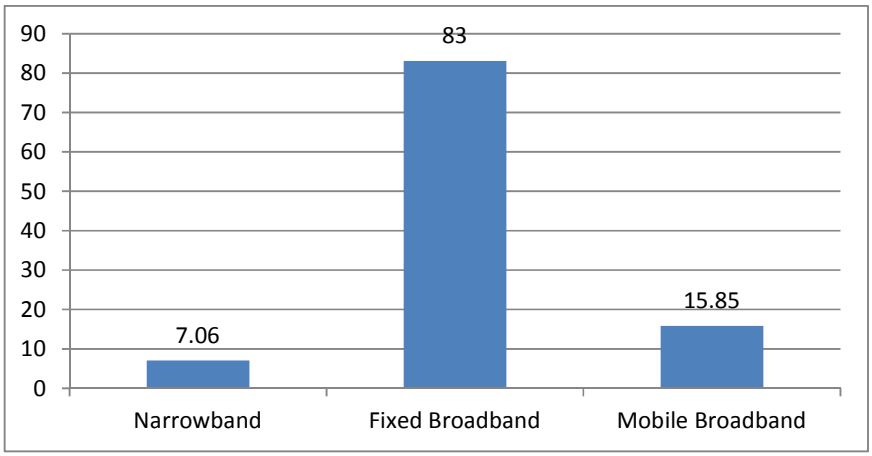


Figure 2. 2 The adopted internet connection in Indonesia

2.5 Indonesian government plans for the ICT industry

Raising the important role of the ICT industry, the Indonesian government through the Ministry of Communication and Information Technology has formulated many policies and comprehensive strategic moves, as well as a concrete action development plan to support the ICT industry in all areas of operation. The government of Indonesia is continuously strengthening enabling infrastructure to promote the development of the high-performing ICT industry through acculturation of a pro-business climate, as well as the provision of a wide array of incentives. The following subsections discuss the main strategies and policies of the Indonesian government to improve the development of the ICT industry.

2.5.1 Regional IT centres of excellence

Regional IT centres of excellence (RICE) are one of the main programs of the Ministry of Industry of Indonesia to support the development of the ICT industry. The objective of this program is to create new employment opportunities in the ICT industry. The RICE are expected to help small medium enterprises (SMEs) by providing legal software, including accounting software applications, marketing software applications and applications for product design. In addition, the RICE may help students in developing entrepreneurship ability through IT training and workshops, in collaboration with SMEs to improve their competitive position in the marketplace. The Indonesian ICT industry is also supported by the Indonesian government through its Ministry of Industry in collaboration with universities and government-owned organisations through training, seminars and workshops, exhibitions and supervised IT development.

Figure 2. 3 The distribution of RICE

To accelerate the development of the ICT industry, there are 14 RICE located in four main islands in Indonesia. Most RICE in Java are distributed in ten cities including Jakarta, Bogor,

Bandung, Cimahi, Surabaya, Denpasar, Depok, Salatiga, Solo and Kudus. There is only one in each of Sumatra, Borneo and Sulawesi.

2.5.2 Roadmap for the ICT industry

In the road map of the Ministry of Industry, there is a comprehensive blueprint prepared to develop clusters of IT industry in Indonesia. The blueprint was announced on November 2009 and covers the period from 2009 to 2014. In the road map, the ICT industry in Indonesia is supported through several activities: (1) improving the ability of human resources in knowledge of IT and then enhancing their competitive position in the marketplace; and (2) enhancing the competitive capabilities of local ICT organisations supported by competent human resources. Furthermore, the Indonesian government through the Ministry of Industry: (1) encourages ICT organisations to collaborate with international ICT organisations in order to improve their products in the market environment; (2) builds IT and telecommunications design centres in Indonesia; (3) encourages the establishment of animation centres in Indonesia; (4) facilitates the building of ICT clusters in several cities; (5) builds ICT laboratories to test local IT and telecommunications products; and (6) builds ICT techno parks to support the development of ICT products. For example, Bandung Digital Valley (BDV) launched in January 2012 and is used as a new IT facility. This IT hub is sponsored by PT. Telkom to encourage the developing of applications and content. PT. Telkom has committed IDR50 bn over the next three years to this project, which is hoped to motivate the digital creative industry by uniting developers and tech entrepreneurs. The purpose of this project is to create 600 SaaS-type cloud computing applications and 5000 application stores.

2.5.3 Green ICT

The Indonesian government has considered the environmental issues caused by industries including the ICT industry. This is because the industry produces CO_2 emissions that can

affect the natural environment. Therefore, the Indonesian government has implemented 'green ICT' which makes ICT organisations pay attention to environmental issues.

Green ICT is a movement that requires the ICT industry to reduce the impact of its business processes on the natural environment. This program has goals to help ICT organisations to conduct their business in ways that are environmentally friendly, as well as producing ICT products that are environmentally friendly and support resource conservation and the environment. Thus, the green ICT action program is expected to build a community of ICT users with little environmental impact (a low-environmental footprint society). With this concept of green ICT, the use of innovative and efficient ICT is predicted to reduce approximately 20% of CO_2 emissions from other industries. Indonesia as a country with ICT user trends which continue to rise sharply is very concerned about this issue. The Indonesian government managed to incorporate two important agenda items for a meeting of the ICT ministers of the ASEAN countries (ASEAN TELMIN), one of which is a strategic policy for ASEAN to promote green ICT.

2.5.4 De TIKNas

DeTIKNas or the National Technology Council is the coordinating agency established and chaired by the President of the Republic of Indonesia through the Decree of the President of the Republic of Indonesia No. 20/2006. Based on the white paper IT Indonesia, DeTIKNas was established to accelerate the growth of ICT in Indonesia efficiently by creating a national ICT policy through synchronisation of ICT programs across ministries and agencies. DeTIKNas involvement in this activity is open to central government, local and state-owned enterprises and regional enterprises, world business, professional institutions and community ICT, as well as the community at large, in order to develop ICT continuously every year.

Based on the Presidential Decree, in 2006, DeTIKNas implemented programs taken one from each component of the ICT blueprint. This does not mean that the other programs are not to be conducted, but the flagship programs will be the foundation for the other programs for the development of ICT and then the programs will be more focused and efficient.

Although DeTIKNas has had a number of flagship programs (priority programs: the National Single Window, e-Education, Palapa Ring, Legal Software, e-Procurement, e-Budget, Single Identity Number, e-Health, e-Cultural Heritage and e-Agriculture), during 2010 there was a lot of attention on DeTIKNas activities that involved socialisation, which is among the national ICT strategies in South Kalimantan, Riau and North Sumatra. The benefits are aimed at disseminating understanding of the national ICT strategy. In addition, it is expected to encourage the dissemination of ICT strategies that can be developed in order to realise better governance of information and communication for the good of society and the progress of governance.

2.6 Summary

This chapter has sought to review the importance of the Indonesian ICT industry. This review has revealed that the Indonesian government has implemented several polices and strategies in order to help ICT organisations to elevate their products and compete in the marketplace. ICT industrial development has been growing tremendously and in fact is one of the main industries that have contributed greatly to the economy of Indonesia. The importance of this study has been further described in this chapter. An overview of the local or domestic telecommunications, IT organisations and ISPs involved in the ICT industry has also been highlighted in this chapter. This discussion leads to Chapter 3 on the critical factors of IT capabilities and environmental performance that underpin this study.

Chapter 3
Literature review

3.1 Introduction

The focus of the current research is on investigating the relationship between IT capabilities and environmental performance in the Indonesian ICT industry. As such, the measurement and determining factors of the IT capabilities construct need to be well understood. Hence, the purpose of this chapter is to review the IT capability, theoretical background and environmental performance literature that aims to identify the concepts, dimensions, perspectives and determinants which can be used for improving environmental performance in organisations.

The chapter is organised into five sections. Section 3.2 presents a review of the various perspectives on the sources and determinants of IT capability in the literature, namely IT infrastructure quality, IT human resource competence, business process digitisation and environmental competence of organisations. Section 3.3 discusses the environmental performance of IT. The last section provides a summary of this chapter.

3.2 IT capabilities

Nowadays, IT is the main component of organisations in their business operations and also organisational investment. Furthermore, in business processes, the IT is placed among the top concerns of overall business management. Therefore, organisations spend a considerable amount of money and time to build their capabilities to create business processes effectively and efficiently.

IT has the capability to make a business sustainable (Adela, Marie-Claude & Richard 2008; Huang 2009; Pappis 2011). It plays an important role in monitoring, evaluating, improving and communicating the environmental performance of an organisation, including providing

information baselines on inputs (energy, water, materials, etc.) and outputs (waste, emissions, etc.) in the organisation (Adela, Marie-Claude & Richard 2008). There are various IT solutions that can be used for improving the environmental performance of an organisation. Video conferencing and web services, for example, can be used for reducing travelling costs and energy usage (Huang 2009). It is therefore unsurprising that many organisations have begun to develop specific strategies and policies for effectively using IT to improve their environmental performance. This leads to the development of specific IT capabilities in organisations for the pursuit of better environment performance.

IT capability as the ability of an organisation has been discussed from various approaches and viewpoints including business operations, management activities, service activities and organisation resources. For example, Bharadwaj (2000) identifies IT capability as the ability of an organisation to effectively and efficiently use IT resources to improve organisational performance. It is classified into tangible resources, including IT infrastructure and IT human resources, and intangible resources, including customer orientation, knowledge assets and synergy.

Tippins and Sohi (2003) examine the relationship between IT capability and organisational performance. In this study, IT capability is divided into three components: IT object; IT knowledge; and IT operation. IT knowledge is the knowledge that is possessed by an organisation to manage their IT resources. IT operation is conceptualised as the ability to manage the market and customer information. The IT object is defined as the IT infrastructure, including hardware, software and IT personnel, which helps organisations to distribute information around the entire organisation.

Yoon (2011) investigates the instrumentality of IT capability in assisting organisations with efficient management activities and task performance. This study shows that IT capability can

be classified into four components based on a literature review and expert review: IT strategy; IT knowledge; IT operation; and IT infrastructure. IT infrastructure refers to IT resources including hardware, software, networks and IT personnel. IT knowledge represents the technical knowledge that an organisation should maintain, such as information technology, IT patents, IT solutions and applications. IT operation is the ability of an organisation in applying IT solutions, while IT strategy is defined as organisation IT policy including information vision, information strategy plan and information implementation plan.

Melville, Kraemer and Gurbaxani (2004) investigate the role of IT capability in improving organisational performance, such as productivity enhancement, profitability improvement, cost reduction and competitive advantage. In this study, IT capability is classified based on business processes and the role of IT capability in business activities. This research develops a conceptual framework that posits IT resources including IT infrastructure and IT human resources and complementary organisational resources including policies and rules, organisational structure, workplace practice, culture, etc. Those resources can create valuable business processes that improve business process performance and organisational performance including productivity, efficiency, profitability and competitive advantage.

Mulligan (2002) reviews the previous studies that have investigated the role of IT capability in improving organisational performance. This study focuses on to identify the critical factors of IT capability and its relationship with business activities. The study shows that IT capability enables organisational performance through integration, system scope, system focus and accessibility.

Table 3.1 summarises the discussion above. In this research, IT capability is defined as the ability of an organisation to use their IT resources for improving their performance. This means that IT capability is considered a key resource in an organisation that is used for

transferring and deploying in business activities through combining those resources. It is determined by IT infrastructure quality, the competence of IT human resources, business process digitisation and environmental IT competence, as shown in Table 3.1.

Table 3.1 Summary of IT capabilities

References	IT capabilities			
	IT infrastructure	**IT human resources**	**Environmental IT competence**	**Business process digitisation**
Adela et al. (2008)	**X**			
Benitez-Amado et al. (2010)	**X**	**X**		
Benitez-Amando & Walczurh (2012)	**X**	**X**		**X**
Cooper & Molla (2012)		**X**		
Daly & Butler (2009)	**X**			
Dao et al. (2011)	**X**	**X**		
Ijab et al. (2010)	**X**			
Maruster, Faber & Peters (2008)		**X**		
Loos et al. (2011)	**X**			
Mann et al. (2009)	**X**			
Melville (2010)	**X**			
Molla (2008)	**X**			**X**
Molla et al (2008)	**X**			**X**
Molla et al. (2009)	**X**	**X**		**X**
Molla et al. (2012)	**X**	**X**	**X**	**X**
Molla & Abareshi (2012)	**X**			
Onetti et al. (2011)	**X**	**X**		**X**
Sayeed & Gill (2011)	**X**			
Toffel & Horvath (2004)	**X**			
Watson et al. (2008)	**X**			

Watson et al. (2010)	**X**			

3.2.1 IT infrastructure quality

IT infrastructure quality is about the foundation of IT resources that can be used for sharing capabilities and services in order to support business operations in organisations. Furthermore, Duncan (1995) states that IT infrastructure quality is a resource planning and management capability that may affect the design and capabilities of infrastructure in organisations. Similarly, Broadbent, M., Weill and Neo (1999) and Broadbent, Marianne and Weill (1997) define IT infrastructure quality as a significant component of organisations for meeting market change, redesigning business processes and extending international or geographically dispersed operations. Therefore, IT infrastructure quality is an essential competence or capability of organisations used to meet market needs and achieve business objectives.

The concept of IT infrastructure quality can be determined from many perspectives. Duncan (1995) posits a flexibility approach to the use of IT infrastructure in organisations, which is associated with the alignment of IT and business objectives, business design and IT plans, and the skill of IT human resources. Liu (2002) further supports the notion that IT infrastructure is a service ability of organisations used to enhance the efficiency and effectiveness of business operations. Harmon and Auseklis (2009) utilise the "green computing" approach to integrate power management, virtualisation, recycling, electric waste disposal and optimisation of IT infrastructure, in order to decrease the impact of business operations on the environment. Similarly, Molla, Cooper and Pittayachawan (2009) involve "green capabilities" to encompass the IT and communication resources of an organisation, along with the shared services and business applications.

In this study, the greenness capability refers to the ability of IT infrastructure to be used for reducing the impact of business operations on the natural environment. It is used to help

organisations to support environmental competence and business process digitisation in order to improve environmental performance. Molla (2008) states that the greenness capabilities of IT can help organisations to reduce the effects of pollution and take responsibility for their actions through several perspectives including: (1) a sourcing perspective, such as adoption of a product environmental assessment tool, development of a clear policy statement of environmental IT purchasing and evaluation of the green track record of software and IT service providers; (2) an operation perspective, namely upgrading to energy-efficient servers, retiring old systems and designing energy-efficient systems; (3) a service perspective, including adoption of desktop virtualisation and implementation of policies for PC management; and (4) an end of IT life management perspective, which refers to practices in reusing, recycling and disposing of IT hardware.

Adela, Marie-Claude and Richard (2008) explore the relationship between the use of IT infrastructure, including IS, and ecological sustainability to achieve environmentally friendly business operations. The finding shows that organisations can meet government regulations and international requirements and achieve eco-efficiency, eco-equity and eco-effectiveness through automating, informing and transforming organisations.

Sayeed and Gill (2008) explore the relationship between environmental sustainability and the use of IT in business operations. Their framework was developed based on interviews with seven ‘green IT’ experts and evangelists. It is supported by a questionnaire completed by CIOs. The research shows that the purpose of business processes is to engender environmentally sustainable consequences in the conduct of information activities in an organisation. For example: a data centre is relevant to improving environmental performance. Furthermore, the study indicates that resources like virtual servers, and the technical skills of IT human resources reduce capital and operating costs.

Ijab et al. (2010) highlight the importance of IS for greening organizations' business practices. The study presents a conceptual framework used to help organisations in reducing the impact of their business activities. The framework was developed by identifying the indicators of greenness based on a green IS lifecycle framework and prior literature. It consists of the spirit of IS, the practice of IS and the impact of IS. The spirit of IS is about the IS processes designed and developed to be environmentally friendly as a guide for users to improve environmental performance in organisations. The practice of IS is described as the faithful and unfaithful appropriations of a given IS. For example, the adoption of video conferencing and environmental management systems is utilised for reducing operational costs in organisations. The impact of IS is described as the untended and unintended outcomes of an IS showing how greenness appears in the post-use stage. For example, the implementation of email, e-commerce and virtualisation technology can help organisations to promote the environmental behaviour of employees in business operations.

Molla, Cooper and Pittayachawan (2009) develop and test a green IT framework model to understand the relationship between IT infrastructure and environmental competence in business activities. The study shows that there are many main dimensions, namely, IT attitude, IT policy, IT practice, IT technology and IT governance, which can be used to address eco-sustainability issues in business processes. IT attitude is concerned with energy efficiency in managing the IT infrastructure of business processes. IT policy is about procedures that guide the use of IT infrastructure in reducing the impact of business processes on the environment. IT technology consists of IT technical infrastructure, data centre air-flow management, data centre cooling systems and power-delivery systems concerned with technological solutions for reducing emissions and e-waste. IT governance concerns top management support and the initiatives and responsibilities of organisations in improving their environmental performance.

From the literature discussed above, the greenness capabilities of IT infrastructure quality can be considered to help organisations to support their business process digitisation and to develop their environmental IT competence. Although the constructs of IT infrastructure quality can be traced back to information systems, business processes and innovation literature, it has become very popular in the green IT and environmental performance literature. Therefore, this study promotes the constructs of IT infrastructure quality that have greenness capabilities in order to examine the relationship between IT infrastructure quality and business process digitisation and environmental IT competence in organisations. The constructs of IT infrastructure quality consist of the adoption of server virtualisation, database virtualisation and desktop virtualisation, implementation of cloud computing, implementation of radio frequency identification (RFID), modularisation of information systems, and standardisation of information systems and reports. Furthermore, these constructs of IT infrastructure quality can give many advantages to organisations in developing business process digitisation and environmental IT competence. Therefore, it is important that the current research investigates the IT infrastructure quality associated with business process digitisation and environmental IT competence.

3.2.2 IT human resources competence

Besides IT infrastructure quality, an organisation needs competent IT human resources in order to build and develop business process digitisation and environmental IT competence. IT human resources competence is defined as an organisation's ability to use its valued human resources to integrate IT and business planning processes more effectively, to consider and develop reliable and cost-effective applications, to communicate and work with business units more efficiently, and to anticipate future business needs by innovating valuable new products (Bharadwaj 2000). Similarity, Powell and Dent-Micallef (1997) state that IT human resources competence is needed to provide system information that can make planning more effective,

creating a symbiotic IT–planning relationship. Therefore, IT human resources competence is an essential component of IT capability and has a significant role in business processes.

IT human resources competence has been studied by researchers from different perspectives including managerial capacity and technical capacity. In terms of technical capacity, Bharadwaj (2000) defines the technical capacity of IT human resources as the ability of IT personnel to link between IT resources and business processes more effectively and efficiently through developing effective applications. Furthermore, Benitez-Amado, Perez-Arostegui and Tamayo-Torres (2010) argue that the technical competence of IT human resources refers to the IT staff associated with the use, exploitation, and leveraging of IT skills including database design, development of applications software in order to achieve efficiency in communications service and knowledge of different programming languages. Thus, the technical competence of IT human resources has a significant role in building and developing the processes of business more effectively and efficiently through IT skills.

There is much research investigating the critical factors of IT human resources used to help organisations to develop their business processes and environmental IT competence. Duncan (1995), for example, explores the role of the technical skills of IT human resources as a critical component of IT infrastructure in organisations, used for improving competitive position in the marketplace. This study provides a framework based on IT executives' perspectives. The findings show that IT infrastructure is dependent on the technical skills of IT staff including programming and mainframe maintenance skills. Thus, the technical skill is an essential factors used for aligning business plans, organisation goals and business operations.

Benitez-Amado et al. (2010) examine the relationship between IT human resources and environmental performance in an organisation. The resource-based theory is adopted for

investigating how IT human resources are utilised for improving the performance of an organisation. The study shows that IT human resources can support the business processes of an organization by the use of technical skills including database design, development of applications software and programming languages. However, the role of IT human resources in improving organisational performance has not been discussed comprehensively in this study. In particular, the role of IT human resources in supporting the organisation's environmental vision and strategy has not been discussed.

Dao, Langella and Carbo (2011) examine the role of IT human resources in improving organisational environmental performance. The triple-bottom-line approach is used for identifying the role of IT human resources in developing organisational capability for adequately addressing environmental issues. The resource-based theory is used for better understanding of how an organisation can develop its IT capability to improve its environmental performance. The study shows that integration of IT human resources, business operations and IT resources can develop the environmental capability of an organisation through automating information processing. However, this study does not explore some potential environmental issues, including the role of IT human resources in supporting an organisation's environmental strategy and policy and in developing ecological initiatives to improve environmental performance.

Table 3.2 Previous studies on technical competence of IT human resources

No.	Authors	Descriptions
1	Duncan (1995); Bharadwaj (2000).	There are three factors of technical skills: programming languages, system analysis and design, and competence in emerging technologies.
2	Benitez-Amado, Perez-Arostegui and Tamayo-Torres (2010)	Database design, development of applications software and programming languages are important in technical competence of IT human resources.

3	Broadbent, Marianne and Weill (1997); Broadbent, M., Weill and Neo (1999)	There are three technical competences of IT human resources: computer network system, data communication and data management.
4	Byrd and Turner (2000)	The technical competence of IT human resources is importance in IT infrastructure flexibility, namely, programming language, database, mainframe computer, operating system, network management, data warehouse and web-based applications.
5	Molla, Cooper and Pittayachawan (2009); Sayeed and Gill (2008)	Competence in server virtualisation, desktop virtualisation.

Based on existing and previous studies over the years from different perspectives, it is revealed that four constructs are of major importance to the technical competence of IT human resources: computer network system; server virtualisation; desktop virtualisation; and emerging technologies. This is because those constructs generally exist in business process digitisation and environmental IT competence. For example, virtualisation technologies including server virtualisations and desktop virtualisations can benefit organisations by improving their business operations effectively and efficiently and also developing environmental competence to compete in the business environment. Those constructs may lead to improving the environmental performance of organisations.

The technical capability of IT human resources is necessary but insufficient. This is because the IT infrastructure in organisations also depends on IT human resources who have managerial competence. With this capacity, IT human resources can build a bridge between IT and business strategies through allocating appropriate IT resources for improving business processes more effectively and efficiently (Speshock 2010). Furthermore, the managerial capacity of IT human resources can coordinate various activities with the successful implementation of specific IT applications (Bharadwaj 2000). In addition, the managerial

skill of IT human resources can support the business process of an organisation by managing and redesigning environmentally sustainable business operations for reducing the consumption of materials and energy in the organisation. Therefore, it is important to investigate whether the managerial competence of IT human resources in organisations has a positive or negative effect on business process digitisation and environmental IT competence.

To find out whether the managerial competence of IT human resources has a positive or negative impact on business process digitisation and environmental IT competence, this current study identifies the critical factors from previous studies. Powell and Dent-Micallef (1997) explore the relationship among IT human resources, business operations and technology resources in retail organisations. This study uses resource-based view theory to identify the critical capabilities of IT infrastructure including the managerial skills of IT human resources. The findings show that managerial skills including IT strategic competence have a significant impact on business operations. Therefore, organisation resources can be driven by this competence to communicate among business units of organisations.

Fink and Neumann (2007) investigate the role of IT human resources associated with IT infrastructure to achieve organisational agility. This study provides a framework that consists of the technical and managerial capabilities of IT human resources, IT infrastructure capabilities and IT-dependent organisational agility. The findings show that the managerial competence of IT human resources is required in order to provide extensive infrastructure capabilities. This is because managerial behaviour is valuable and allows organisations to establish better partnerships with business clients based on their effective interpersonal communication skills and also to provide IT capabilities that best serve business objectives based on their understanding of the business environment.

Molla, Cooper and Pittayachawan (2009) investigate the relationship between IT and eco-sustainability in order to improve the environmental performance of organisations. Furthermore, the authors provide a framework of green IT readiness that identifies the primary dimensions and they develop a reliable and valid instrument to address sustainability concerns. The findings show that there is a role for IT human resources especially in managerial skills, to ensure sustainable operation of each layer of IT infrastructure to reduce IT, business process and supply-chain related emissions and waste and to improve energy efficiency to meet government regulations. Therefore, the study advises that organisations consider knowledge of government regulations, management system standards and standardisation of IT equipment in their business operations.

Table 3.3 Previous studies on managerial competence of IT human resources

No.	Authors	Descriptions
1	Colbert and Kurucz (2007); Shirley, Dennis and Nigel (2007); Duncan (1995); Bharadwaj (2000)	IT staff have the knowledge of organisational plans and policies, alignment of business strategies and IT.
2	Broadbent, Marianne and Weill (1997); Broadbent, M., Weill and Neo (1999)	Managerial capacity of IT human resources is purposed to build a bridge between IT components and IT services. It consists of skills around business strategies and plans
3	Jabbour and Santos (2008); Byrd and Turner (2000); Fink and Neumann (2007)	The managerial competence of IT human resources include interpersonal communication skills and understanding of the business environment.
4	Molla, Cooper and Pittayachawan (2009); Molla et al. (2011)	Knowledge of government regulations, management system standards and standardisation of IT equipment in business operations.
5	Antoni and Jie (2013); Antoni and Jie (2012)	Critical factors of managerial competence of IT human resources: government environmental regulations, redesigning environmentally sustainable business operations.

Table 3.3 shows a summary of previous studies investigating the role of the managerial capacity of IT human resources from different perspectives. From the literature discussed above and the table, the managerial competence of IT human resources is considered to help organisations to support their business process digitisation and to develop their environmental IT competence of IT. Therefore, this study considers that the constructs of managerial competence should be used to examine IT human resources and business process digitisation and environmental IT competence in organisations. The constructs of managerial competence of IT human resources consist of knowledge of organisational plans and policies and the business environment, alignment of IT and business strategies, management system standards, government regulations and standardisation of IT equipment. Therefore, those constructs are important to be investigated in the current research when considering the IT human resources associated with business process digitisation and environmental IT competence.

3.2.3 Environmental competence of organisations

Environmental issues are now influencing businesses' competitive landscapes in new ways. Organisations with the IT and vision to provide products and services that address environmental issues will achieve a competitive edge. One reason is that when making decisions about purchasing, leasing or outsourcing, many customers now take into account the environmental initiatives of the provider of products or services (Murugesan, San 2008). Therefore, organisations need to consider using IT to develop and improve their environmental competence.

To develop their environmental IT competence, organisations have to consider their ecological competence in business operations to improve environmental performance. This is because environmental IT competence is being used as a new source of strategic advantage,

value differentiation and intangible brand value (Molla et al. 2012; Porter 2006). Furthermore, this competence can facilitate organisations in meeting government laws and regulations (Adela, Marie-Claude & Richard 2008) and international environmental requirements (Zhu, Q., Sarkis & Lai 2007). Therefore, environmental IT competence has emerged as an important new archetype for organisations to achieve profits and market share objectives by lowering their environmental risks and impacts while improving their environmental performance (Remko 1999; Zhu, Q., Sarkis & Lai 2007).

Numerous studies have attempted to explain environmental IT competence in order to improve the environmental performance of an organisation. For example, Hart (1995) investigates the environmental competence of an organisation based on RBV theory, which can be accomplished through pollution prevention, resources stewardship and sustainability vision. Pollution prevention focuses on the control and prevention of pollution emissions and effluents during business activities. Resources stewardship refers to an organisation's ability to evaluate the environmental impacts of its resources and main business activities. Sustainability vision aims to change human behaviour to more sustainable options (Hart 1995; Hart & Milstein 2003).

Molla et al. (2012) provide an ecological IT competence model drawn from Hart's (1995) environmental competence and previous studies of green IS and green IT. The study identifies three components of environmental competence that can be enhanced by IT. The first environmental IT competence is emission management, defined as the ability of an organisation to manage its emissions in business operations through implementing its environmental vision, goals and policies. Resource stewardship as the second competence refers to the ability of an organisation to re-use IT resources to improve its efficiency in business operations. The last competence is sustainability behaviour, which refers to building

behavioural values that encourage the employees of an organisation to consider environmental issues in their business operations.

A recent study by Antoni and Jie (2013) involves the IT capabilities used for developing the environmental competence of organisations. This study develops an ecological competence model based on previous studies of green IT and environmental performance. The most interesting findings show that organisations are enabled to develop their environmental competence through the use of IT capabilities to delivery sustainable value to relevant stakeholders and improve environmental performance. For example, the adoption of IT equipment made from hazardous materials can help organisations to meet government regulations in order to improve their environmental performance, including environmental reputation.

Based on the studies above, this current study attempts to classify environmental IT competence into three competences including emission management, IT resources stewardship and sustainability behaviour. In the following sub-sections, each environmental IT competence will be discussed.

3.2.3.1 Emission management

Emission management is the ability of an organisation to manage the emissions of harmful substances during business operations. Organisations can use IT to manage emissions effectively by having policies and procedures for deploying their IT resources to meet this goal (Molla, Cooper & Pittayachawan 2009). Good emission management includes environmentally friendly procedures for purchasing IT equipment to comply with government regulations and international standards (Adela, Marie-Claude & Richard 2008; Zhu, Qinghua, Sarkis & Geng 2005). Similarly, reusable IT equipment procedures assist an organisation to reuse IT equipment in order to improve business operation efficiency, as well as to reduce

environmental impacts. IT equipment disposal policies, based on government regulations, are essential for reducing environmental damage when disposing of IT hardware (Molla, Cooper & Pittayachawan 2009). In these ways, emission management is directed by organisational goals and policies so that environmental performance is improved.

3.2.3.2 IT resource stewardship

One capability that can be used to enhance organisational environmental performance is resource stewardship, which refers to the ability of an organisation to re-use IT resources to improve the efficiency of its business operations (Loos et al. 2011) and to reduce the effects of business operations on the natural environment. To achieve this aim, IT equipment can be made from non-hazardous materials as stipulated in management system standards and government regulations. IT resource stewardship also complies with international regulations such as the European Union's Waste Electrical and Electronic Equipment Directive (Adela, Marie-Claude & Richard 2008). This regulation involves low energy consumption, effective energy management and the ability of IT equipment to be used more than once. Additionally, IT manufacturers provide product information that describes how to recycle their IT products. The environmental performance of an organisation can be improved by using IT resources that are made with these environmentally friendly practices.

3.2.3.3 Sustainability behaviour

The next ecological IT competence is sustainability behaviour. This refers to building behavioural values that encourage employees to consider environmental issues in their business operations. The use of IS functions can help organisations to develop sustainability in order to enhance environmental performance, because IS functions can deliver information that relates to environmentally friendly work practices (Adela, Marie-Claude & Richard 2008). In addition, York et al. (2009) argue that the use of IS functions can help an organisation to promote the choice of environmentally sustainable courses of action by their

employees. Molla, Cooper and Pittayachawan (2009) argue that eBay uses its market portal and other Web 2.0 technology to empower its internal green team, which helps concerned buyers to evaluate and select 'green' merchants. From this perspective, it has been shown that the sustainability behaviour of an organisation can be developed by using IT resources, including IS functions, to reduce the impact of business operations on the environment.

3.2.4 Business process digitisation

There has been a dramatic increase in the scope of business-related activities that are conducted through digitised business processes in organisations. Business process digitisation is a form of electronic communication that allows trading partners in two or more organisations to exchange business transaction data in structured formats that can be processed by computer applications software (Senn 1992). Likewise, BarNir, Gallaugher and Auger (2003) argue that business process digitisation denotes the transition from conducting business activities in a traditional manner to conducting them in a digital system. In addition, for Molla et al. (2012) business process digitisation refers to the extent to which an organisation executes electronically both its internal and external business operations. Therefore, business process digitisation has a significant impact on organisations in communicating and interacting with internal and external organisations.

Recent development in business process digitisation has heightened the need for improving environmental performance, including reducing an organisation's emissions and energy consumption in the natural environment (Hilty et al. 2006). Similarly, Loos et al. (2011) highlight the role of business process digitisation and specifically its contributions. The management of these processes can play an important role in leveraging the transformative power of IS in order to create an environmentally sustainable society. Adela, Marie-Claude and Richard (2008) state that the improvement of environmental performance can be achieved in organisations through use of IS and IT in their business operations. For example, the use of

electronic media in business operations can reduce paper consumption. Therefore, organisations with business process digitisation can make extensive and intensive use of IT for communications and business transactions in business processes to improve environmental performance (Molla et al. 2012).

There is much research investigating the role of business process digitisation for improving environmental performance. For example, Loos et al. (2011) investigate the relationship between “green IT” and “green business processes” to enhance the environmental performance of an organisation. The study considers the four approaches to business process digitisation that can be used to improve environmental performance. The first component is a design process that is used to accommodate sustainability concepts associated with carbon emissions or the energy consumption of business activities. The second is process measurement regarding organisation needs in order to embed sustainability goals at all levels of business operations. The third stage is process improvement. In this stage, organisations deliberate and redesign business processes that can contribute to improving environmental performance. The last stage is process implementation. It is associated with sufficient resources, training for employees and definitions of measurement, which are required by organisations to improve their environmental performance.

BarNir, Gallaugher and Auger (2003) explore the relationship between business process digitisation and strategy in organisations. In this study, the internet is used as the important element in business process digitisation. Furthermore, the study utilises the innovation and efficiency approach to develop the environmental competence of organisations. With the innovation orientation, the study shows that the internet facilitates organisations in improving communication with stakeholders, to explorer large audiences. Through the efficiency orientation, the study shows that the internet can provide lower cost to market and automation of administrative processes. Therefore, organisations can use the internet to produce lower

costs and more efficient and effective business operations in order to improve environmental performance.

Antoni and Jie (2012) investigate the relationship between IT capabilities as a component of business process digitisation and environmental performance. The study emphasises the role of IT capabilities in business operations to help organisations to improve environmental performance. Furthermore, this study shows that organisations require IT infrastructure to connect whole business units of the organisation and customers. For example, the use of computer network systems and teleconferencing technology in business operations is an essential component for linking stakeholders inside and outside organisations. Furthermore, the use of software applications such as enterprise resources planning facilitates organisations in sharing information and services across the entire organisation. Therefore, appropriate IT infrastructure resources can help organisations to improve environmental performance.

The approach to business process digitisation in this research is drawn from the business process of Molla et al. (Molla et al. 2012) and the previous studies discussed above. It is divided into two categories: digital business transactions and digital communication. Digital communication refers to the extent to which an organisation deploys IT resources (e.g. email, websites and teleconferencing technology) to connect its business units and stakeholders (e.g. suppliers and customers). Digital business transactions refer to the breadth of services and the volume of different types of information shared across the organisation.

3.2.4.1 Digital business communications

Digital communication concerns the quality of internal and external communication in an organisation. Communicating effectively depends on the use of appropriate IT equipment for email, broadband communication networks, video conferencing, tele-presence technology, right-sizing communication equipment, WIMAX technology, and LAN and WAN

technology. Using email to replace paper documents delivered by postal carriers for internal and external communication significantly reduces energy consumption in business operations (BarNir, Gallaugher & Auger 2003; Linjun, Ming-Te & Wong 2003). Moreover, for rapid communication, organisations can use broadband networks that can carry high bandwidth applications including images and video (Becher et al. 2001; Mann, Grant & Singh 2009; Molla, Cooper & Pittayachawan 2009; Yi, Z et al. 2010) . Video conferencing and tele-presence technology help organisations to connect their resources using the newest generation of hand-held mobile devices to enable multi-party conferencing in real time, independent of location (Adela, Marie-Claude & Richard 2008; Mann, Grant & Singh 2009; Molla, Cooper & Pittayachawan 2009; Yi, L & Thomas 2007). This means that organisations can significantly reduce transport costs. In addition, the adoption of right-sizing communications equipment also reduces operational costs and the size of the workforce to adapt to the multiple environments of the business market. Therefore, digital business communication results in improved efficiency in business operations.

3.2.4.2 Digital business transactions

Business process digitisation is widely used for enhancing organisational environment performance. For example, the adoption of electronic procurement (e-procurement) reduces paper usage in business activities for improved organisational environment performance (Loos et al. 2011). The adoption of customer service systems through providing a website that provides electronic forms and other e-services can reduce the costs of office space and human intervention to minimise business operation costs (De Ruyter, Wetzels & Kleijnen 2001). The adoption of environmental information disclosure can help an organisation to achieve pollution prevention and control with relatively low regulatory costs. Furthermore, it can improve the environmental reputation of an organisation (worldbank.org). The adoption of a web database for a document management system helps organisations to manage their

documents efficiently. In this system, documents are indexed and filed electronically and stored centrally so that every authorised user has access to them through an internet connection. With text search and optical character recognition features, retrieving documents can be as fast and easy as a Google search. Therefore, employees do not need a lot of time to search through filing cabinets to find a file.

3.3 Environmental performance

Improvement of environmental performance in organisations has been becoming popular in business activities. It can be associated with business processes of organisations that use less energy, reduce CO_2 emissions, recycle and reuse materials, and preserve natural resources (Hart 1995). Effective improvement of their environmental performance has a significant impact on organisations for meeting government environmental regulations, complying with standards, improving organisational profitability, providing business opportunities and improving the competitive position of organisations in the marketplace (Antoni & Jie 2012; Watson, Boudreau & Chen 2010; Zhu, Qinghua, Sarkis & Geng 2005). As a result, organisations have been implementing specific strategies and approaches for improving their environmental performance.

There are many strategies and approaches to improving environmental performance. For example, Elsayed and Paton (2005) argue that environmental performance can be improved by reducing the consumption of raw materials and energy, the waste produced and the impact of business operations on the natural environment. Olsthoorn et al (2001) state that environmental performance can be enhanced by the initiatives and actions that an organisation takes for reducing the consumption of natural resources and the impact of its operations on the natural environment. Singh et al. (2009) state that the improvement of environmental performance can be reflected by the natural resources consumed, the waste produced, the proportion of the waste being treated and the impact of business operations on

the environment. Daniel (1996) argues that environmental performance can be improved by quantifying the impact of business operations on the environmental in "natural" units such as physical, chemical or biological units through studying the impact of a given product over all stages of its lifecycle, including resource extraction, energy use, production, distribution, use and ultimate disposal. Summaries of some previous studies of environmental performance can be seen in Table 3.4. Most environmental performance frameworks have been tested empirically in previous studies. There are several indicators of environmental performance: energy consumption; CO_2 emission reduction; environmental management systems; environmental initiatives; environmental information disclosure; and environmental reputation.

Table 3.4 Previous studies on environmental performance

No.	Authors	Descriptions
1	Jasch (2000); Elsayed and Paton (2005); Claver et al. (2007); Singh et al. (2009)	Environmental performance indicators consist of CO_2 emission reduction, energy and material consumption, land use, amounts of recycled and reused waste on site.
2	Patten (2002); (Al-Tuwaijri, Christensen & Hughes Ii 2004)	Environmental disclosure an is important indicator of environmental performance.
3	Moneva and Ortas (2010)	There are four indicators of environmental performance including environmental disclosure, environmental management system, program to reduce environmental impacts, energy consumption.
4	Daniel (1996)	Environmental performance of an organisation can be improved by quantifying the impact of its business operations on the environmental in "natural" unit such as physical, chemical or biological units through studying the impact of a given product over all stages of its lifecycle, including resource extraction, energy use, production, distribution, use and ultimate disposal.
5	Olsthoorn et al. (2001); Melville (2010)	This study focuses on the significance of environmental initiative indicators.

6	Klassen and McLaughlin (1996); Van Passel et al. (2007)	Environmental reputation indicators are often used to assess social responsibility.
7	Large and Gimenez Thomsen (2011)	There are six indicators of environmental performance: waste reduction, compliance, recycling, environmental protection, environmental reputation and overall environmental performance.

Based on the discussion above, this study adopts the environmental performance indicators that have been researched by previous studies. The energy consumption of an organisation focuses on the overall environmental performance through its consumption of resources and its impact on the environment. The energy efficiency of an organisation is related to the amount of CO_2 emissions per million of sales revenue in a specified period (Daniel 1996). The environmental reputation of an organisation is related to the environmentally friendly image that the organisation wants to project in the public on its overall commitment towards environmentally sustainable operations (Van Passel et al. 2007). The environmental initiatives of an organisation are about the extra effort that an organisation takes for improving its environmental performance in addition to meeting the basic environmental compliance requirements (Olsthoorn et al. 2001). Environmental disclosure is defined as the environmental activities of an organisation and its consideration of environmental matters in its activities, and the improvement of its reputation and its environmental performance (Cho & Patten 2007). The environmental management system refers to the management of an organisation's environmental programs in a comprehensive, systematic, planned and documented manner. It also consists of organisational structure planning and resources for developing, implementing and maintaining policy for environmental protection (Moneva & Ortas 2010). Therefore, whole environmental performance indicators are used to measure the degree of compliance with existing environmental standards and regulations.

3.4 Summary

This chapter has aimed to review the previous studies related to the theoretical background of the study, IT capabilities and environmental performance. Table 2.6 summarises the constructs of IT capabilities including IT and environmental performance. IT capabilities consist of IT infrastructure quality, IT human resources, business process digitisation and environmental IT competence. Business process digitisation emphasises digital communications and digital business transactions. Furthermore, environmental IT competence focuses on emission management, IT resource stewardship and sustainability behaviour.

Table 3.5 Summary of constructs of IT capabilities and environmental performance

Constructs	Items	References
IT infrastructure quality (ITQ)	• Adoption of server virtualisation • Adoption of storage virtualisation • Adoption of desktop virtualisation • Implementation Radio Frequency identification (RFID) • Modularisation of information system • Standardisation of information system and reports	• Molla and Abareshi (2012) • Loos et al. (2011) • Molla, Cooper and Pittayachawan (2009) • (Mann, Grant & Singh 2009) • (Duncan 1995)
IT human resources competencies (ITH)	• Knowledge of environmental government regulations • Knowledge of management system standards • Knowledge of standardisation of IT equipment • Competency of network system • Competency of technologies virtualisation • Competency of emerging technologies	• Cooper, Vanessa A and Molla, Alemayehu (2012) • Benitez-Amado, Perez-Arostegui and Tamayo-Torres (2010) • Speshock (2010) • (Molla, Cooper & Pittayachawan 2009) • Sayeed and Gill (2008) • Adela, Marie-Claude and Richard (2008)
Emission Management(EM)	• Availability of the IT vision of an organization • Availability of the IT goal of an organization	• Molla, Cooper and Pittayachawan (2009) • Sayeed and Gill (2008)

	• Availability of high degree of consensus among our top management about the role of environment IT in an organization • Availability of the IT policy for managing IT resources • Availability of environmentally of friendly IT purchasing procedures • Availability of reusable IT equipment procedures • Availability of IT equipment disposal procedures • Availability of the end of IT life management	
Sustainability Behaviour (SB)	• IS functions are able to deliver information that relates to environmentally friendly work practices in an organization • IS functions are able to build the commitment of employees to environmentally friendly work practices in an organization • IS functions are able to promote the choices of environmentally sustainable course of actions • IS functions are able to educate the employees' behaviour reducing the energy consumption • IS functions are able to change the employees' behaviour to environmentally friendly work practices in an organization	• Cooper, V.A and Molla, A (2012)
Resources Stewardship (RS)	• IT components are easily adopted in business operations • IS functions are easy upgraded in business operations • IT components are widely reused in new IT infrastructure • IT components are easily shared business operations • IS functions are easily used to communicate among business units • IT components are made from	• (Byrd & Turner 2000; Mann, Grant & Singh 2009)

	non-hazardous materials • Power management of IT components • Recycling Information of IT components • Reusable software modules are widely reused in new system development • The Application used in our organization are designed to be reusable	
Digital communications (DC)	• Adoption of email for internal and external communication • Adoption of the electronic data interchange for formal external communication • Adoption of teleconferencing technologies • Adoption of tele-presence technologies • Adoption of energy-efficient communication equipment • Adoption of rightsizing communication equipment • Adoption of LAN and WAN for internal communication	• Molla et al. (2012) • Mann, Grant and Singh (2009) • (Murugesan, San 2008) • Weill and Vitale (2002) • Byrd and Turner (2000)
Digital Business transactions (BT)	• Adoption of the enterprise resources planning • Adoption of e-procurements • Adoption of online delivery systems • Adoption of automated workflow systems • Adoption of document flow systems • Adoption of document management /archival systems	• Loos et al. (2011) • Melville (2010) • Molla, Cooper and Pittayachawan (2009) • Molla (2008) •
Environmental Performance (EP)	• Energy consumption • CO2 emission management • Environmental management system • Organisational environmental system • Environmental information disclosure • Environmental reputations	• Moneva and Ortas (2010) • Jacobs, Singhal and Subramanian (2010) • Elsayed and Paton (2005)

Chapter 4
Conceptual framework and hypothesis development

4.1 Introduction

The purpose of this research is to investigate the relationship between IT capability and environmental performance in the Indonesian ICT industry with the use of a survey. To accomplish the aim of this research, this study has developed a theoretical framework as the foundation for carrying out the quantitative study. It is beneficial to hypothesise the critical factors for investigating the critical factors of IT capability to improve environmental performance.

To fulfil the objectives of this research, this chapter is organised in five sections including this section. Section 4.2 provides a discussion of how the theoretical framework is developed based on the prior literature presented in the previous chapter. The next section describes the conceptual model and discusses the hypothesis development of the research model, respectively. The last section presents a summary of the conceptual framework in this research.

4.2 The theoretical background of the research

This section presents the two theories which act as the foundations to this study.

4.2.1 Resource-based view theory

Resource-based view (RBV) theory has emerged in recent years as a popular theory of competitive advantage. This theory, developed by Wernerfelt (1984), asserts that organisations can gain and sustain competitive advantage by developing and deploying valuable resources and capabilities. Capabilities are complex bundles of skills and accumulated knowledge, exercised through organisational business processes, which enable organisations to control activities and to make good use of their assets (Day 1994). Bharadwaj

(2000) argues that capabilities are the organisational abilities that are created by the interaction among organisational resources in an organisation. Hafeez, Zhang and Malak (2002) define capability as the combination ability of an organisation which is obtained from its resources that enables it to perform several business processes or activities in order to achieve competitive advantage. De Bakker and Nijhof (2002) argue that the capabilities of an organisation can be derived from collaboration with other organisations in regard to resources and capabilities that are not present in the organisation, in order to achieve competitive advantage. Therefore, the main objective of RBV is to identify the resources and capabilities required by an organisation to obtain competitive advantage.

RBV highlights the importance of resources and capabilities that are valuable, rare, inimitable and non-substitutable for delivering services or producing goods more economically (Barney 1991). The characteristic of value refers to the capacity of organisational resources to make a difference in performance and create sustainable value for an organisation. Rarity refers to the scarcity of the resource, that is, the heterogeneously distributed nature of a resource which is possessed by few organisations. It can also refer to the resources of an organisation which have the potential to create a superior advantage for the organisation. The inimitable characteristic means that it would be difficult for other organisations to imitate or copy the resource. The non-substitutable attribute is a strategic resource that cannot easily be substituted. Therefore, RBV is a theory that covers key resources and capabilities which, when combined, enable an organisation to compete successfully with other organisations in the market (Barney 1991).

Adopting RBV theory, scholars have identified several types of IT capabilities in organisations. For example, Kettinger et al. (1994) argue that the IT capability of an organisation for achieving competitive advantage is determined by its IT infrastructure. Bharadwaj (2000) states that IT capability is the organisational ability created by the

interaction between IT infrastructure, IT human resources and IT intangible assets in an organisation for improving its organisational performance. Tippins and Sohi (2003) argue that IT capability is the ability of an organisation to use IT resources for improving its performance. Jiao, Chang and Lu (2008) state that IT capability, determined by IT infrastructure, IT human resources and IT management, can be used for improving organisational performance. Therefore, RBV is used in this study to define IT capability as the IT infrastructure quality and IT human resources competence required for enhancing an organisation's performance, including its environmental performance.

In the context of business process digitisation, RBV is used to recognise how an organisation uses its IT human resources competence and IT infrastructure quality to transform its business process (Bharadwaj 2000; Ray, Barney & Muhanna 2004). In this study, business process digitisation encompasses business digital communication and business digital transaction. Email, teleconferencing and computer network systems for digital business communication cannot easily be replaced by other resources (Darroch & McNaughton 2003). Further, the adoption of enterprise resources planning, e-procurement, environmental management systems and document management systems is valuable, rare and heterogeneously distributed, thus influencing the success of business process digitisation (Sher & Lee 2004).

4.2.2 Natural resource-based view theory

In the previous sub-section, the RBV theory concerns the relationships among the organisation's resources and capabilities to improve the environmental performance. This sub-section discusses the extended RVB theory called natural-resources-based view (natural-RBV) theory. This theory aims to add the natural environment as a unique resource or capability into the RBV to develop the theory (Hart 1997). Hart argues that organisations need to develop key competence in their engagement with the natural environment and that competence can contribute to sustained competitive advantage. Therefore, natural-RBV is

developed with the connection between environmental challenge and organisation resources operationalised through the environmental competence in organisations.

Environmental competence in organisations can be achieved through many approaches. Hart (1995) argues that environmental competence can be accomplished through pollution prevention, product stewardship and sustainability vision. Pollution prevention focuses on the control and prevention of pollution emissions and effluents during business activities. Resource stewardship refers to an organisation's ability to evaluate the environmental impacts of its resources and main business activities. Sustainability vision aims to change human behaviour to more sustainable options (Hart 1995; Hart & Milstein 2003).

Pollution prevention can be achieved through reducing the emissions and effluents in business processes. Through pollution prevention, the organisation can reduce the business operation costs to realise significant savings, resulting in a cost advantage relative to competitors (Hart 1995). Furthermore, Hart states that pollution prevention may reduce cycle times by simplifying or removing unimportant stages in business activities to increase productivity and efficiency. Therefore, pollution prevention can facilitate the organisation in providing lower costs that can enhance profitability and improve the competitive position in the marketplace (Hart 1995, 1997; Hart & Milstein 2003).

In terms of product stewardship, the organisation must be concerned with its whole business processes and operations. This involves integrating the voice of the stakeholders into business processes through extensive interaction with external parties such as suppliers, customers, regulators, communities, non-governmental organizations and the media (Hart & Milstein 2003). Product stewardship benefits existing environmentally hazardous business activities, redesigning existing product systems to reduce liability and developing new products with lower lifecycle costs. Therefore, through product stewardship, organisations can build their

reputations and differentiate their products by establishing themselves as green organisations (Hart 1995).

Pollution prevention is used as fundamental emission reduction and product stewardship is employed as a guide or procedure for selecting raw material and designing products in order to minimise the environmental impact of business processes. The sustainability vision is emphasised where the other stages build the base for the vision of sustainability for the organisation (Hart & Milstein 2003; Ijab et al. 2010). It can be achieved by creating a shared roadmap for future business guidance to employees in term of organisational priorities, technology development, resource allocation and business model design (Hart & Milstein 2003). Therefore, organisations with a sustainability vision have the potential to reveal future markets of immense scale and scope (Hart & Milstein 2003).

Considering the relationship between natural-RBV and IT capabilities, this study has identified three types of environmental IT competence that are relevant for the research. These environmental IT competences vary in terms of the degree to which they can help organisations to use their IT capabilities to reduce the impact of business processes on the natural environment. For example, Jenkin, Webster and McShane (2011) introduce objectives to reduce energy consumption through use of IT as pollution prevention, to develop a strategy to use IT to help reduce the environmental impact of an organisation's products and also to introduce sustainable development as a goal to substantially reduce business travel using IT.

Likewise, in this research, environmental competence is developed into three categories based on natural-RBV theory, namely, emission management, resource stewardship and sustainability behaviour. Emission management provides strategies or procedures for the use of IT capabilities to improve environmental performance. Resource stewardship is used in how an organisation adopts IT capacities to reduce the impact on the environment of business

processes. Sustainability behaviour is about the use of IT capabilities in order to build the behaviour of employees to consider environmental issues in their business operations. Therefore, these environmental IT competences are required for organisations as key resources for improving environmental performance (Jenkin, Webster & McShane 2011).

Table 4.1 Summary of adopted theories

Theories	Definitions	Authors
Resource-based view	A complex bundle of IT infrastructure and competence of IT human resources that are exercised through organisational business processes, which enable improvement of competitive advantage	Wenerfelt (1984) Berney (1991) Duncan (1995) Bharadwaj (2000) Molla, Cooper & Pittayachawan (2011) Benitez et al. (2012)
Natural-resource-based view	The connection between resources and capabilities of organisations and their environmental performance.	Hart (1995 and 1997) Hart & Milstein (2003) Menguc & Ozanne (2005) Setterstrom (2008) Molla, Cooper & Pittayachawan (2009)

4.3 Conceptual framework

Drawing from the literature review discussed in Chapter 2, a conceptual framework has been developed and is shown in Figure 3.1. There are four main variables in this study:

1. IT infrastructure quality (ITQ), also as known as the foundation of IT used to share the capabilities of IT resources in order to enable business applications in organisations (Bharadja, 2000). It is an essential competence or capability of organisations used to meet market needs and to achieve business objectives. This study measures ITQ using six indicators including the adoption of server virtualisation, storage virtualisation, desktop virtualisation, RFID, modularisation of information systems and standardisation of reports.

2. IT human resources competence (ITH) is defined as an organisation's ability to use its valued resources to integrate IT infrastructure and business planning processes more effectively, to consider and develop reliable and cost-effective applications, to communicate and work with business unit more efficiently, and to anticipate future business needs by innovating valuable new products. In this research, ITH is examined through knowledge of environmental government regulations, management system standards, standardisation of IT equipment and competence of computer network systems, virtualisation and emerging technologies.

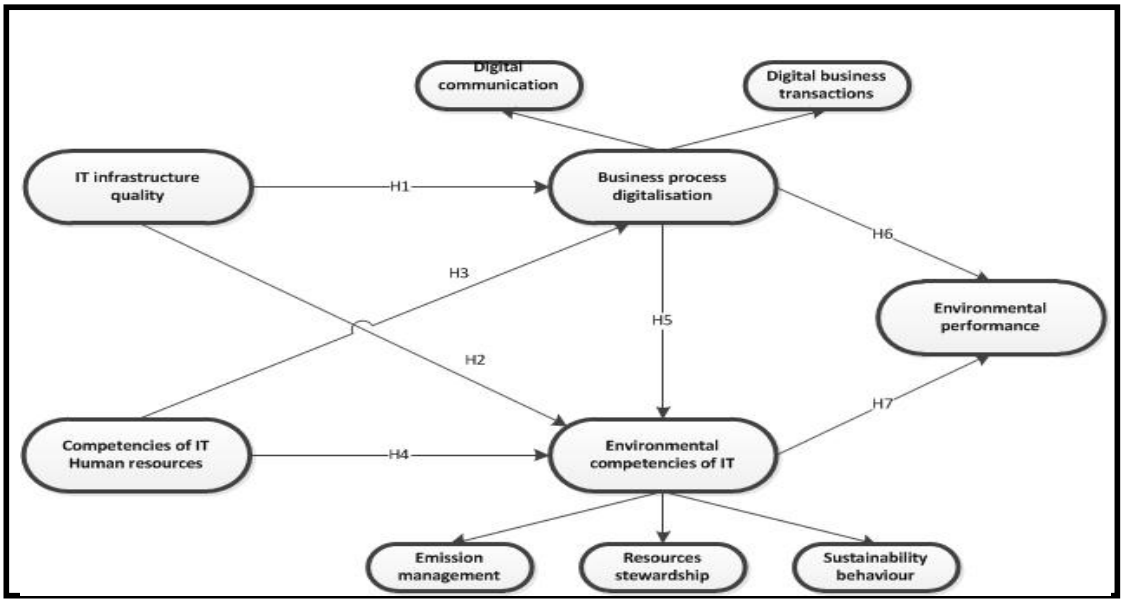


Figure 4.1 Conceptual framework of the research

3. Environmental competence of IT (EIT) is a bridge to link IT capabilities and environmental performance. Organisations with EIT can address environmental issues and achieve competitive edge. This study analyses EIT using three factors including emission management (EM), resource stewardship (RS) and sustainability behaviour (SB).

4. Business process digitisation (BPD) refers to the extent to which an organisation executes electronically both its internal and its external business operations. It has a significant impact on organisations for communicating and interacting with internal and external organisations. In this study, BPD is determined by digital communications (DC) and digital business transactions (DT).
5. Environmental performance (EP) can be associated with business processes that use less energy, reduce CO_2 emissions, recycle and reuse materials, and preserve natural resources. Therefore, in this study, EP is measured by energy consumption, CO_2 emission management, environmental management systems, environmental reputation, environmental information disclosure and environmental initiatives.

4.4 Research hypothesis development

Working from the literature review and conceptual framework, this section focuses on developing hypotheses that relate to IT capabilities and environmental performance. This study develops six hypotheses to be investigated and analysed in the process of answering the research question addressed in Chapter 1.

4.4.1 IT infrastructure quality

ITQ is a foundation for organisations to compete in the market. In the dynamic business environment, successful organisations require digitalised business processes to enhance their product and/or service value for internal and external business operations. Drawing from RBV literature, ITQ in this study is determined by the adoption of server virtualisation, storage virtualisation, desktop virtualisation, modularisation of IS and standardisation of reports.

Virtualisation technology refers to IT infrastructure that has the ability to share services with different platform technologies including hardware platforms, base software platforms,

communication technology and middleware. It is also used to support commonality between different applications and uses as well as facilitating information sharing across and outside the organisation, cross-functional integration of infrastructure and reducing business operation costs. For example, Kovar (2008) argues that server virtualisations ensure critical business functions can be accomplished and user productivity remains high even during disruptions by achieving high availability at the device, network and data centre levels, and by providing displaced workers with fast, convenient, reliable and secure access to the desktops, applications and data they require to do their jobs.

Likewise, Miller and Pegah (2007) state that server virtualisations can increase the business agility in an organisation. This is because server virtualisations provide the flexibility to rapidly roll out new applications in a highly efficient and centralised manner. This technology can be accessed by almost any computer or terminal over any type of network in order to build new offices. In addition, server virtualisations provide the capability for users and staff to work from any location with any device at any time, facilitating cost slashing by shifting staff to full-time home offices or desk-sharing arrangements. Therefore, business operations can be reduced associated with travel budgets and relocations of new offices.

Virtualisation technologies offer an organisation three important components when it comes to building a disaster recovery solution (Delahunty 2011; Gmach & Holcomb 2004; Kovar 2008; McKendrick 2010). The first is their hardware abstraction capability. By removing dependence on a particular hardware vendor or server model, a disaster recovery site no longer needs to keep identical hardware on hand to match the production environment and IT can save money by buying cheaper hardware for the site since it rarely gets used. Second, by consolidating servers down to fewer physical machines in production, an organisation can more easily create an affordable replication site. Third, most enterprise server virtualisation platforms have software that can help to automate the recovery when a disaster does strike.

The same software usually provides a way to test a disaster recovery as well. Imagine being able to actually test and see your recovery plan working in reality, rather than hoping and praying that it will work if and when the time comes.

The IS functions as part of IT infrastructure provide standardisation of information and data that can be accessed by all business partners including customers and suppliers. It also is developed and designed by modulating business functions to adopt uncertain environments.

In term of environmental IT competence, IT infrastructure can be used for meeting organisation business process demands that focus on environmental performance (Broadbent, M., Weill & Neo 1999; Weill & Vitale 2002). This is because ITQ offers capabilities that help organisations to reduce the impact of their business processes on the environment. For example, Watson (2008) argues that the adoption of virtual servers in business operations can help organisations to reduce energy consumption. This is because the server virtualisation has the capacity to share its services, including hardware and software resources, with other operating systems.

In addition, the virtualisation of storages or databases is an essential component of business operations and can help an organisation to enhance ecological competence. For example, McKendrick (2010) argues that database virtualisation is used by organisations to more effectively grow their data capabilities while reducing staff time and operational costs. Chaudhuri, Dayal and Narasayya (2011) argues that database virtualisation can increase the flexibility and agility of existing computing infrastructure for reducing business operation costs. Molla et al. (2008) state that virtualisation of databases helps organisations to mitigate energy consumption in business activities. Thus, organisations can reduce energy consumption in business operations through increasing the utilisation of the excess capacity possessed by virtualisation technologies.

Desktop virtualisation refers to a computer or computer program that depends heavily on some other computer including servers to fulfil its computational roles through the network system. There are many advantages of using thin client computers including lowering administration costs, lowering energy consumption, lowering hardware costs, more efficient use of computing resources, using less network bandwidth and lowering upgrading costs (Mann, Grant & Singh 2009). Therefore, based on this study, the adoption of desktop visualisation assists the ability of organisations to improve their environmental performance.

Watson, Boudreau and Chen (2010) investigate the role of IS functions in reducing the impact of business operations on the natural environment. The outcome of this study is that IS functions can improve operational efficiency through the enhanced organisational ability of information processing. This refers to the extent to which an organisation provides automatic business operations controlled and operated by electronics to reduce human intervention for improving information efficiency.

In term of IS, modularity is required as an approach for improving services to customers and suppliers by modifying, removing and adding software, hardware and data components of an infrastructure. This means that modularity has capabilities to support organisations to improve and develop environmental performance. For example, repeated IS functions such as data or software module call routines, as well as data, can and will be converted into reusable objects. As data and application components become independent and reusable, they become part of the infrastructure, and the processes of development, maintenance or engineering of "direct-purpose" systems are simplified and the costs are reduced (Duncan 1995). Furthermore, adequate use of selected modules of publicly available software packages (e.g. ERP) can support the standardisation of information in business operations. This means that the data and information provided by software packages are easy to share across organisations.

Hypothesis 1: IT infrastructure quality has a significant impact on the digitalisation of business operations.

Hypothesis 2: IT infrastructure quality has a significant impact on the development of environmental IT competence.

4.4.2 IT human resources competence

Besides IT infrastructure quality, an organisation needs IT human resources that have competence to build and develop their information systems in order to improve organisational performance including environmental performance. Competence of IT human resources is determined by the technical skills and the managerial skills of the IT personnel available in an organisation (Benitez-Amado, Perez-Arostegui & Tamayo-Torres 2010; Powell & Dent-Micallef 1997). The technical skills are the abilities of IT personnel in programming, system analysis and design, network systems and communications, and competence in emerging technologies (Bharadwaj 2000). The managerial skills are the ability to manage IT resources in organisations. Through these skills, IT human resources can contribute to the implementation of various IT-related applications for effectively and efficiently improving organisational operations (Powell & Dent-Micallef 1997).

IT human resources can help organisations to support environmental competence as well as BPD through their skills, including both managerial and technical skills (Benitez-Amado, Perez-Arostegui & Tamayo-Torres 2010; Speshock 2010). The managerial skills of IT human resources can build a bridge between IT and business strategies through allocating appropriate IT resources for improving environmental performance (Speshock 2010). They can coordinate various activities with the successful implementation of specific IT applications (Bharadwaj 2000). The technical skills of IT human resources can assist the organisation to integrate IT and business processes more effectively. They can also create

more efficient communications among business units through developing effective applications (Bharadwaj 2000; Luftman 2003).

There are many studies that have investigated the role of the managerial capacities of IT human resources in improving organisation environmental performance. Benitez-Amado et al. (2010) state that IT human resources can support business processes by managing and redesigning environmentally sustainable business operations for reducing the consumption of materials and energy in the organization. Molla, Cooper and Pittayachawan (2009) argue that IT human resources who have knowledge about business environments can help the organisation to adopt and allocate the appropriate IT resources in its business operations. Dao, Langella and Carbo (2011) describe how IT human resources are able to interpret business problems and address these with appropriate technical solutions. With this ability, IT personnel can redesign business processes to be more environmentally friendly, for example, by developing IS functions for automating business operations. Cooper, Vanessa A and Molla, Alemayehu (2012) argue that IT human resources who have knowledge regarding government environmental regulations can help an organisation to reduce the impact of business operations on the natural environment. For example, SAP environmental compliance application is designed to help organisations ensure compliance with environmental laws and policies, and reduce associated costs, efforts and risks on the plant and organisation levels (Molla, Cooper & Pittayachawan 2009).

Numerous studies have argued that the technical capabilities of IT human resources can help organisations to develop their ecological competence. For example, Molla, Cooper and Pittayachawan (2009) argue that environmental performance can be improved through adopting virtualisation of information technologies including database, server and desktop virtualization. This means that organisations should have IT human resources who have the ability to develop and build business information systems based on virtual technologies.

Furthermore, Sayeed and Gill (2008) argue that IT human resources can help an organisation to reduce operating costs and transportation costs through developing the computer network systems and digitalised communication used for connecting all business units and branches. Adela, Marie-Claude and Richard (2008) argue that an organisation needs IS to automate business operations to improve environmental performance. Furthermore, organisations need to develop IS functions providing information for meeting external stakeholder compliance requirements including government policies. Thus, the IT personnel of an organization must be able to build IS for automating business operations and meeting government regulations.

Hypothesis 3: IT human resource competences have a significant impact on the digitalisation of business operations.

Hypothesis 4: IT human resource competences have a significant impact on the environmental competence.

4.4.3 Business process digitisation

Many previous studies have classified business process digitisation (BPD) from different approaches. For example, Sambamurthy, Bharadwaj and Grover (2003) studied BPD in an organisation. In this study, BPD refers to the extent to which an organisation executes electronically both its internal and its external business operations. It is divided into two categories: digitised process reach and digitised process richness. Digitised process reach refers to the extent to which an organisation deploys common, integrated and connected IT-enabled processes. Digitised process richness is defined as the quality of information collected about transactions in the process, the transparency of that information to the process and systems that are linked to it, and the ability to use that information to re-engineer the process.

Weill and Vitale (2002) argue that organisation with high BPD make intensive and extensive use of IT for communications, business transactions and key business processes. The use of IT for internal and external communications refers to the intensity of electronic communications media for business operations such as email, intranets and wireless devices. The use of IT for business transactions refers to a high degree of digitalisation of an organisation's repetitive transactions, particularly sales, customer interaction and purchasing. The use of IT for key business processes refers to internet-based architectures for key business functions including salesforce management, employee performance measurement, training and post-sales customer support.

Molla et al. (2012) investigate the relationship between information systems and the environmental performance of an organisation. To improve environmental performance, this study identifies the intensity of BPD in an organization. This refers to the extent to which the organisation uses IT for internal activities as well as for transactions with stakeholders including suppliers, customers and government. The intensity of BPD is divided into two types: (1) digital communication and (2) digital business. Digital communication refers to the extent to which an organisation makes extensive and intensive use of electronic channels such as email, teleconferencing technology, e-commerce, intranets and enterprise portals. Digital business refers to the conduct of electronic transactions with customers, other businesses and government. For example, customer-oriented digitisation and computerised procurement systems provide stakeholders with information, products and services. These activities can allow an organisation to overcome some of the geographical barriers of trading globally.

Based on this literature, BPD can be defined as the utilisation of ICT resources in business operations. It is divided into two categories: digital communication and digital business transactions. Digital communication refers to the extent to which an organisation deploys IT resources (e.g. email, websites and teleconferencing technology) to connect with its business

units and stakeholders (e.g. suppliers and customers). Digital business transactions refer to the breadth of services and the volume of different types of information shared across the organisation. For example, customer-oriented digitisation provides information, products and services to customers. This digital transaction allows an organisation to serve customers in different locations and times. Computerised procurement systems can facilitate an organisation in communicating, coordinating and collaborating with suppliers to address information access and asymmetry.

Numerous studies have researched how digital communication can be used for improving environmental performance as well as to support the ecological competence of an organization. For example, Ijab et al. (2010) argue that videoconferencing technology can reduce CO_2 emissions in business activities including business travel and ancillary expenses. Senn (1992) and Byrd and Turner (2000) state that electronic data interchange (EDI) is easily used for sharing information and data between organisations through communication networks. The adoption of EDI can help an organisation reduce service delivery costs. Molla et al. (2008) argue that tele-presence technology can improve environmental performance including mitigating the organisational footprint and environmental impact on the natural environment. The study further claims that the adoption of websites for publishing sustainability reports can improve environmental reputation. Frost (2011) argues that the adoption of advanced network technologies can improve environmental performance including reducing the response time of a web server. For example, the adoption of broadband networks offers a wide range of data rates to the end users. This indicates that the organisation provides faster services in sharing information and products to stakeholders including customers and suppliers.

BPD is widely used for enhancing environmental performance. For example, the adoption of electronic procurement (e-procurement) supports reducing paper usage in business activities

and improving environmental performance (Loos et al. 2011). The adoption of customer service systems with websites that provide electronic forms and e-services can reduce the costs of office space and human intervention to minimum business operation costs (De Ruyter, Wetzels & Kleijnen 2001). The adoption of environmental information disclosure can help an organisation to achieve pollution prevention and control with relatively lower regulatory costs. Furthermore, it can improve the environmental reputation of an organisation (worldbank.org). Adoption of web databases as document management systems helps organisations to manage their documents. In this system, documents are indexed and filed electronically and stored centrally so that every authorised user has access to them through any internet connection where they are located. With text search and optical character recognition features, retrieving documents is as quick and easy as a Google search. Therefore, employees do not need much time to go searching through file cabinets to find a file.

Hypothesis 5: business process digitisation has a significant impact on environmental performance.

Hypothesis 6: business process digitisation has a significant impact on environmental IT competence.

4.4.4 Environmental competence of organisations

Environmental issues influence businesses' competitive landscapes in new ways. Organisations with the technology and vision to provide products and services that address environmental issues will achieve a competitive edge. For example, when making purchasing, leasing or outsourcing decisions, many customers now consider the service provider's environmental record and initiatives (Murugesan, San 2008). Therefore, organisations should consider using IT for support and improving their environmental competence.

There are three ecological competences of an organisation supported by IT, namely, emission management, resource stewardship and sustainability behaviour (Hart 1995). Emission management is defined as the ability of an organisation to manage its emission in business operations through implementing environmental visions, goals and policies. For example, ANZ has policies for banning screensavers and retiring the energy in an efficient system (Molla, Cooper & Pittayachawan 2009). Resource stewardship refers to the ability of an organisation to re-use IT resources to improve its efficiency of business operations (Loos et al. 2011). For example, IS functions are easily upgraded to meet business demands. Sustainability behaviour refers to building behavioural values that encourage employees of an organisation to consider environmental issues in their business operations. For example, IS functions are able to educate employees' behaviour around reducing the energy consumption. Therefore, the adoption of IT is needed to help an organisation to build and improve its ecological competence.

Several studies have revealed that emission management can be conducted by implementing environmental strategies and policies. For example, Tom (2011) argues that environmentally friendly IT purchasing policies can be implemented by an organisation for meeting government regulations regarding the waste of electrical and electronic equipment. Furthermore, the availability of reusable IT equipment procedures can fulfil government regulations as well as reducing operating costs. Molla (2008) argues that organisations have to be concerned about their IT suppliers' environmental footprints in order to improve their environmental reputation. In the supply-chain management view, Zhu, Qinghua, Sarkis and Geng (2005) argue that there are pressures and drivers for implementing and adopting the ISO 14001 environmental management system to comply with standards and to improve competitive position in the marketplace.

With the rapid development of IS in organisations, there is an increasing need to use IS functions to improve environmental performance, including developing sustainability behaviour of human resources in an organisation. There is much previous research on the relationship between the use of IS and sustainability behaviour in organizations. For example, Adela, Marie-Claude and Richard (2008) argue that IS functions are able to build the commitment of employees to environmentally friendly work practices in an organisation. York et al. (2009) argue that the use of IS functions can help an organisation to promote the choice of environmentally sustainable courses of actions by their employees. Molla et al. (2008) argue that eBay uses its market portal and other web 2.0 technologies to empower its internal green team, which helps concerned buyers to evaluate and select greener merchants.

Every organisation has a unique history of developing its ecological competence, which can be seen in the IS literature. For example, Loos et al. (2011) argue that the organisation can use IT equipment that is easily reused in new IT infrastructure for facilitating resource stewardship. Furthermore, they claim that IS can facilitate resource stewardship by providing information and creating networks to support recycling. Molla (2008) argues that IT equipment made from non-hazardous materials supports resource stewardship in an organization. Furthermore, these resources have some green features and options to assist organisations to reduce energy consumption in business operations. For example, at ANZ, IT leads green IT initiatives through setting all the computers and printers of an organisation to switch into a low-power mode when not in use.

Hypothesis 7: environmental competence of an organisation has a significant impact on the improvement of its environmental performance.

4.5 Summary

This chapter has proposed the conceptual research model based on the related literature, the resources and complementary competence perspectives of RBV theory. This theoretical framework encompasses various perspectives on IT capabilities including IT infrastructure quality, IT human resources competence, environmental competence and business process digitisation associated with the environmental performance of an organisation. In addition, the chapter describes the components of IT capabilities that have been captured to explain how those components developed the hypotheses implied by the theoretical model. Therefore, based on the developed theoretical model and research hypotheses, the next chapter will discuss the methods and techniques followed to operationalise the theoretical model and empirically test the hypotheses.

Chapter 5
Research methodology

5.1 Introduction

Chapter 4 introduced the conceptual research model based on IT capability, organisational environmental performance and RBV theory and insights from the exploratory study. This chapter describes the research philosophy and paradigm that have guided this study and the methods and techniques pursued for instrument design, sample design, data collection and data analysis.

Chapter 5 consists of five sections. Section 5.2 provides an overview of the research paradigm of this study. Section 5.3 gives the research design and stages. Section 5.4 discusses the empirical and quantitative survey methodology that has been used. Section 5.5 discusses the research instrument development; section 5.6 presents the process of survey development including literature review, pre-test, pilot study and main survey. Section 5.7 provides the ethical consideration undertaken in this study. The last section summarises the chapter.

5.2 Research paradigm

As discussed in Chapter 4, this study encompasses several main research concerns. The first is to develop a conceptual framework to investigate the relationship between IT capability and organisational environmental performance in Indonesian ICT organisations. The second is to develop a set of hypotheses, based on the literature review, regarding the relationships between the variables of IT capability, namely, IT infrastructure quality, IT human resources competence, business process digitisation, environmental IT competence and environmental performance, that are to be empirically tested. Thirdly, the purpose of this study is to reveal the impact of the use of IT capability constructs on environmental performance in organisations. Therefore, this study needs a set of beliefs and perceptions to guide the

investigation of the relationship between IT capability and organisational environmental performance.

The research paradigm is aimed at helping the research to provide a set of beliefs and assumptions for investigating a specific phenomenon (Lincoln, Lynham & Guba 2011). The dimensions of a research paradigm consist of three components: ontology, epistemology and methodology. Ontology is associated with the nature of the phenomenon. It refers to whether the phenomenon is objective and external to the researcher or is created by the consciousness of the researcher. Epistemology is linked to the nature of knowledge and emphasises whether the knowledge is constructed and evaluated by empirically verifying the theories or by involving the researcher in the social context. Methodology is concerned with how the research data is collected and analysed for validating the conclusion. There are quantitative and qualitative methods for collecting and analysing data (Orlikowski & Baroudi 1991).

There are three main research paradigms: positivism, interpretivism and critical realism (Carlsson 2005; Lincoln, Lynham & Guba 2011; Orlikowski & Baroudi 1991). Positivism is used to make valid and reliable generalisations regarding a theory. It is also utilised to explore a literature review, personal interview, survey, multivariate analysis and structural equation modelling. Interpretivism is used to gain understanding about and explain a specific phenomenon. This paradigm is most often context-based and the research questions often involve ‘why’ and ‘how’ questions, which are amenable to the hermeneutical interpretation of qualitative data (Lincoln, Lynham & Guba 2011). Critical realism is aimed at developing better understanding of the underlying structures and mechanisms of a particular phenomenon and poses questions that can be answered by positivist and interpretivist methods (Creswell, J.W. 2009).

A research paradigm is determined based on the position of the researcher towards those components. The positivism paradigm is applied in this study to test the hypotheses and

theoretical model that have been developed from the literature review. Statistical methods are used to test the theoretical model, which is based on the data collected by a survey questionnaire administered within the Indonesian ICT industry. This data is used to explain and describe the relationship between the use of IT capability and organisational environmental performance.

Figure 5.1 below shows that the positivist paradigm is conducted through an exploratory literature review, personal interviews, surveys, multivariate analysis and structural equation modelling (Healy & Perry 2000).

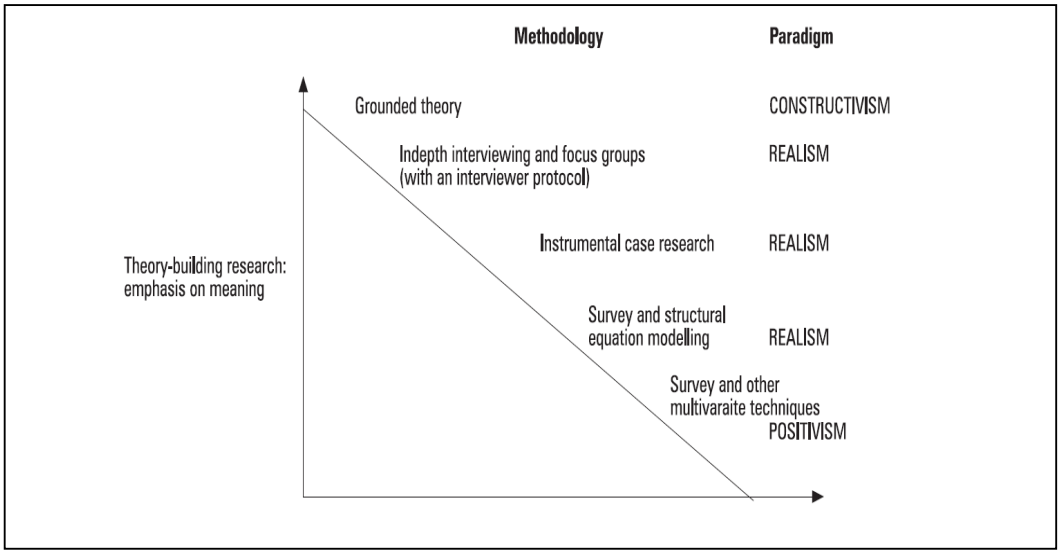


Figure 5.1 A representative range of methodologies and their related paradigms (Healy & Perry 2000)

Table 5.1 An overview of the research paradigms

Basic principles	**Positivism**	**Interpretivism**
View of the world	The world is external and objective	The world is socially constructed and subjective
Involvement of researcher	Researcher is independent	Researcher is part of what is observed and sometimes even actively collaborates
Researcher's influence	Researcher is value-free	Research is driven by human interests

Assumptions		
What is observed?	Objective, often quantitative, facts	Subjective interpretations of meanings
How is knowledge developed?	Reducing phenomena to simple elements representing general laws	Taking a broad and total view of phenomena to detect explanations beyond the current knowledge

Source: Cooper and Schindler (2005)

5.3 Research design and stages

This study uses the positivist paradigm to investigate the relationship between the use of IT capability and organisational environmental performance. The findings of the investigation are expected to discover the critical factors of IT capability that are used for improving environmental peformance in organisations.

To obtain the findings, this study requires a research design utilised for assembling, organising and integrating the research data (Johnson & Onwuegbuzie 2004). It also can be used for dealing with the research issues including the research questions, data collection and data analysis (Creswell, John W & Clark 2007). A sequential exploratory design has been adopted in this study, characterised by quantitative data collection and data analysis. This research design has four stages or steps, as seen in Figure 5.2.

The first stage of a sequential exploratory design is a literature review as the primary research method. This was directed towards reviewing all related literature and existing models, and collecting information from prior studies that relate to IT infrastructure quality, competence of IT human resources, business process digitisation (BPD), environmental IT competence and environmental performance. The investigation of IT infrastructure quality emphasises serviceability, flexibility and greenness. The competence of IT human resources focuses on technical capacity and management capacity. BPD embraces digital communication and digital business transactions. Environmental IT competence consists of emission

management, resource stewardship and sustainbility behaviour. The last variable in organisational environment performance is emphasised through environmental management systems, energy consumption, CO_2 emission reduction, environmental initiatives, environmental disclosure and environmental reputation. Those constructs are used for developing a conceptual model and formulating the research question, objectives and hypotheses. The selected constructs of the model development are operationalised and referred to in developing the research instruments.

The next research stage involved data collection, pre-test, pilot study and main survey. At the beginning of this phase, a pilot study of the instruments with a small number of participants was conducted. The purpose of the pilot study was to ensure that the questionnaire was well developed. Then the questionnaire was structured and presented on a seven-point Likert scale to facilitate examination of the relationship between the role of IT capability and organisational environmental performance. A seven-point Likert scale was used to measure the perceptions of participants in using IT capability for improving environmental performance in each organisation, which later determined the critical factors of IT capability for improving environmental performance.

The main survey involved the distribution of survey questionnaires to identified respondents. The questionnaire survey respondents were selected from Indonesian ICT organisations. To determine the sample size, the respondents were calculated by the ratio of cases per independent variable. In determining the sample size, Green suggests a formula that sample size should be greater or equal 50+8m (m is defined as the number of independent variables) for testing multiple correlations and N=104+m for testing individual independent variables (Green 1991). In addition, the sample size can affect the generalisability of the results by the ratio of observations to independent variables (Hair 1995). A desirable ratio is 15–20

observations for each independent variable. With these guidelines, the sample size of this study was more than one thousand respondents.

The distribution of questionnaires to organisations was identified based on information from the Ministry of Trade, Republic of Indonesia. There are currently 2265 ICT organisations in Indonesia. The respondents were selected by a clustering approach based on the regions where ICT organisations are located. This means that the region that has more ICT organisations more than other region had the most respondents to the questionnaire. There were one thousand IT managers from IT divisions or departments of ICT organisations asked to complete the survey. Managers are key participants in improving environmental performance in organisations (Bowen et al. 2001; Carter & Ellram 1998; Zhu, Qinghua, Sarkis & Geng 2005).

In stage three, the data collected were analysed and processed using statistical methods. This included confirmatory data analysis (CFA), structural equation modelling (SEM) and SEM multigroup analysis. Drawing on the existing literature of the use of IT capability in improving environmental performance, this study developed a theoretical model to answer the research questions that are described in Chapter 1 and to test the hypotheses developed in Chapter 3. Furthermore, the research requires a method that is aligned with the research questions (Punch 2003). A quantitative method, therefore, is an appropriate method for this research to test the hypotheses and then answer the research questions.

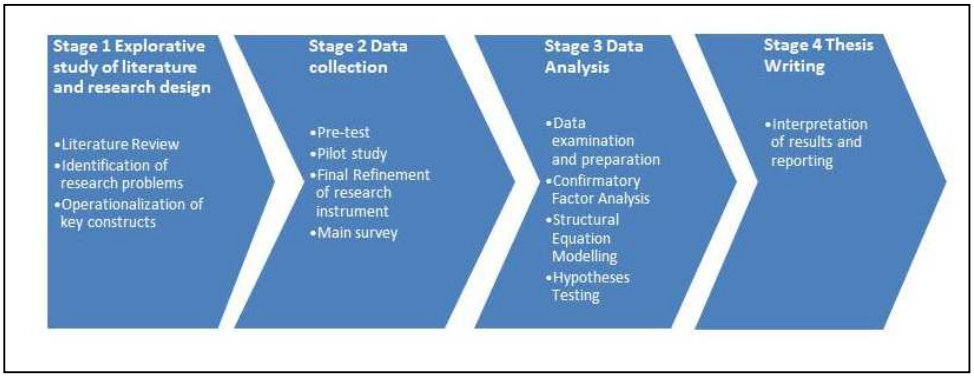


Figure 5.2 Research design and stages

There is much information about quantitative research to help researchers to establish statistical evidence to verify their hypotheses and provide strong reliability and valididy. For example, according to Neuman, Bryman and Bell (2007), quantitative methods are organised methods for combining deductive logic with precise empirical observations of individual behaviour, in order to discover and confirm a set of probabilistic causal laws that can be used to predict general patterns of human activity. Amaratunga et al. (2002) highlight that applying quantitative research helps the researcher to establish statistical evidence on the strengths of relationships between both exogenous and endogenous constructs. They also emphasise that the statistical results provide the directions of relationships when combined with theory and literature. Quantitative methodology can verify hypotheses and provide strong reliability and validity (Amaratunga et al. 2002; Bryman & Bell 2007).

Extensive research has been conducted in similar studies of the use of IT capability and environmental performance employing this methodology (Fink & Neumann 2007; Molla & Abareshi 2012; Molla, Cooper & Pittayachawan 2009). Since the objectives of this study are to empirically investigate casual relationships among the underlying constructs, this methodology has been deemed to be appropriate (Molla, Cooper & Pittayachawan 2009).

5.4 Justification of an empirical research design

An empirical research design is required in this study. This is because it presents stages or steps for data collection and analysis to answer research questions. This study has adopted the eight components of research design that are relevant to the aims of the study (Cooper & Schindler 2006; Sekaran & Bougie 2010). They are: type of investigation; extent of researcher's interference; study setting; unit of analysis; sampling design; time horizon; data collection; and measurement of variables.

As quantitative research, this study has goals to identify the current patterns of and the critical determinants for the use of IT capability to improve environmental peformance in the

Indonesian ICT industry. The critical factors of IT capability and environmental performance are derived from prior studies and related literature, which are used for developing the hypotheses and theoretical framework of the research (Veal & Ticehurst 2005). Therefore, these hypotheses and framework are tested by the collection, measurement and analysis of data to discover the critical factors of IT capability and environmental performance in organisations (Bryman & Bell 2007). This is consistent with the effort of this research to find out the expected factors of IT infrastructure quality and competence of IT human resources, which relate to business process digitisation and environmental IT competence, and in the end they affect environmental performance in organisations.

There are two types of investigation in business research: causal and correlation perspectives. The causal research perspective assesses the causes and effects of one or more problems. However, this approach is impractical for this study due to its complex, costly and time-consuming nature. In this study there is emphasis on the correlational effects that can help the research to identify the significant variables and factors related to the problem (Sekaran & Bougie 2010), that use the organisational level as its unit of analysis, and that involves minimal interference into the activities of the organisations studied, and so the correlational approach is appropriate.

5.4.1 Data collection method

As quantitative research, a survey questionnaire was used as the data collection method in this study. The questionnaire was developed to be implemented in Indonesian ICT organisations. This stage of this research encompassed the main research activity that is designed to obtain the data needed to validate statistically the conceptual model, answer the research quentions and attain the research objectives. Drawing on prior literature of the use of IT capability and environmental performance, this study has developed a theoretical model to answer the research questions that were identified in Chapter 1 and to test the hypotheses that were

developed in Chapter 3. Therefore, a survey questionnaire is used in this study to understand the picture of these organisations at a certain point in time.

Indonesia is a hugely diverse nation. It has more than 17,500 islands that are home to over 300 ethnic groups. Indonesia has 34 provinces located on those islands. Each province has its own language, culture, religions and history. For example, the people in West Sumatra speak the Minangkabau language. These local languages are usually spoken at home and in the local community as part of their culture and identity. Therefore, in this study, to make it easier to enter the culture and community of the respondents, the researcher employed families, relatives and friends who could speak the local language to approach the respondents to answer the questionnaire.

The ethnic background should also be taken into consideration when contacting various respondents. Respecting the cultural and ethnic background is necessary in order to be accepted and respected by the respondents. Respondents who have a Sumatran ethnic background permit some jokes in conversation, while Javanese participants prefer polite, relaxed conversation. By respecting this type of background, the research activities flowed smoothly. Further, the contacts and meetings were held several times, so that the respondents became more familiar with the researcher.

The organisation culture approach was used to access the Indonesian ICT organisations. Ravasi and Schultz (2006) argue that organisation culture is a set of shared mental assumptions that guide interpretation and action in organisations by defining appropriate behaviour for various situations. This embraces organisation behaviour, values, vision, working language, beliefs and habits, which have negative and positive aspects in causing cultural conflict. To understand the culture of an organisation, the researcher needs a key person as an informant to give information about the organisation’s situation and as an entry

point into a specific community or organisation. The informant also can help the researcher in determining the best respondents for answering the questionnaire. Therefore, the researcher can establish a relaxed and appropriate environment for the research processes.

This research adopted a drop-and-collect method involving the distribution of a self-administered questionnaire to identified respondents from Indonesian ICT organisations. This method provides a fast, cheap and reliable research tool (Brown 1993). Futhermore, the drop-and-collect method may avoid the risk of bias from non-participation, interviewer effects and social desiability effects, by harnessing the benefits of face-to-face recruitment and follow-up while leaving participants to complete the survey alone and in their own time (Maclennan, Langley & Kypri 2011).

Despite the reliability of the drop-and-collect method, this research also adopted a technology approach to carrying out the survey. Tablet technology, namely the iPad, was used to access the survey on the internet. This interactive device interested respondents in completing the questionnaire (Davis, Thompson & Schweizer 2012). Although the iPad has many interesting features including being light and portable, easily used and carried anywhere, the most important reason is that in Indonesia, the iPad is an expensive, luxury good that is difficult to obtain and therefore rarely used. Therefore, when the researcher showed the iPad as the tool for completing the survey, the respondents were more enthusiastic.

The list of identified respondents was derived from the Ministry of Trade. The final survey questionnaire consisted of 9 demographic and 66 content questions. To help the respondents understand easily and for quick response, the questionnaire was translated into Bahasa Indonesia, that is, the national language of Indonesia. This was to give choice and ensure clear communication with respondents, especially those from small ICT organisations.

5.4.2. Time horizon

This study used one-short or cross-sectional data, in which samples are analysed once in time, as opposed to a longitudinal study (Sekaran & Bougie 2010). Cross-sectional surveys are the most popular form of survey (Zikmund 2003). The information designed for cross-sectional analysis can be completely descriptive or involve testing relationships among population characteristics (Graziano & Raulin 2007). This type of research is low-cost and less time-consuming than a longitudinal study. This approach provides many opportunities to access relations among variables (Reis & Judd 2000); therefore, the cross-sectional approach was employed for conducting the survey.

5.4.3 Measurement of variables

There are four kinds of scales for quantifiying information: nominal, ordinal, interval and ratio (Bryman & Bell 2007). The nominal scale is classification of data into two or more categories that are mutually exclusive and collectively exhaustive. The ordinal scale is about data that is ordered and transitivity applies. The interval scale is numeric and the intervals have the same interpretation throughout. The ratio scale is an interval scale with the additional property that the zero position indicates the absence of the quantity being measured.

In this study, the interval and nominal scales were used in the questionnaire. The instruments in part 1 of the questionnaire mainly used nominative scales to describe respondents' profiles. In sections 2 to 6 of the questionnaire, an interval scale, namely the seven-point Likert scale, was used for the whole instrument.

There are several motivations for the use of a Likert scale in this study. First, this scale was chosen because most similar research used this scale. Furthermore, the scale allows respondents to express their favourable or unfavourable attitudes towards the object of interest. Second, the Likert scale is easy to develop, reliable and applicable to both

respondent-centred and stimulus-centred studies (Emory 1985). The last motivation is that the scale gave respondents more options for expressing their option.

5.5 Research instrument development

This section describes and rationalises the research instruments used in the survey questionnaire. The operationalisation of the instruments are discussed as follows.

5.5.1 Operationalisation of constructs

In this study, the required information to empirically comfirm the conceptual framework was acquired through the use of IT capability. More especially, the construct indicating the use of IT capability was investigated through previous literature. To facilitate the development of the scale items, an initial list of potential questions was drafted, based on previous literature. As a result, the questionnaire containing items to measure each variable was prepared for this purpose.

This study utilises the measurement of IT capability to find out the contributing factors to business process digitisation and environmental IT competence. The items capturing information about the use of IT capabilities are associated with IT infrastructure quality (ITQ) and IT human resource competence (ITC). Each construct was represented with a set of items. ITQ is represented by adoption of server virtualisation, database virtualisation, desktop virtualisation, implementation of cloud computing, implementation Radio Frequency identification (RFID), modularisation of information system and standardisation of information system and reports.

IT human resource competence consists of knowledge of organisational plans and policies, business environment, alignment of IT and business strategy, management system standard, government regulations and standardisation of IT equipment..

This study also examined the impact of business process digitisation (BPD) and environmental IT competence (EIT) on organisational environmental performance (OEP). BPD is divided into two factors: digital communication (DC) and digital business transactions (DBT). DC is determined by email, broadband communication networks, teleconferencing technology, tele-presence technology, right-sizing communication equipment, Wimax technology and network systems. DBT is represented by enterprise resource planning (ERP), e-procurement, environmental management systems, document management systems and electronic data interchange. OEP is measured by environmental management systems, energy consumption, CO_2 emission reduction, environmental initiatives, environmental disclosure and organisational environmental reputation.

Respondents' profiles and organisation backgrounds were considered obligatory questions on the survey, because there were several purposes for those questions. The first was to understand the profiles of the respondents as the main sources for this research. The second was to analyse the backgrounds of ICT organisations and business areas of organisations. The third was to develop related information that may be used as part of the research.

The questions about respondents' profiles were organised to meet the requirements of RMIT University's Human Research Ethics Committee. There were nine questions covering general characteristics: (1) job title; (2) organisational area of business; (3) work experiences; (4) how long they had worked in current organisation; (5) number of employees; (6) gender; (7) age; (8) level of education; and (9) level of computer skill. Those questions took the form of determinant-choice questions (Zikmund 2003) to recognise the background and nature of the business management of the respondent organisations. Furthermore, Zikmund (2003) states that these types of questions can be analysed with descriptive statistics. Table 5.2 summarises the characteristics of the questions asked in part 1 of the questionnaire.

Table 5.2 Characteristics of the questions for respondents' profile

Items	Questions	Type of question
Role of respondent	1. What is your job title?	Determinant-choice
	2. Please indicate your level of education.	
	3. What is your gender?	
	4. Please specify your age range.	
Respondent experience	1. How long have you been in the workforce?	Determinant-choice
	2. How long have you been working for your current organisation?	
	3. Please indicate your level of proficiency in the use of information technology.	
Type of organisation	1. In what business areas is your organisation involved?	Determinant-choice
Organisation category	1. How many employees does your organisation have?	Determinant-choice

5.5.2 Scaling and measurement

For the aim of investigating the critical capabilities of IT, a seven-point Likert scale was used. The Likert scale is the most widely used method of scaling in the social sciences today. It has been shown that a seven-point scale is just as good as any and that an increase from five to seven to nine points on a rating scale does not improve the reliability of the ratings (Elmore & Beggs 1975). It is sufficient to maintain an acceptable level of reliability while allowing greater flexibility in choosing data-analysing techniques for both metric and non-metric models, and it is likely to provide a better measure of the intensity of participants' attitudes or opinions. Further, the use of a Likert-type scale is recommended for IS research involving IT capabilities, concerns and performance measurement (Byrd & Turner 2000; Duncan 1995; Karimi, Somers & Bhattacherjee 2007; Tippins & Sohi 2003) and the implementation of structural equation modelling (SEM) as a data-collection method (Hair 2010). With the

exception of respondents' profiles, all variables were measured on a seven-point Likert scale. The point '1' on the scale indicated 'not at all important' while '7' represented 'extremely important' in response to the statements.

5.5.3 Item development

Items of each construct in the questionnaire were adopted from previous studies that investigated similiar issues. Some items were modificated to be implemented in Indonesian ICT organisations. For example, the words 'digital business' were replaced with 'business process' to be more easily understood by respondents. All items were examined and assessed for content validity and relevance by experts, which helped to obtain appropriate items used for the data analysis in this research.

5.6 Process of survey development

The large-scale survey through a survey questionnaire was developed based on the method suggested by Sekaran and Bougie (2010). Figure 5.3 shows that there were three major stages involved before conducting the main survey or the large-scale survey in the final step of this study.

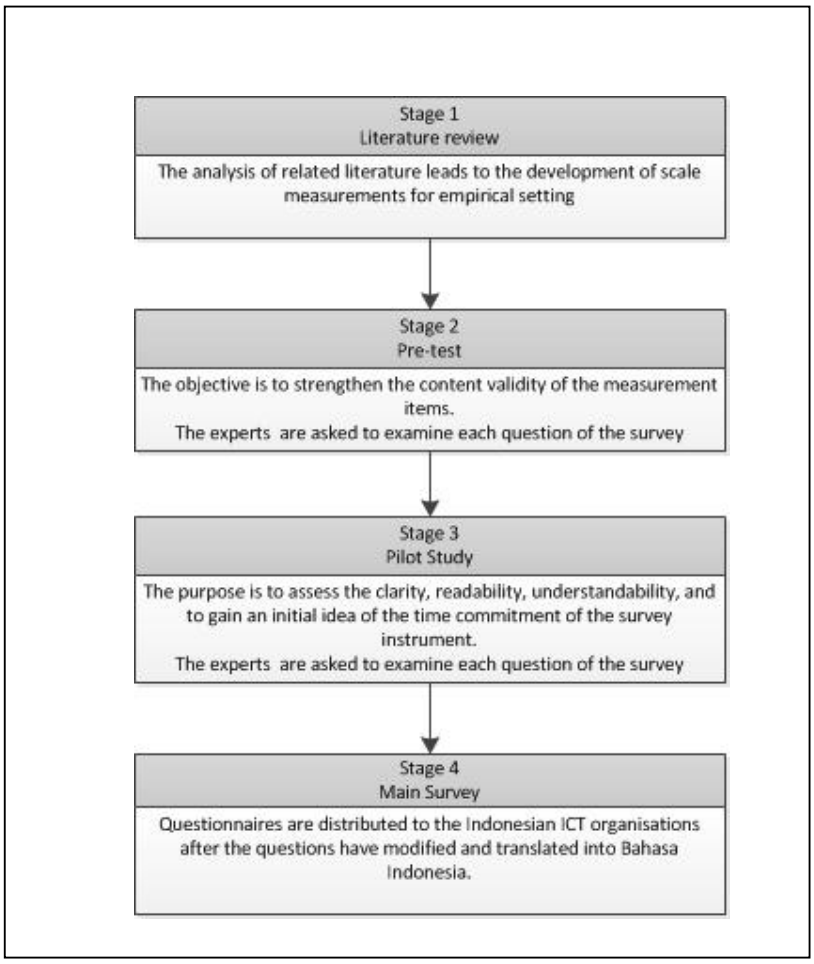


Figure 5.3 Survey instrument development procedures (Sekaran and Bougie (2010)

The next sub-sections comprehensively discuss each step of the survey instrument development in this study. Section 5.6.1 provides the literature analysis. Section 5.6.2 discusses the pre-test. Section 5.6.3 presents a discussion of the pilot study. The last section provides the data collection using a survey questionnaire.

5.6.1 Literature analysis

The literature analysis was used for developing a survey questionnaire of the study in deciding the use of the scale of measurement. There are several scales of measurement used in previous studies. Those scales of measurements are adopted based on different contexts and backgrounds of the research. Therefore, there is a need to analyse, modify and review the instruments obtained from existing studies which fit the business environment of the ICT industry. The selection and use of an accurate statistical technique to choose the appropriate and suitable scale also required time; after comprehensive analysis of the literature, this study

chose the seven-point Likert scale because the it has benefits in providing more accurate and consistent results for multivariate analysis than smaller ranges, such as a five-point Likert scale (Hair 2010).

5.6.2 Pre-test

A pre-test was required to refine the survey instruments for the research. This is used for determining the content validity of survey instruments (Hair 2010). The content validity is about the activity that involves the different aspects or dimensions of the construct for investigating the extent to which measurement items are used in the research (Hair 2010). This process can be identified by assessment of the wording, comprehensibility, interpretation consistency, logical sequencing and overall impression from the look and feel of the survey. Experts were involved to conduct the pre-test of the survey instruments. They were academic and business experts who had knowledge of the use of IT in organisations. The experts were requested to examine each question of the survey carefully and to provide advice and comments on content relevance, wording and the structure of the survey instruments. The advice from the experts was used to refine and modify the survey instruments.

5.6.3 Pilot study

After gathering the comments and advice from the experts to improve the survey instruments, the latest version of the survey questionnaire was then sent to one CEO of a computer organisation and five managers in telecommunications organisations for the pilot study. This activity is conducted for assessing the clarity, readability and comprehensibility and to gain an initial idea of the survey instruments. There was minor revision done based on the pilot study. It included the modification of some instruments of the survey. Then the survey was considered ready for collecting the data. The following tables present the final constructs and the associated items for measuring the individual constructs.

Table 5.3 The final constructs and the associated items for measuring the indiviual constructs

No.	Constructs	Items
1	IT infrastructure quality	• Adoption of server virtualisation • Adoption of storage virtualisation • Adoption of desktop virtualisation • Implementation of radio frequency identification (RFID) • Modularisation of information system • Standardisation of information system and reports
2	IT human resources competence	• Knowledge of environmental government regulations • Knowledge of management system standards • Knowledge of standardisation of IT equipment • Competence of network system • Competence of virtualisation technology • Competence of emerging technologies
3	Emission management	• Availability of the IT vision of an organisation • Availability of the IT goals of an organisation • Availability of a high degree of consensus among top management about the role of environmental IT in an organisation • Availability of the IT policy for managing IT resources • Availability of environmentally friendly IT purchasing procedures • Availability of reusable IT equipment procedures • Availability of IT equipment disposal procedures • Availability of end of IT life management

4	Sustainability behaviour	• IS functions are able to deliver information that relates to environmentally friendly work practices in an organisation • IS functions are able to build the commitment of employees to environmentally friendly work practices in an organisation • IS functions are able to promote the choice of environmentally sustainable courses of actions • IS functions are able to educate employees' behaviour reducing the energy consumption • IS functions are able to change employees' behaviour to environmentally friendly work practices in an organisation
5	Resources stewardship	• IT components are easily adopted in business operations • IS functions are easily upgraded in business operations • IT components are widely reused in new IT infrastructure • IT components are easily shared across business operations • IS functions are easily used to communicate among business units • IT components are made from non-hazardous materials • Power management of IT components • Recycling Information of IT components • Reusable software modules are widely reused in new system development • Applications used in organisation are designed to be reusable
6	Digital communications	• Adoption of email for internal and external communication • Adoption of electronic data interchange for formal external communication • Adoption of teleconferencing technology • Adoption of tele-presence technology • Adoption of energy-efficient communication equipment • Adoption of right-sizing communication equipment • Adoption of LAN and WAN for internal communication

7	Digital business transactions	• Adoption of enterprise resource planning • Adoption of e-procurement • Adoption of online delivery systems • Adoption of automated workflow systems • Adoption of document flow systems • Adoption of document management /archival systems
8	Environmental performance	• Energy consumption • CO_2 emission management • Environmental management system • Organisational environmental system • Environmental information disclosure • Environmental reputation

5.7 Data analysis approaches and tools

This study applies structural equation modelling (SEM), which is widely accepted as one of the most powerful statistical approaches in quantitative data analysis for testing both construct validity and theoretical relationships among constructs (Hair 2010). Before data analysis conducted, the data has to be assessed for missing data values, outliers, normality, linearity, non-response bias and common method bias. Then the data can be tested for validity and the reliability of the measurement instrument underlying the research model has to be established using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) (Straub, Boudreau & Gefen 2004). The last stage is when the research hypotheses are applied to find out the relationships among the constructs in the research model.

To prepare the data for EFA, this study used SPSS version 22 software. SPSS is a famous software package used for statistical analysis in the social sciences. In this research, it was utilised to store the data collected from the survey, generate descriptive statistics, identify missing data, detect outliers, test for normality, examine linearity, test for non-response bias, assess common method bias and test for EFA. The analysis of moment structures (AMOS)

version 22 was employed for the instrument and structural validity assessments, including CFA and the structural model.

5.8 Ethics

The study was undertaken in accordance with RMIT's ethics guidelines. The aim of these procedures were to ensure that the questionnaire was designed based on the standard requirements of the Ethics Committee. Ethical approval was obtained from the RMIT Human Research Ethics Committee (HREC) prior to conducting the survey in Indonesia over the period 20 February 2013 to 20 April 2013. The approval letter can be seen in Appendix 5.

5.9 Summary

This chapter has discussed the methodology used in this research. The research followed the positivist paradigm and used a quantitative-method research design. A sequential exploratory design that involved a literature review, pre-test, pilot study and main survey was adopted in this research. The data collection was conducted by a paper-based and online survey. Finally, the last section of this chaper discusssed the ethical considerations of this study which were approved by the HREC, RMIT University. The next chapter will discuss the data examination and preparation.

Chapter 6
Data examination and preparation

6.1 Introduction

The previous chapter discussed the research methodology comprehensively used in this research. The aim of this chapter is to understand the fundamental properties of the data and examine that data to meet the essential statistical requirements for conducting SEM/AMOS analysis. This step involves several tests to detect missing values, outliers, kurtosis and skews in assessing the normality of the data set.

This chapter is organised into seven sections. Section 6.2 discusses an overview of the survey data. Section 6.3 provides the steps to identify missing data values and provide remedies. Section 6.4 discusses the steps and procedures used for determining outliers. Section 6.5 discusses the test for normality and Section 6.6 the test for linearity. Section 6.7 presents discussion of the test for non-respondent bias and Section 6.8 for common method bias. Section 6.9 presents a summary of this chapter.

6.2 An overview of the survey data

This section presents the profiles of respondents including job title, business area, age, education level, level of proficiency in the use of information technology and number of employees, which is explored as part of the data validation in this study.

As mentioned in Chapter 5 Research methodology, the sample in this research was limited to the IT managers of Indonesian ICT organisations, with a response rate of 30% with 378 respondents. Table 6.1 provides a detailed descriptive frequency table of organisation types. As shown, computer hardware and peripheral information technology accounted for about 45% of respondents; telecommunications organisations for 32.8%; IT training and consultants

for 6.3%; software IT solutions for 9.9%; and other organisations including internet service providers for 5.7%.

Table 6.1 Organisation types

No.	Organisation types	Freq.	%
1	Computer hardware and peripheral IT	174	45
2	Telecommunications	126	32.8
3	IT training and consultants	24	6.3
4	Software IT solutions	38	9.9
5	Others	22	5.7
	Total	380	100

In terms of the positions held by respondents, the majority were managers (27.5%). Supervisors were 26.3%, CEOs were 5.7% followed by directors at 4.7%. The other 35% of respondents consisted of assistant managers, assistant supervisors and officers.

Table 6.2 Respondent positions

No.	Positions	Freq.	%
1	CEO/President	22	5.7
2	Director	18	4.7
3	Manager	105	27.3
4	Supervisor	101	26.3
5	Others	138	35.9
	Total	380	100

In terms of the size of the organisations, 50.8% of respondents had between 1 and 50 employees, 30.7% had between 51 and 100 employees at the time of study and 10.2% had between 101 and 250 employees. The organisations that had between 251 and 500 employees numbered 3.1% followed by the organisations that had between 500 and 1000 employees and more than 1000 employees, which numbered 2.6%.

Table 6.3 Organisation size

No.	Organisation size	Freq.	%
1	1–50 employees	195	50.8
2	51–100 employees	118	30.7
3	101–250 employees	39	10.2

4	251–500 employees	12	3.1
5	501–1000 employees	10	2.6
6	>1001 employees	10	2.6
	Total	380	100

The majority of respondents had 6 to 10 years of experience, numbering 45.3%. The second group was the respondents who had 1 to 5 years of experience, 24%. Those who had more than 20 years' experience were in third place with 13.8%. Then 9.9% and 7% of respondents had experience of 11 to 15 years and 16 to 20 years respectively.

Table 6.4 Respondent experience

No.	Experience	Freq.	%
1	1–5 years	92	24
2	6–10 years	174	45.3
3	11–15 years	38	9.9
4	16–20 years	27	7
5	>20 years	53	13.8
	Total	380	100

Table 6.5 shows the education of respondents. Those who had completed their bachelor degrees contributed 70.8%, those who had master's degrees numbered 18.8% and 7.3% had diplomas or advanced diplomas. This was followed by respondent who had high school education with 3.1%.

Table 6.5 Respondent education

No.	Education	Freq.	%
1	High school	12	3.1
2	Diploma / advanced diploma	28	7.3
3	Bachelor degree	272	70.8
4	Master's degree	72	18.8
5	Doctoral degree	0	0
	Total	380	100

In terms of the level of proficiency in the use of IT, most respondents had a high level of proficiency with 50%, 45.6% had average proficiency followed by low-skilled respondents with 4.4%.

Table 6.6 Level of proficiency in the use of IT

No.	Level of proficiency	Freq.	%
1	Low	17	4.4
2	Average	175	45.6
3	High	192	50
	Total	380	100

6.3 Missing data values

The data for this study was collected in Indonesia using a paper-based questionnaire and an online survey (see Appendix 4 for the survey questionnaire). The questionnaire was distributed to approximately 904 ICT organisations in Indonesia. After the initial mailout in February 2013, to encourage responses, follow-up efforts were undertaken both in person and by phone until the end of May 2013. After a four-month period, 404 responses were received (31.9% return rate). Initial examination of the 404 responses identified 20 incomplete cases with too much missing data and so these responses were excluded. This left 384 cases for further analysis. With a new response rate of 20%, all necessary efforts were made to avoid data entry error through utilising SPSS's feature of defining acceptable values and labels for each variable.

Missing data refers to a situation in which valid values for one or more variables are not available for analysis (Hair 2010). All the missing data in this study was due to the respondents not having supplied answers to some questions. This necessitated further assessment of the extent and impact of the missing data. The overall extent of missing data is assessed by calculating the number of the cases with missing data for each variable and the number of variables missing in a particular case. The analysis showed that there were 9 missing cases in the data set, excluding non-metric data values. Based on the analysis, the missing data was less than 10% and appeared at random and so the missing data could generally be ignored (Kaplan 2009; Hair et al 2010). This is because the missing data does

not affect the overall observation of the research finding (Hair et al. 2010). Therefore, the missing data can be replaced by appropriate values (Kaplan 2009).

Table 6.7 Missing data values

No	Variables	Indicators	Missing	Percent
1	IT infrastructure quality	ITG11	1	0.3%
		ITG12	1	0.3%
		ITG14	2	0.5%
2	Business process digitisation	BDC06	2	0.5%
		BDC08	1	0.3%
3	Environmental IT competence	SB07	1	0.3%
		RS14	1	0.3%
	Total		9	0.25%

After identifying the missing data, the next step is to replace the missing data using SPSS software. The replacing of missing data with the use of the expectation-maximisation (EM) technique is widely accepted for dealing with missing data (Kaplan, 2009). This is a technique that is suitable when the missing data appears at random. The missing data values are replaced with appropriate values that are generated by the EM technique in SPSS software (Kaplan, 2009).

6.4 Outliers

An outlier refers to a case or observation of the value of a variable or combination of variables that is substantially different from those values in other cases or observations (Byrne 2010; Hair et al. 2010) . Outliers can be defined not to be representative of the population. They can distort statistical tests and thus work counter to the objectives of a research study. Outliers can be checked from univariate, bivariate and multivariate perspectives. This research performed a multivariate test for outliers, as the study used a SEM-based multivariate analysis that investigates for multivariate outliers that have extreme scores on two or more variables. This is opposed to univariate outliers that have an extreme score on a single variable.

There are several common methods for identifying multivariate outliers in research. Computation of the squared Mahalanobis distance (D2) is one of the popular methods for detecting outliers. It measures the distance of a case from the centroid (multidimensional mean) of a distribution, given the covariance (multidimensional variance) of distribution. With the use of this statistical measure, the survey data was examined for detecting outliers that could seriously affect the data analysis. According to Hair et al. (2010), outliers can be identified where the D2/df value exceeds three or four in large samples. Therefore, in this research, out of 384 samples, there were 6 cases detected as serious outliers that had D2/df values equal to or exceeding three. These outliers were deleted from the analysis (Shumacker & Lomax, 2004). The following table shows the cases dropped from further analysis.

Table 6.8 Multivariate outlier test results

No.	Id	Independent variables	D2/df
1	50	IT human resources	4.4
2	61	IT human resources	4.4
3	96	IT human resources	3.1
4	145	Business process digitisation	3.9
5	160	Environmental IT competence	4.0
6	345	Environmental IT competence	3.9

In summary, the analysis for the presence of multivariate outliers identified 6 cases as outliers and dropped them from further analysis. Therefore, only the remaining 378 cases were used in all subsequent analyses performed as part of this study.

6.5 Normality

In previous sections, missing data and outliers were examined and appropriate remedies were applied to prepare the data in a form suitable for multivariate analysis. In this section, the data is tested for normality, which is needed to comply with several multivariate analyses including SEM/AMOS.

A normality test is needed to establish the distribution and characteristics of the statistics for a single individual variable that approximates a normal distribution. As suggested by Hair et al. (2010), this can be examined based on skewness and kurtosis values. Skewness describes the symmetrical balance of the distribution. It can be either negative (the distribution is tended and shifted to the right) or positive (the distribution is tended and shifted to the left). Kurtosis refers to the 'peakiness' or height of a distribution. Positive kurtosis indicates a higher peak than the normal distribution. Negative kurtosis indicates that the distribution is flatter than the normal distribution. Departure from normality in term of kurtosis and skewness indicates a violation of the assumption of normality.

Assessment of the skewness and kurtosis values can be conducted by several methods including the visual test and statistical test. In this study, the skewness and kurtosis were measured by statistical test values. This method is named z-skewness and z-kurtosis respectively. As a rule of thumb, the value of skewness and kurtosis divided by the standard error should be between +1.96 and –1.96 for the desired corresponding 0.05 error level or, more linearly, within –2.58 and +2.58 for the desired 0.01 error level for normally distributed variables. The more lenient –3 to + 3 is also widely used in the literature. A study by West, (Hoyle 1995) suggests that the standardised kurtosis index value equal to or greater than 7.0 is an indication of departure from normality. Kline (2010) suggests a more lenient measure of +10 to –10 for kurtosis.

The kurtosis and the skewness for the survey dataset were assessed using AMOS 21. Appendix 2 provides the statistical results for skewness and kurtosis, in which their statistics were divided by their respective standard errors to obtain the critical ratios of skewness (ZSkewness) and kurtosis (ZKurtosis) for 45 metric variables. From the 45 metric variables, there was only one variable that showed deviation from normality in the overall normality tests, applying the stringent +7 and –7 critical ratio of kurtosis. According to the more lenient measure of kurtosis, none of the three variables suggests a problem (Kline 2010).

Regarding the metric variables that have a problem with skewness, they were inconsequential, since skewness tends to affect only mean-based analyses, such as partial least square. As already mentioned, SEM/AMOS is based on covariance-analysis, which is more sensitive to problems of kurtosis rather than skewness. Furthermore, because of the large sample size of this study (larger than 300 sample organisations) and considering that the departure from normality observed with three of the variables was not significant enough to affect the analysis that this study intended to conduct, the presence of those non-normal variables could be tolerated. A large sample size has the potential to reduce the detrimental effect of departures from normality (Hair et al. 2006, 80–81; Byrne 2010).

6.6 Linearity

The linearity test is an essential requirement for conducting factor analysis procedures. Hair et al. (2010) state that linearity is a consistent slope of change that represents the relationship between the independent variable and the dependent variable. If the association between variables is nonlinear, the association effects will not be represented in the correlation value. This means that the association results in an underestimation of the actual strength of the relationship (Hair et al. 2010).

The test for linearity can be obtained by the graphical method and statistical method (Tabachnick & Fidell 2001). With the statistical technique, the hypothesis test for linearity is examined. The relationship is linear if the difference between the linear correlation coefficient and the nonlinear correlation coefficient is small. In the graphical method, a scatter plot of the observed versus the predicted values or a plot of residuals versus predicted values is analysed. The point has to be symmetrically distributed around the diagonal line in the former plot and the horizontal line in the latter plot.

In this study, scatter plots were used for identifying the linear relationship between variables. Figures 5.1 to 5.4 show the results of the regression analysis, which displays the normal P-P

plot of items for IT infrastructure quality, IT human resource competence, environmental IT competence and business process digitisation. The outputs confirm linear relationships between the dependent and independent variables in each level of the model and also show that the distribution of scores is normal.

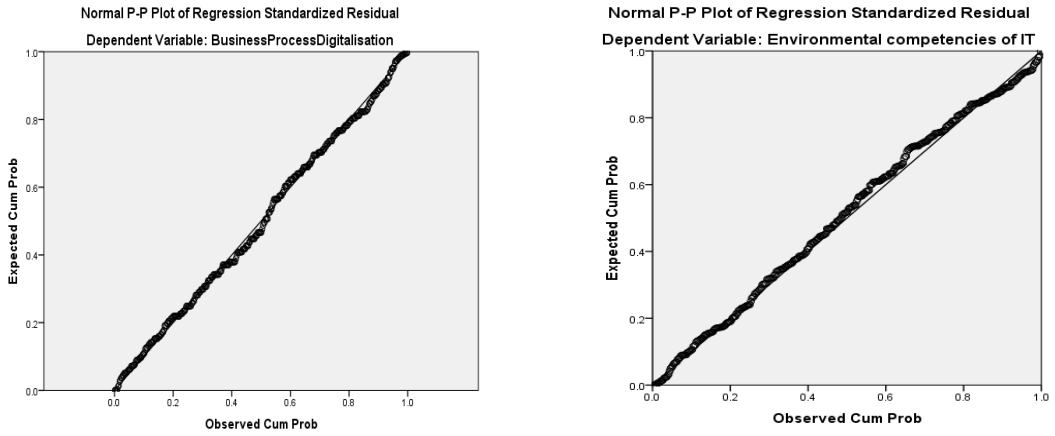


Figure 6.1 Normal P-P plot of IT infrastructure quality

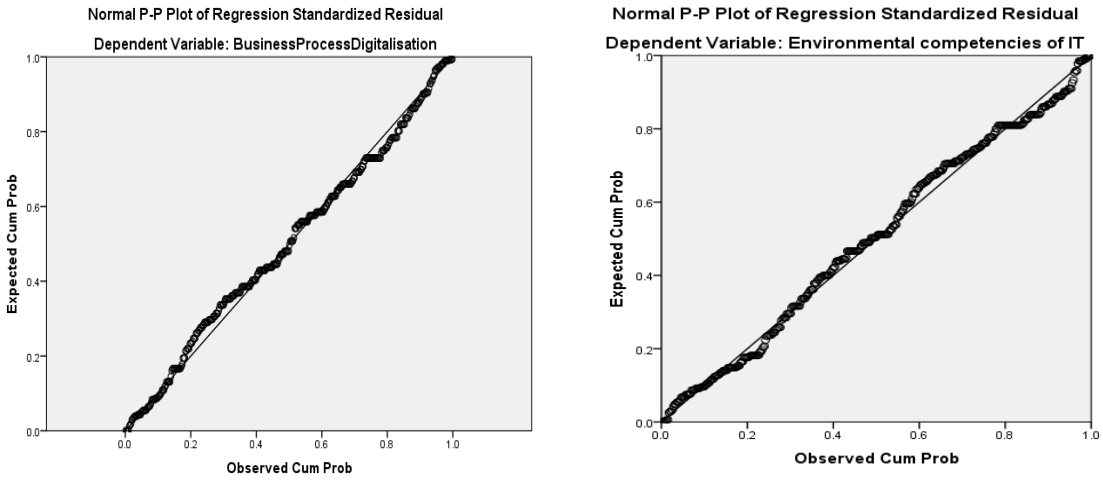


Figure 6.2 Normal P-P plot of IT human resources competence

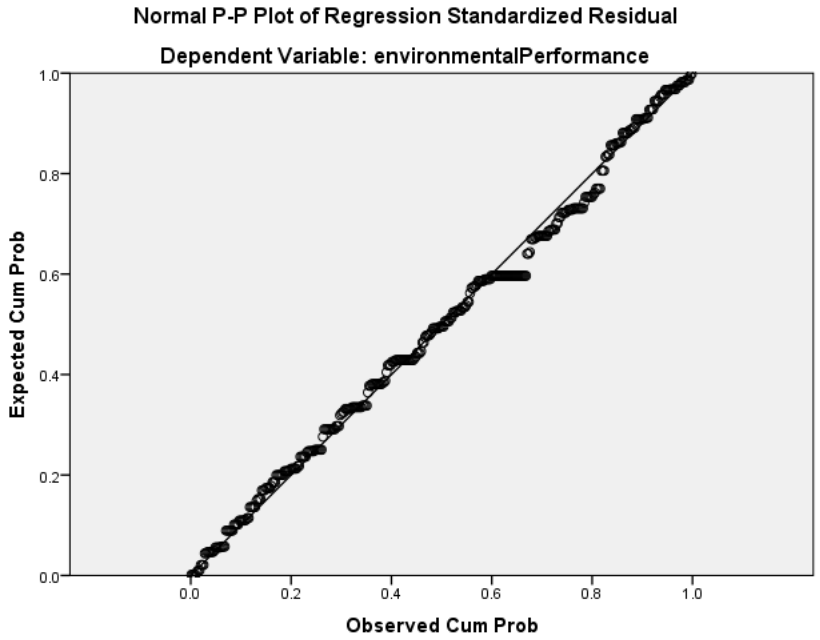


Figure 6.3 Normal P-P plot of environmental IT competence

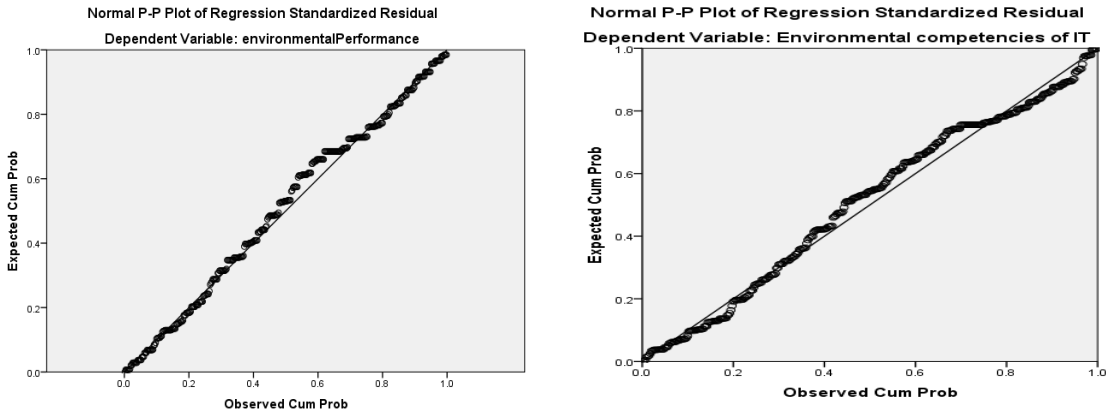


Figure 6.4 Normal P-P plot of business process digitisation

6.7 Non-response bias test

Non-response bias is defined in various ways by researchers. Several previous studies have defined that non-response bias is an inevitable issue in statistical surveys when the answers of the respondents differ from the potential answers of those who did not answer. Other studies have described that late respondents answer differently from early respondents, and the differences may be due to the different level of interest in the subject. Furthermore, non-

response bias can be defined as a low accuracy of estimation when the research findings are generalised to the population.

From the definition discussed above, there was a need to conduct a test of non-response bias in the current research in order to generalise the research findings to the population. The most popular method is comparison of the responses of early respondents against those of late respondents during the data collection period, which helps to estimate the potential effect of non-response bias. Although there is no established norm for the characteristics that can be used to compare early with late respondents, the literature suggests that respondents who are more interested in a survey respond earlier than those who have no interest and who are, therefore, assumed not to respond (Collis et al. 2003; Lewis-Beck 2003).

To assess non-response bias, the current research uses the independent sample T-test in SPSS software. It is tested by comparison of the pattern of 'early' responses as phase 1 and 'late' responses as phase 2 through returned questionnaires being marked and recorded with the dates they were received. Phase 1 contained 50 respondents, 13% of total respondents, while phase 2 also contained 50 respondents or 13%. The objective is to determine whether there is a statistically significant different in the mean scores of the demographic data including mean of organisation size, mean of organisational business areas, mean of respondent's education level and respondent's gender of those participants who responded earlier and later.

Table 6.8 provides the statistical findings of the independent T-test. The T-test for equality of means shows that the appropriate values of mean difference = 0.100 for organisation size, organisation business areas = 0.040, education level of respondents = 0.040 and gende r= – 0.140. As a result, the outputs of the test for non-response bias in the table reveal no significant difference between earlier and later respondents at a 95% confidence interval for the chosen variables. This finding suggests that even if there is a non-response bias, it is not statistically significant in biasing the data and does not prevent us from making generalisations from the sample to the population.

Table 6.9 Independent sample test for non-response bias

No	Variables	F	Sig.	T	Mean			Std error differences
					Ear	La	Diff.	
1	Organisation size	0.609	0.437	0.393	5.500	5.400	0.100	0.254
2	Organisation business area	0.157	0.393	0. 404	2.020	1.980	0.040	0.098
3	Education level of respondents	0.090	0.765	0.450	3.180	3.140	0.040	0.088

6.8 Common method bias test

Common method bias or common method variance is a variance that may occur as the result of the measurement method, rather than being due to the constructs that the measures represent. Data collected from the same person for both the predicator and criterion variables using a single method and/or at one point of time may have a part of variance that the measurement items share in common, due to the method of data collection, rather than being due to the relationship hypothesised in a given research model. Method bias, if it exists, causes a measurement error that negatively affects the validity of the conclusion drawn.

There are several methods in the literature for testing and diagnosing common method bias. Harman's single factor test is the most widely used, by loading the measurement items into the factor analysis and examining the unrotated factor solution of an exploratory factor analysis to determine the number of factors accounting for the variance in the measurement items (Podsakoff et al. 2003). According to this method, common method bias occurs if there is a substantial amount of common method variance when a) a single factor appears from the factor analysis or b) one factor accounts for the majority of the covariance (more than 50%) among the variables.

An exploratory factor analysis was performed to assess the possibility of common method bias in this research under the conditions that the number of factors was extracted to 1 and no

rotation method is used. The finding shows that one general factor accounts for 34.116% of the total variance. This number indicates that a substantial amount of variance is described by a single factor. However, it does not account for the majority (more than 50%). The finding provides no significant bias in the data set due to the research method. Therefore, the test for generalisability of the data and for common method bias confirm that there is no significant bias.

6.9 Summary

The aims of this chapter were to provide a profile of the respondents and to examine the data collected from the survey for missing data values, outliers, normality, linearity, non-respondent bias and common method bias, the results of which were used for preparing the data analysis. The respondent profile presents the organisation type, organisation size, respondent's position, gender, proficiency in computer use and also the experience of the respondent. In the missing data test, there were 9 cases and remedial actions were also taken. The test for outliers revealed that 6 cases had to deleted from the dataset and further analysis. The finding of the linearity test revealed that there were linear relationships between the dependent and independent variables of this research. For non-response bias and common method bias, the tests confirmed that there is no significant bias in this research. A total of 6 cases were deleted after the data screening and cleaning procedures discussed above, which left a final sample size consisting of the data from 378 respondents. Therefore, after the data was ensured to be free from missing data values, outlier cases, non-normal cases, non-linear cases, non-respondent bias and common method bias, this stage of examination and preparation has made the data ready for further analysis in the next chapter, including exploratory factor analysis, confirmatory factor analysis and the hypothesised structural model test.

Chapter 7
Instrument validation and measurement model

7.1 Introduction

This chapter ensures the validity and reliability of the measurement model. Several rigorous validation procedures were employed to ensure the instrument of measurement was both valid and reliable. These procedures involved content validity, reliability assessment, exploratory factor analysis and construct validity through confirmatory factor analysis. Validity and reliability are properties of instrument measurement that provide the research community with confidence in the results of the study. Validity measures whether an instrument actually measures what it sets out to measure. It represents the degree of accuracy with which the instrument is measuring the construct it is purporting to measure and the uniqueness of the measurement instrument from measures of other constructs. Reliability measures whether an instrument is consistent across different situations or on repeated occasions. EFA is an approach utilised to reveal the underlying structure of a relatively large set of variables. This method examines whether a theoretical construct is a uni– or multidimensional factor and also ensures items are sufficiently intercorrelated to produce representative items. Once the factor structure underlying each of the theorised research constructs was determined through EFA, it was necessary to assess construct validity further through CFA before assessing the structural model and testing the research hypotheses.

The chapter is structured as follows. First, a brief introduction is presented in Section 7.1. Section 7.2 provides a discussion of the process to purify the initial measure. Section 7.3 explains the reliability assessment and establishing dimensionality using EFA is discussed in Section 7.4. Section 7.5 discusses the ensured construct validity associated with the convergent validity and discriminant validity of both first-order and full measurement models using CFA. Section 7.6 provides a summary of this chapter.

7.2 Content validity

Content validity is defined as the degree to which items in the measurement reflect the content universe to which the instrument will generalised (Boudreau, M-C, Gefen & Straub 2001). It measures the extent to which the questionnaire items pulled are representative of the universe of all possible measures for a given latent construct.

Content validity is generally established by a literature review and expert judges or panels. This latter procedure is often termed a POE survey. Pre-testing and/or pilot testing is another method of establishing content validity. Pre-testing is a preliminary trial of some or all aspects of the instrument to ensure that there are no unanticipated difficulties. A pilot test, on the other hand, refers to a brief preliminary survey, often using a small convenient sample of the same population to which the final survey will be administered. In this research, the content validity was ensured through:

- Defining the area constructs comprising the theoretical model clearly and unambiguously. Previous literature was reviewed in depth and where appropriate items were taken from existing instruments and adapted in light of the preliminary case study findings conducted prior to instrument development.
- Pulling a large number of items initially (see Appendix 5.1a)
- Conducting a pre-test survey that involved academic and business experts (see Section 5.6.2) to rate the relevance of the items to the construct supposedly being measured
- Conducting a pilot test with 6 respondents representing one CIO of a computer organisation and five managers in telecommunications organisations of the sample frame to which the final questionnaire survey was to be administered. This stage helped to purify and tailor the wording of some of the measurement items based on suggestions received from pre-test respondents.

The procedures discussed above ensured that the individual instruments had sufficient content validity.

7.3 Reliability assessment

A reliability assessment is a recommended method for conducting a purification measure before conducting exploratory factor analysis (EFA). It identifies and removes the unnecessary items through statistical approaches. This method is required as the first measure used to ensure the quality of a construct. The most common statistic for evaluating internal consistency reliability is the coefficient of internal consistency (Cronbach's Alpha) (Straub, Boudreau & Gefen 2004). The coefficient alpha measures the average ratio of item variance to scale variance, taking into account the number of items in the scale. Furthermore, Cronbach's Alpha was calculated for each construct as recommended by Straub, Boudreau and Gefen (2004).

The value of Cronbach's Alpha is from 0 to 1, where 0 is completely unreliable and 1 is perfectly reliable. As a rule of thumb, an alpha value range of 0.5 to 0.6 is considered acceptable for exploratory research and a Cronbach's Alpha value greater than 0.7 is highly preferred (Hair 2006). Therefore, based on the recommended practices, this study followed the procedures above to identify and remove the unnecessary items to ensure the quality of a construct.

Using the IBM SPSS statistics software version 22, this study assessed psychometric properties of eight constructs including IT infrastructure quality, IT human resources competence, digital communication, digital business transactions, emission management, sustainability behaviour, resource stewardship and environmental performance. The results showed Cronbach's Alpha values of ITQ=0.835, ITH=0.877, EM=0.812, SB=0.917, RS=0.890, DC=0.846, DT=0.891 and EP=0.912, confirming acceptable reliability and evidence of content and construct validity for all the measurement items of the eight constructs. Table 7.1 shows the output of overall Cronbach's Alpha.

Table 7.1 Summary of Cronbach's Alpha

No	Variables	Constructs	Items	Number of items	Cronbach's Alpha
1	IT Infrastructure Quality (ITQ)	IT Infrastructure Quality (ITQ)	ITF01, ITF02, ITG03, ITG04, ITG05, ITG06	6	0.835
2	IT Human Resources Competence (ITH)	IT Human Resources Competence (ITH)	HRM01, HRM02, HRM03, HRT04, HRT05, HRT06	6	0.877
3	Environmental IT Competence (EIT)	Emission Management (EM)	EM01, EM02, EM03, EM04, EM05, EM06	6	0.812
		Sustainability Behaviour (SB)	SB07, SB08, SB09, SB10, SB11	5	0.917
		Resource Stewardship (RS)	RS12, RS13, RS14,RS15	4	0.890
4	Business Process Digitisation (BPD)	Business Digital Communication (BDC)	BDC01, BDC02, BDC03, BDC04, BDC05, BDC06, BDC07	7	0.846
		Business Digital Transactions (BDB)	BDB08, BDB09, BDB10, BDB11, BDB12	6	0.894
5	Environmental Performance (EP)	Environmental Performance (EP)	EP01, EP02, EP03, EP04, EP05, EP06	6	0.912
		Total		45	

Besides Cronbach's Alpha, the estimated values of items from five variables including ITQ, ITH, BPD, EIT and EP were calculated. The items with an estimated value of less than 0.5 were identified. From this procedure, three items were deleted due to low estimate values less than 0.5. Table 7.2 show the summary of the deleted items from this purification stage.

7.4 Exploratory factor analysis

Exploratory factor analysis (EFA) is a statistical approach utilised to reveal the underlying structure of a relatively large set of variables. This method examines whether a theoretical constructs is a uni– or multidimensional factor and also ensures items are sufficiently intercorrelated to produce representative items. Furthermore, based on Straub, Boudreau and Gefen (2004), the EFA is formed separately for each set of items posited to reflect a given theoretical construct. Therefore, in the current research, EFA is used as a statistical method to derive the initial set of items for the constructs that will be used for further analysis.

Sample adequacy is an important concern in EFA. Hair et al. (2010) argue that the sample size should satisfy the case-to-variable ratio of 5:1 as a minimum, but should preferably be v10:1. The measurement model contained a total of 52 variables with a sample size of 378, where ITQ consisted of 6 variables, ITH competence contained 6 variables, BPD had 15 variables, EIT consisted of 21 variables and EP had 6 variables. Therefore, the sample size of this study, which is 378 organisations, also satisfies the case-to-variable ratio of 5:1–10:1 and thus lends further support to the appropriateness of running EFA (Hair et al. 2010).

After the case-to-variable ratio was checked and found to be adequate to support EFA, the measurement model required further data analysis to establish the appropriateness of the data for the five EFA models through the Kaiser-Meyer-Olkin measure of sampling adequacy (KMOMSA) and Bartlett's test of sphericity (BTOS) (see Table 7.1). Generally, data is factorable (that is, EFA is possible) if the KMOMSA value is between 0.5 and 1 and the BTOS is significant (that is, below 0.05) (Hair et al. 2010, 132). Furthermore, the results in Table 7.2 show that the sample correlation matrix differed significantly from the identity matrix and, as such, sufficient correlations do exist among the items measuring the constructs.

Table 7.2 KMOMSA and BTOS

No	Constructs	No. of items	KMOSA	BTOS	Case-to-variable ratio	Comments
1	ITQ	6	0.809	0.000	63:1	KMOMSA supported
2	ITH	6	0.891	0.000	63:1	KMOMSA supported
3	EIT	21	0.909	0.000	18:1	KMOMSA supported
4	BPD	13	0.901	0.000	29:1	KMOMSA supported
5	EP	6	0.865	0.000	63:1	KMOMSA supported
	Total	52				

After the appropriateness of the data for EFA was determined, the following rules and procedures were utilised to extract the factors in this research.

Principal component analysis

In this study, the factors were extracted utilising principal component analysis (PCA). This is because the aim of factor analysis is to reveal relatively uncorrelated (orthogonal) common factors that summarise the major part of the information represented by the original variables (Mulaik 2009). Further, PCA produces the most essential set of variables that maximally capture the variance of a factor and is the most commonly followed factor extraction method in IS research (Gefen & Straub 2005). PCA is also the preferred method in empirical research, as it uses mathematically convenient algorithms to estimate communalities, to determine the number of factors and to compute factor scores (Mulaik 2010, 219).

KMOMSA

The number of items in each of the five factors in this study were determined based on Kaiser's criterion of retaining factors with eigenvalues greater than 1.0 (Hair et al., 2010).

Varimax rotation method

This method was used to rotate the factors to load items to factors more clearly and for better interpretability (Hair et al., 2010, 115).

Factor loading

The minimum factor loading to allocate an item to a factor was set at 0.5. Field (2009) and Hair et al. (2010) suggest selecting a threshold level that improves the within-factor correlation and reliability. They also suggest taking into account the sample size, as smaller samples require higher factor loadings, whereas larger ones require relatively smaller factor loadings. For a sample size of 200, a factor loading of 0.40 or higher is considered to be statistically significant at the 0.05 significance level.

Appendix 4 provides the results of the five EFA models and Table 7.3 presents the summary of deleted items that did not meet the factor extraction criteria including factor loading. Several items have significant factor loadings above 0.5. The result establishes factorial validity and represents an initial specification of the measurement model in this study. Furthermore, the results from this stage will be used in the next analysis including construct validity through CFA using AMOS.

Table 7.3 The deleted items of constructs

Constructs	Factors	Deleted items	Factor loadings	Comments
Business Process Digitisation	DC	BDC01: Adoption of email for internal and external communication	0.344	Factor loading < 0.5
		BDC06: Adoption of WIMAX technologies for wireless communication	0.316	Factor loading < 0.5

7.5 Assessment of construct validity through CFA

Once the factor structure underlying each of the theorised research constructs was determined through EFA, it was necessary to assess construct validity further through CFA before assessing the structural model and testing the research hypotheses (Byrne 2010; Hair et al. 2010). A critical consideration in using CFA is sample size. A sample size above 200 is

generally considered good (Hair et al. 2010, 662; Lewis, Templeton and Byrd 2005, 394). Since the valid sample size for this study is 209, it meets the requirement.

Construct validity assesses the extent to which a set of measured items actually reflect the underlying factor model that those items are designed to measure (Hair et al. 2010, 708). Construct validity focuses on the measurement of individual constructs. Two construct validity assessments – convergent and discriminant – were tested. The tests were undertaken first for each individual factor model, then for the higher order model (whenever appropriate) and finally for the full measurement model (Lewis, Templeton & Byrd 2005). This section provides an overview of convergent and discriminant validity and reports the results of the construct validity of the measurement model.

7.5.1 Convergent validity

Convergent validity assesses the extent to which the indicators of a specific construct converge or share a high proportion of variance in common (Hair et al. 2010; Straub, Boudreau & Gefen 2004). The convergent validity of an indicator can be established by assessing whether all factor loadings for the indicators measuring the same construct are statistically significant. In this study, AMOS is utilised to measure the convergence validity of a construct through assessing one or a combination of the following measures.

In AMOS, the convergence validity of a construct can be assessed using one or a combination of the following measures: goodness of fit (GOF) measures; squared multiple correlation (SMC), which is a function of the size of the standardised factor loadings (SFL); average variance extracted (AVE); and construct reliability (CR) (Straub, Boudreau and Gefen 2004; Hair et al. 2010). When the GOF showed poor fit to the theorised model, the model was respecified. The various measures of convergent validity and the considerations for model respecification are discussed briefly below.

GOF indices: GOF indices are important to be used to determine the goodness of fit between theory and reality (Hair et al. 2010). It can be measured for many criteria. For example, Byrne (2010) says GOF can be categorised into three groups: absolute, incremental and parsimony fit measures. In addition, Hair et al. (2010) argue that GOF indices can be grouped into three general categories: absolute fit indices, incremental fit indices and parsimony fit indices. In this study, the GOF indices recommended by Hair et al. (2010) are considered for evaluating the fit indices due to providing adequate support for a model fit (Hair et al., 2010).

Accordingly, as recommended by Hair et al. (2010), Chi-square (X^2) values and degrees of freedom, at least for the incremental index (CFI of TLI) and at least one absolute index (RMSEA or SRMR) have to be reported. Table 7.4 provides the category of GOF indices and summary of fit measures and established criteria.

Table 7.4 Goodness of fit statistics

Categories	Name of GOF criteria	Definitions	Fit criteria	Comments
Chi-square (X^2)	Chi-square	Difference between observed and estimated covariance matrices	P value > 0.05	P value can be less than 0.05 (this indices is sensitive to large sample sizes)
	Degree of freedom	Covariance in the observed matrix less the number of estimated coefficients	Df ≤ 5	
	Probability statistic (P-value)	Probability that the observed and estimated covariance matrices are actually equal		
Absolute fit indices	GOF index	Measure indicating how well a model reproduces the variance/covariance matrices of the observed sample	X^2/df value between 1 and 5	
	Root mean square error of approximation (RMSEA)	Badness-of-fit index measuring how well a model fits a population taking into account both model	Value ≤ 0.08/0.1 (MacCallum et al. 2001)	Value up to 1.0 is considered acceptable

		complexity and sample size		
	Root mean square residual (RMSR)	Average of the residuals between individual observed and estimated covariance and variance terms	Value ≤ 0.09	
	Standardised root mean residual (SRMR)	Standardised value of RMSR	Value ≤ 0.09	
	Normed Chi-square	Ration of Chi-square to degrees of freedom for a model	X^2/df value between 1 and 5	
Incremental fit indices	Normed fit index (NFI)	Assesses how well a specified model fits relative to some alternative baseline model (often a null model that assumes all observed variables are uncorrelated)	Value ≥ 0.09	Value close to 0 indicates a poor fit, while close to 1 indicates a perfect fit
	Comparative fit index (CFI)			
	Tucker-Lewis index (TLI)			
	Incremental fit indices (IFI)			
Parsimony fit indices	Parsimony comparative fit index (PCFI)	Evaluates the parsimony ratio of the model compared to the GOF such as CFI and NFI	Value ≥ 0.5	
	Parsimony normed fit index (PNFI)			

Source: Hair et al. (2010)

SMC: the squared multiple correlation indicates how much of the variability in the response to individual items can be predicted from other items. Hair et al. (2010) recommend that the SMC value of each item should be more than 0.3 but preferably 0.5 and above, suggesting construct validity and reliability.

AVE and CR: with the GOF indices supporting the model's fit with the data, the model's convergent validity was further assessed based on the size of the factor loading, using average variance extracted (AVE) and construct reliability (CR) (Hair et al. 2010, 722). AVE is calculated by establishing the sum of each individual item's SFL square and dividing the total by the total number of items within the factor. CR is computed by squaring the sum of each

individual item's SFL within the factor and dividing it by the squared sum of each item's SFL square and the sum of each individual item's error variance within the factor (Hair et al. 2010; Holmes-Smith 2010). Evidence of convergence validity exists if the SFL, AVE and CR values are at least 0.7, 0.5 and 0.6, respectively.

Model respecification considerations: a model is said to be correctly specified when it reproduces the sample covariance matrix well. When instances of specification error were noticed, the critical ratios (t-values), the SMC values, the standardised residuals and the modification indices (MIs) were examined to respecify the model. Conceptually, all unstandardised estimates should be in the expected direction and statistically different from zero (that is, the critical ratio is larger than 1.96 at the $\alpha = 0.05$ significance level) (Byrne 2010; Hair et al. 2010). SMC values should be greater than 0.5. Standardised residual covariance should also be less than the benchmark value of |4| but preferably less than |2.58| (Hair et al. 2010, 725). A large residual covariance between any two measurement items indicates that the association between these two items is not accounted for sufficiently by the model. This suggests a problem with one or both of the measurement items. A standardised residual value of |2| indicates that a particular covariance is not well reproduced by the hypothesised model (at the $\alpha = 0.05$ significance level) and a standardised residual value of |4| relates to $\alpha = 0.001$ significance level. When a consistent pattern of large standardised residuals was associated with either a single item or several of the items within a factor, the necessary respecification was made to account for this association between the variables, such as by dropping an item and rerunning the measurement model (Hair et al. 2010, 710).

MIs also suggest a potential source of model respecification. An MI is calculated for each non-free parameter and represents a possible decrease X^2 if the parameter is freely able to be estimated in the respecified model. A Chi-square value of 3.84 with one degree of freedom has $p = 0.05$ and an MI value greater than |4| suggesting that the Chi-square could be significantly reduced if the corresponding parameter were estimated. Based on this guideline,

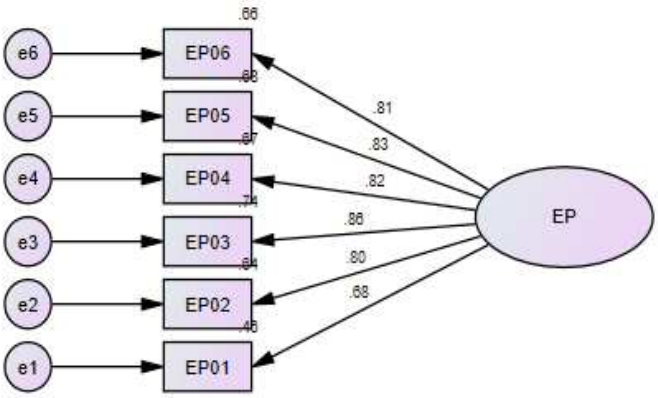
this study examined the measurement items that revealed high MI, that is, above |4| (Byrne 2010; Hair et al. 2010, 725) and made appropriate respecification of the model.

7.5.2 Discriminant validity

Discriminant validity measures the degree to which a concept differs from other concepts (or is not identical). It provides analysis of a distinction between two constructs, confirming that the hypothesised structural parts are free from inconsistency and lead to a precise result. The finding of discriminant validity is used for later interpretation in analysis. In this study, the evaluation of discriminant validity was conducted through the comparison of AVE estimates for individual factors with squared inter-factor correlations estimated that related to that factor (Hair 2010; Hair et al. 2006). Discriminant validity is supported by a condition where the square root of AVE for individual factors is consistently higher than the squared inter-construct correlations estimate (Hair et al. 2006).

7.5.3 Measurement model of organisational environment performance construct

The environment performance (EP) construct was hypothesised to consist of 6 indicator variables, namely, EP01 (Energy Consumption), EP02 (CO2 Emission Reduction), EP03 (Environmental Management System), EP04 (Organisational Environment Initiatives), EP05 (Environmental Information Disclosure) and EP06 (Organisational Environment Reputation). Each item is associated with a measurement error labelled from e1 to e6. Figure 7.1 below shows the estimated initial one-factor congeneric measurement model for the environmental performance.



GOF index	X^2 / df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	17.797	0.000	0.211	. 0270	0.904	0.840	0.704

Figure 7.1 One-factor proposed congeneric model of environmental performance

Examination of the GOF statistics in Figure 7.1 shows that the proposed model does not have sufficient validity, exemplified by the poor X^2/df value of 17.797 which is higher than the recommended value (2.0). In addition, the p-value has an unacceptable value which is lower than the recommended value (0.05). The RMSEA value at 0.211 is more than the recommended value (<0.05). The CFI, TLI and AGFI fit statistics of the model are 0.904, 0.840 and 0.704 respectively. Therefore, in such circumstances, the literature (Brown 2006, 181, 129; Hair et al 2010) suggests conducting further analysis of the one-factor congeneric measurement model.

The model was re-examined with the use of several diagnostic measures including standardised factor loading (SFL), standardised residual (SR), squared multiple correlation (SMC), the cut-off values for the GOF measures and the minimum number of items for a factor. The diagnostic statistics for the one-factor congeneric model for EP were seen through AMOS text outputs. The model diagnosis began with examining the SFLs as shown in Table 7.5 below.

Table 7.5 The standardised factor loading and SMC for EP

No.	Items	SFL	SMC
1	EP01	0.675	0.456
2	EP02	0.798	0.637
3	EP03	0.863	0.744
4	EP04	0.818	0.669
5	EP05	0.826	0.683
6	EP06	0.814	0.662

Table 7.5 shows that most of the SFL and SMC values of each item are within the acceptable range, that is, above 0.5 and 0.7. But the EP01 shows lower values than acceptable SMC and SFL. Therefore, considering that EP01 has unacceptable SFL and SMC values, it was dropped from the measurement model and the model was retested.

The resulting measurement model after deleting indicator variable EP01 is shown in Tables 7.6 and 7.7. Although some of the absolute fit indices such as X^2 (Chi-square), X^2 /df, CFI and TLI improved, the p-value was still outside the acceptable range and hence the model was still a poor fit. Further analysis of the re-examination of the SR value of each item was conducted. As shown in Table 7.7, the items EP02 and EP04 SR values were still outside the acceptable range. Therefore, considering that EP02 and EP04 SR values were higher than the recommended value (<0.40), EP02 and EP04 were deleted from the model measurement.

Table 7.6 Statistics for re-run one-factor congeneric model of environmental performance

GOF index	X^2 / df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	6.163	.000	.117	.0270	.977	.953	.913

Table 7.7 Statistics for standardised residual

	EP06	EP05	EP04	EP03	EP02
EP06	.000				
EP05	.076	.000			
EP04	.034	–.474	.000		
EP03	.024	–.147	.140	.000	
EP02	.0.24	.582	–.208	–.071	.000

After the model was re-tested, based on Figure 7.2, the statistics showed that all the SMC values of individual items were above 0.5 and the factor loading values of items were greater than the recommended threshold of 0.7. Table 7.9 provides the final GOF statistics and the measures for environmental performance. It shows that all of the GOF statistics were within the acceptable range. For example, the CFI, TLI and AGFI fit statistics of the model were 0.999, 0.997 and 0.983, respectively.

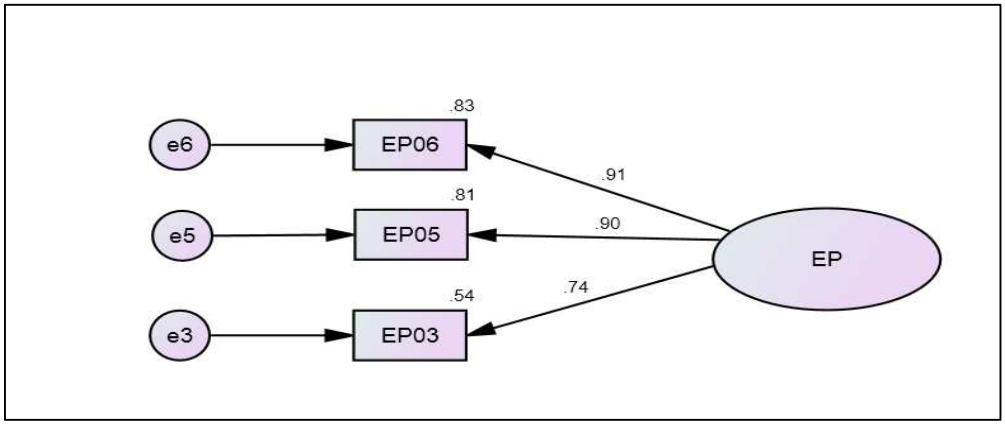


Figure 7.2 Final one-factor congeneric measurement model of environmental performance

Consequently, the results were admissible in terms of all selected fit indices as shown in Figure 7.2 and Table 7.8.

Table 7.8 Statistics for final one-factor congeneric model of environmental performance

GOF index	X^2 / df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	1.596	.206	.040	.0121	.999	.997	.983

7.5.4 Measurement model for IT infrastructure quality

Based on the EFA result, the ITQ construct consisted of six items including modularisation of information system (ITF01), standardisation of information system and reports (ITF02), adoption of server virtualisation (ITG03), storage virtualisation (ITG04), desktop virtualisation (ITG05) and implementation of RFID (ITG06), as discussed in Chapter 3. To measure the convergent validity of the construct, this study followed the procedure for validating a one-factor congeneric measurement model of ITQ.

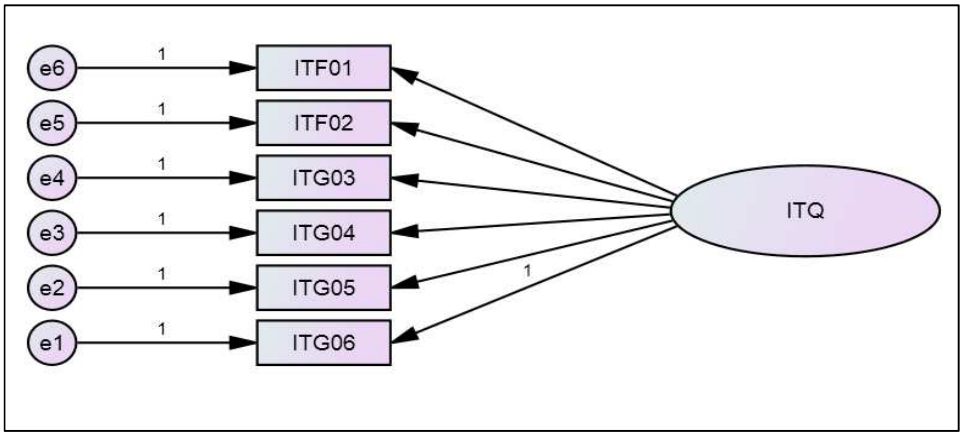


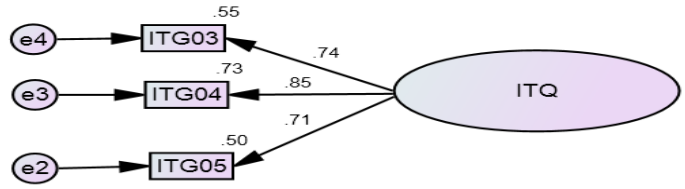
Figure 7.3 One-factor proposed congeneric model of IT infrastructure quality

The results showed that the GOF statistics of the model were unacceptable. This was because the p-value was still outside the acceptable range recommended by Hair et al. (2010). Furthermore, the incremental fit indices including CFI, IFI and TLI were also not within acceptable ranges. In addition, ITF01, ITF02 and ITG06 showed lower than acceptable SMC. The factor loading values of those items revealed that the model was not well accounted for. Therefore, considering that ITF01, ITF02, ITG06 had poor reliability, those items were dropped from further analysis and the model was re-analysed.

Table 7.9 Statistics for one-factor congeneric model of IT infrastructure quality

GOF index	X^2 / df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	7.745	.000	.134	. 0807	.890	.817	.873

After deleting the unacceptable items, the results as shown in Table 7.11 and Figure 7.4 revealed that all the values of SMC and factor loading were higher than the threshold value of 0.5 and 0.7. But all of the GOF statistics were within the acceptable range except the p-value, which was less than 0.05. In this circumstance, Hair (2010) states that the p-value is sensitive to large sample sizes (more than 250 samples). Thus, the p-value of the IT infrastructure quality model can be generally ignored.



GOF index	X^2 / df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	3.830	.022	.087	.0807	.986	.979	.961

Figure 7.4 One-factor final congeneric model of IT infrastructure quality

7.5.5 Measurement model for IT human resources competence

The proposed model for IT human resources competence (ITH) involves six items and these are shown in Figure 7.5. The GOF fit indices of the proposed model that were obtained through AMOS are provided in Table 7.10.

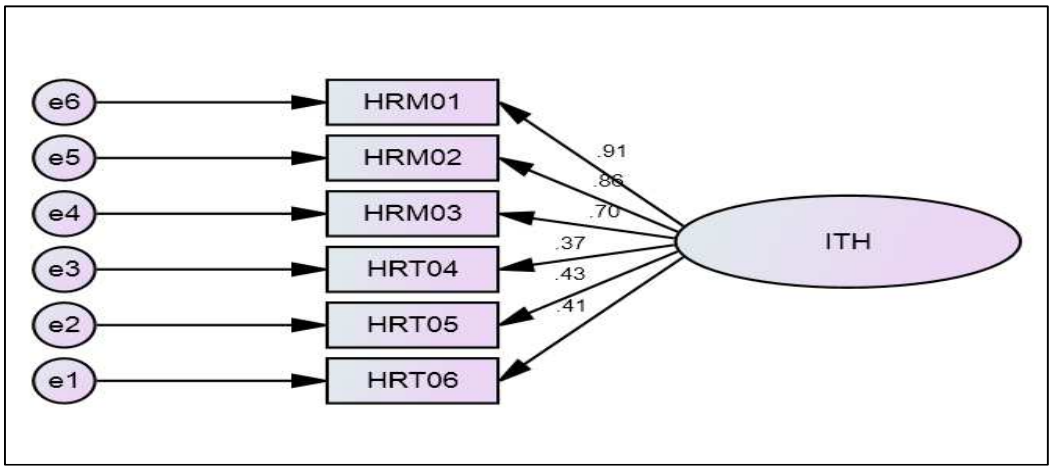


Figure 7.5 One-factor proposed congeneric model of IT human resources competence

As we can see from Table 7.10, the GOF statistics indicated inadmissible model fit in terms of X^2/df, P-value, RMSEA, CFI, TLI and AGFI. Furthermore, as shown in Figure 7.5, the factor loadings of the items showed that there were three items, HRT04, HRT05 and HRT06, with factor loadings that were below the recommended value of 0.7. Therefore, the model of IT human resources competence was re-run without HRT04, HRT05 and HRT06.

Table 7.10 Statistics for one-factor congeneric model of IT human resources competence

GOF index	X^2 / df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	13.344	.000	.173	.0856	.879	.799	.779

Table 7.11 provides the GOF statistics for the final one-factor congeneric model of IT human resources competence. Figure 7.6 presents the respecified one-factor CFA model of IT human resources competence and factor loading values of the measurement item. Both table and figure show that the model had an acceptable fit and all the measurement items exhibited convergent validity. Therefore, this CFA model was accepted.

Table 7.11 Statistics for final one-factor congeneric model of IT human resources competence

GOF index	X^2 / df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	1.237	.027	.000	.0029	1.000	1.000	0.997

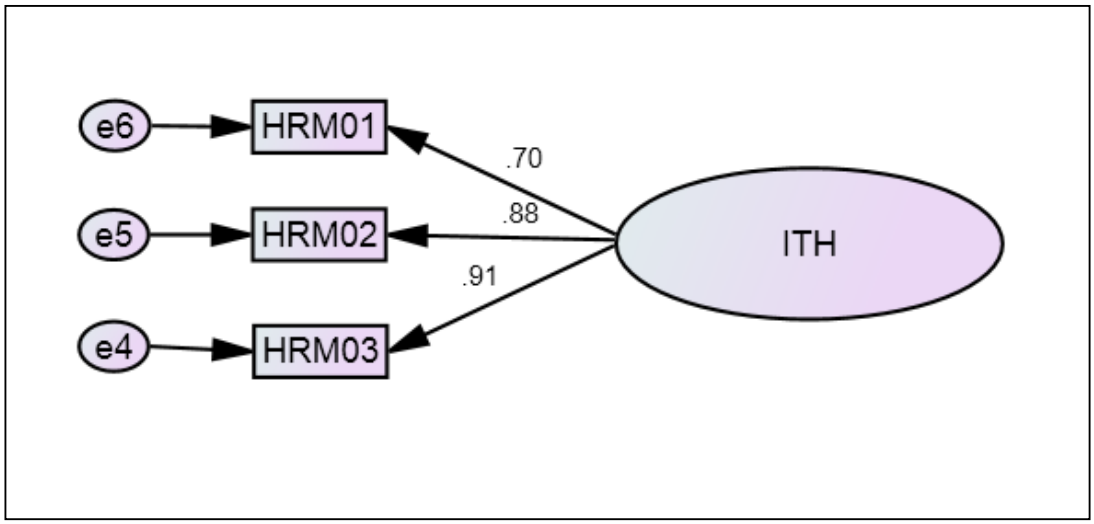


Figure 7.6 One-factor final congeneric model of IT human resources competence

7.5.6 Measurement model for business process digitisation construct

Based on the EFA findings, business process digitisation (BPD) is composed of the four first-order factors of business digital transactions (BDT) and business digital communication (BDC). Therefore, this sub-section discusses the CFA measurement model for both factors BDT and BDC.

7.5.6.1 One-factor congeneric measurement model of BDC

Drawing from the EFA results, the proposed BDC model consists of 5 items shown in Figure 7.7 and the GOF fit indices seen in Table 7.12.

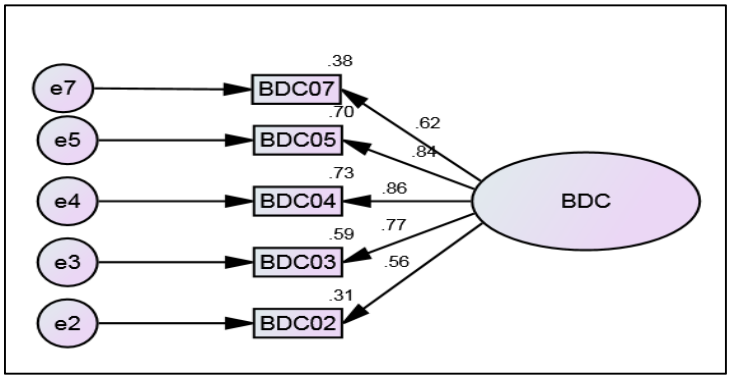
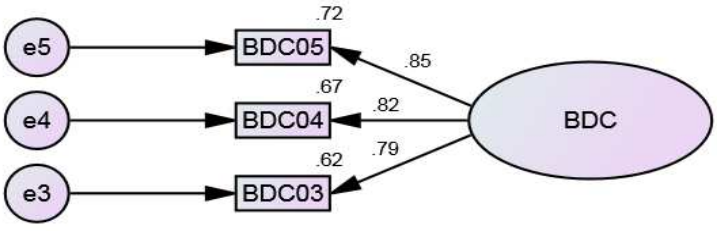


Figure 7.7 One-factor proposed congeneric model of BDC

Table 7.12 Statistics for one-factor congeneric model of BDC

GOF index	X^2 / df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	5.619	.000	.111	.0320	.972	.943	.919

As can be seen from Table 7.12, the GOF results revealed that the model of BDC was inadmissible. This was because only the CFI value was higher than the threshold value of 0.95. In addition, based on Figure 7.7, the factor loading for items BDC02 and BDC07 was lower than the recommended value of 0.7. Furthermore, the SMC value of items BDC02 and BDC07 was also below 0.5. Therefore, those items were removed from the reanalysis of the BDC model.



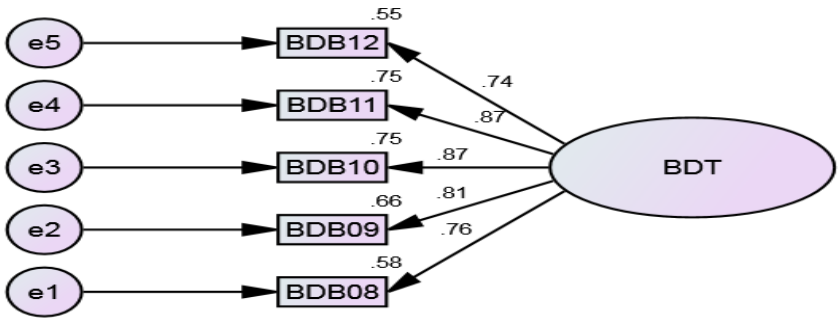
GOF index	X^2 / df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	5.012	.02	.019	.0243	.980	.969	.959

Figure 7.8 One-factor final congeneric model of BDC

Figure 7.8 provides the respecified one-factor congeneric model of BDC and the SMC value and factor loading value of each item were acceptable. Further, Figure 7.8 shows the corresponding GOF statistics of the measurement items. The X^2/df value of 5.012, p-value of 0.02, RMSEA value of 0.019, SRMR value of 0.0243, CFI value of 0.980, TLI value of 0.969 and AGFI value of 0.959 suggest that the BDC model achieved sufficient validity, although the p-value was below the recommended value.

7.5.6.2 One-factor congeneric measurement model of BDT

Based on the EFA results, the proposed BDT model consists of five items, BDB08, BDB09, BDB10, BDB11 and BDB12. Figure 7.9 provides the GOF statistics for the proposed model of BDT.

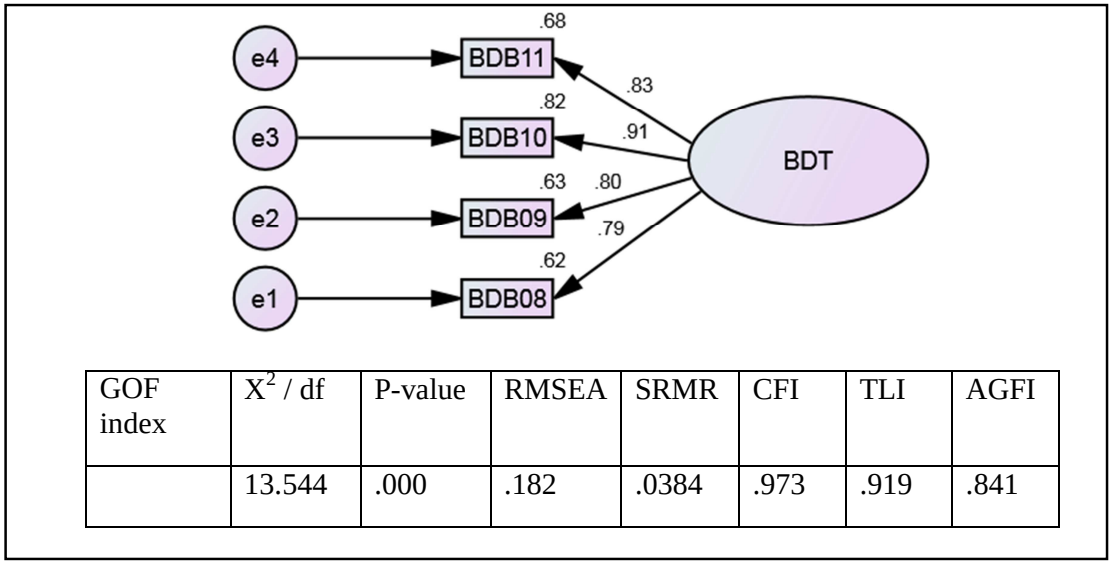


GOF index	X^2 / df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	15.786	.000	.198	.0384	.940	.880	.775

Figure 7.9 Proposed one-factor congeneric model of BDT

Based on Figure 7.9, the model of BDT had not achieved sufficient in terms of X^2/df, p-value, RMSEA, CFI, TLI and AGFI. But, as can be seen in Figure 7.9, all the factor loading and SMC values were within the acceptable range of 0.7 and 0.5. However, the standardised residual covariance reveals that the covariance between BDB12 and BDB10 (1.301), and BDB12 and BDB11 (1.042), was higher than the recommended value. This can also be seen

from the MIs as evident, which proved that the Chi-square can be deducted by 12.967 and 8.468 respectively if the error terms for those three items were covaried. Therefore, the BDT model was re-run without BDB12.

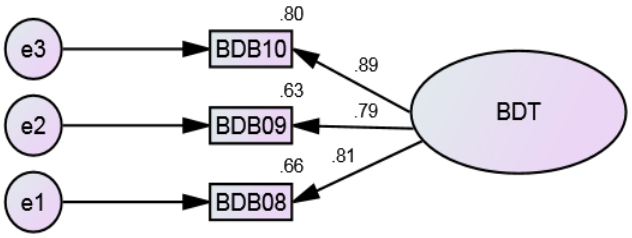


GOF index	X^2 / df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	13.544	.000	.182	.0384	.973	.919	.841

Figure 7.10 One-factor re-run congeneric model of BDT

Figure 7.10 presents the statistics for model fit for BDB after trimming BDB12. The X^2/df, p-value, RMSEA, TLI and AGFI were still outside the threshold values set. However, the measures for reliability as shown in Figure 7.10 show that all the items had an acceptable value. But an examination of the standardised residual covariance indicated that the SR between items BDB11 and BDB08 was –4.900, which is higher than the recommended value. So BDB11 became a candidate for deletion and was dropped from the model.

As can be seen from Figure 7.11, the GOF statistics revealed that the modified one-factor congeneric measurement model adequately fit the data exemplified by X^2/df of 1.639 with p-value of 0.200, RMSEA value of 0.041, SRMR value of 0.0079, CFI, TLI and AGFI values that are very near to 1. Furthermore, Figure 7.11 shows the respecified one-factor CFA model of BDT and reveals that the model has an acceptable value for both SMC and factor loading. Thus, this CFA model is accepted.

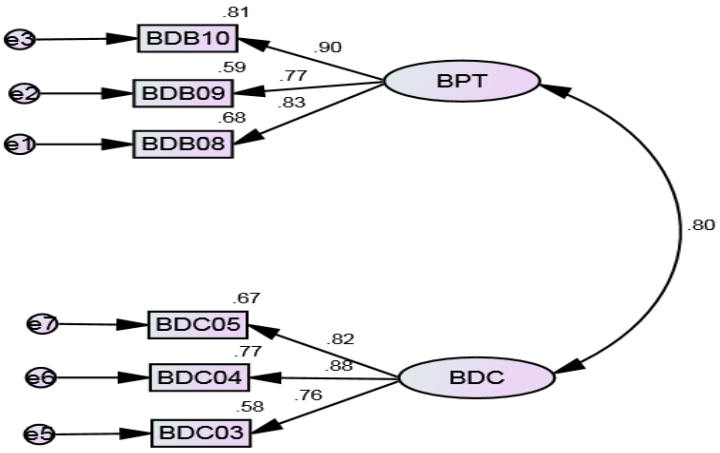


GOF index	X^2 / df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	1.639	.200	.041	.0079	.999	.997	.983

Figure 7.11 Final one-factor congeneric model of BDT

7.5.6.3 Full measurement model for BPD

After validating the individual factors of BPD in previous sections, this section validates both factors BDC and BPT together. Figure 7.12 displays the full model of first-order measurement for BPD. Further, Figure 7.12 and Table 7.20 provide the corresponding GOF statistics and construct validity examination for the BPD model.



GOF index	X^2 / df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	2.176	.0210	.056	.0183	.992	.987	.961

Figure 7.12 Full first-order measurement model of BPD construct

Table 7.13 Convergent validity for full first-order measurement model of BPD construct

Factors	Items	Estimate	SMC	CR	AVE
BPD	BDB08	0.83	0.681	**0.87**	**0.70**
	BDB09	0.77	0.588		
	BDB10	0.90	0.805		
BDC	BDC03	0.76	0.582	**0.86**	**0.67**
	BDC04	0.88	0.766		
	BDC05	0.82	0.671		

The statistics in Figure 7.12 indicated that this measurement model adequately fit the data. The X^2/df is 2.179 with p-value of 0.210, RMSEA value is 0.056, SRMR value is 0.0183, CFI value is 0.992, TLI is 0.987 and AGFI value is 0.961. Furthermore, this model was supported by convergent validity based on factor loading (above 0.7), AVE (above 0.5) and CR (above 0.7). Thus, based on Figure 7.12 and Table 7.13, the model is accepted.

The model fit and convergent validity now established, assessment of the validity of the discriminant was conducted and the results can be seen in Table 7.14. Based on the results, discriminant validity is supported. This is because, in all cases, the AVE values are greater than the maximum shared variances (MSV) and average shared variances (ASV) (Hair et al. 2006).

Table 7.14 Discriminant validity of the BPD full measurement factor model

	CR	AVE	MSV	ASV
BDT	0.87	0.70	0.64	0.64
BPC	0.86	0.67	0.64	0.64

7.5.6.4 The BPD as a second-order construct

The research hypothesis of this study is based on the BPD construct, which is a higher order construct. Hence, this section assesses the construct validity of the BPD construct at second-order level. Figure 7.13 shows the second-order factor model of the BPD construct. Table

7.15 provides GOF statistics and the measures for assessing the convergent validity of the second-order factor model of BPD.

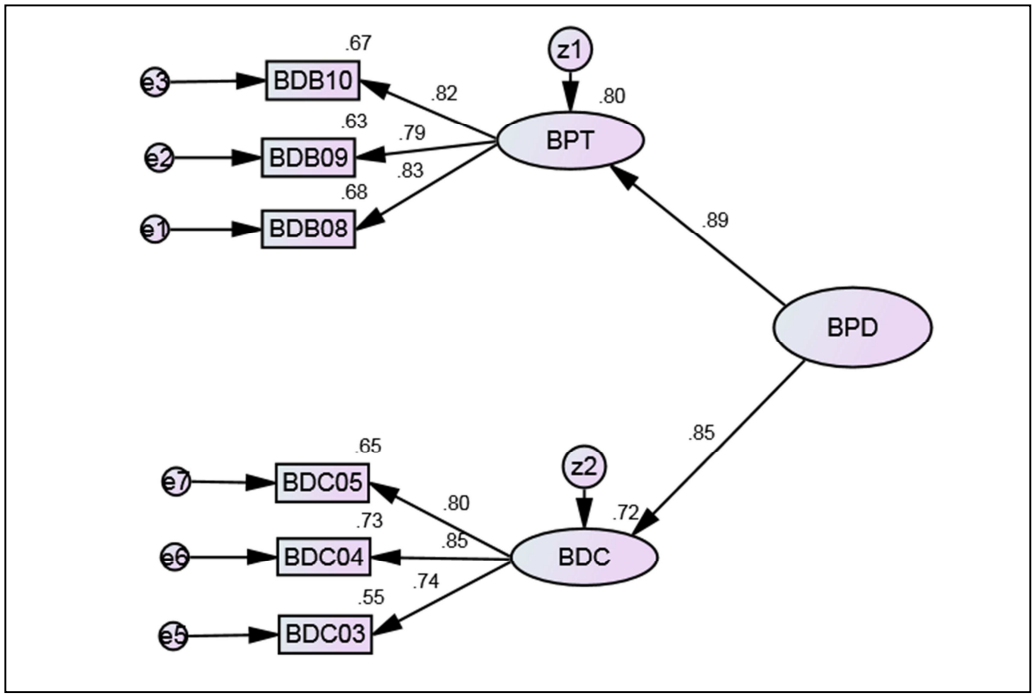


Figure 7.13 Full second-order measurement model of BPD construct

Table 7.15 Statistics for full second-order measurement model of BPD construct

Factors	**Items**	**Estimate**	**SMC**	**CR**	**AVE**	**GOF indices**		
						Absolute	**Incremental**	**Parsimony**
BPD	BDB08	0.825	0.681	**0.849**	**0.694**	X^2/df =2.179	CFI=0.992	PCFI=0.595
	BDB09	0.767	0.588			P-value=0.021	IFI=0.992	PNFI=0.591
	BDB10	0.897	0.805			RMSEA=0.096	TLI=0.987	
BDC	BDC03	0.763	0.582	**0.857**	**0.702**	SRMR=0.0486		
	BDC04	0.875	0.766					
	BDC05	0.819	0.671					

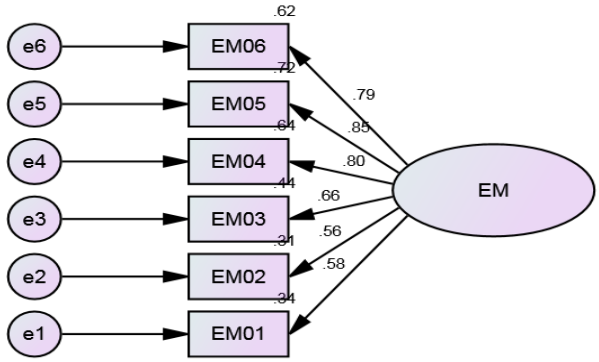
The results in Table 7.15 indicate that all of the GOF values were acceptable and that convergent validity was supported based on the values of AVE and CR. Hence, the second-order CFA model of the BPD construct was accepted.

7.5.7 Measurement model for EIT

Based on the EFA results, the EIT was hypothesised to consist of the following three first-order factors: emission management (EM), sustainability behaviour (SB) and resource stewardship (RS). This section, therefore, discusses the CFA measurement model for each of the three factors individually. The one-factor measurement model is assessed based on GOF statistics and evidence for convergent validity.

7.5.7.1 One-factor congeneric measurement model of EM

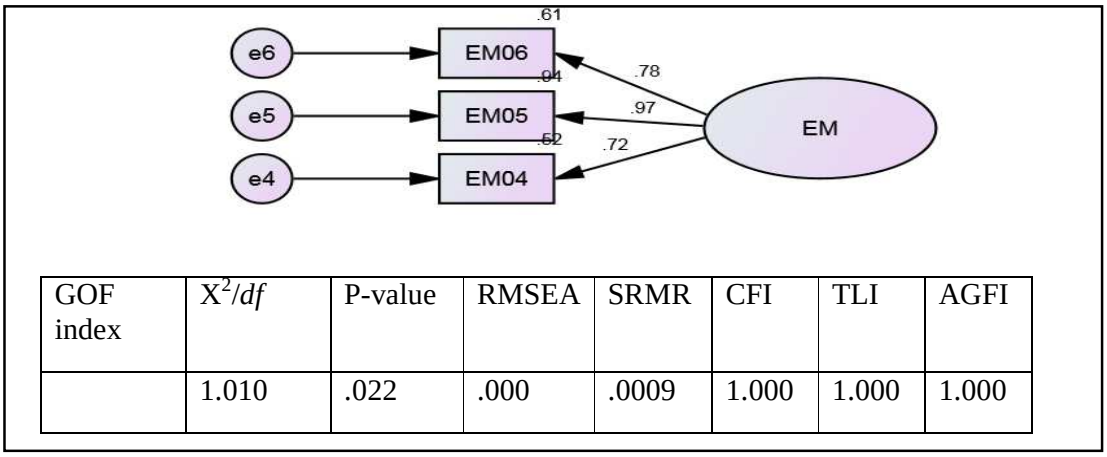
The measurement model of EM obtained from EFA results is presented in Figure 7.14. Theoretically, the EM model consists of six items: Organisation has established clear IT goals (EM01), IT vision of an organisation is clearly defined (EM02), Top management is very concerned with green IT issues (EM03), Implementation of environmentally friendly IT purchasing procedures (EM04), Implementation of reusable IT equipment procedures (EM05) and Implementation of IT equipment disposal procedures (EM06).



GOF index	X^2/df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	23.813	.000	.246	.0183	.819	.698	.633

Figure 7.14 Proposed one-factor congeneric model of EM

As can be seen in Figure 7.14, the GOF statistics revealed that all the findings were outside acceptable ranges. Furthermore, it shows that EM01, EM02 and EM03 have lower factor loading and SMC values. Therefore, the proposed model needed to be re-run without EM01, EM02 and EM03.



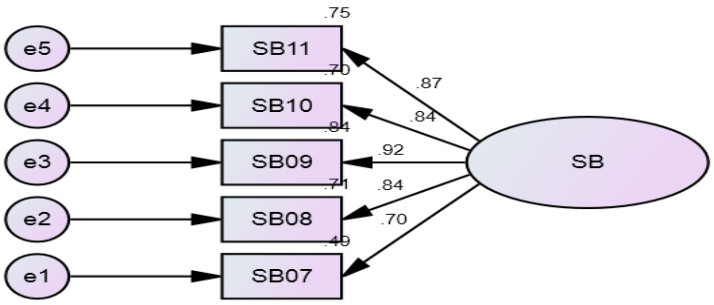
GOF index	X^2/df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	1.010	.022	.000	.0009	1.000	1.000	1.000

Figure 7.15 Final one-factor congeneric model of EM

The results reflect good model fit, according to the parameters suggested in Figure 7.15. All the GOF statistics support that the model fit the data very well and that the model held convergent validity. Furthermore, all the items had very high reliability. Therefore, the one-factor congeneric measurement model shown in Figure 7.15 indicated an excellent fit and it was thus accepted.

7.5.7.2 One-factor congeneric measurement model of SB

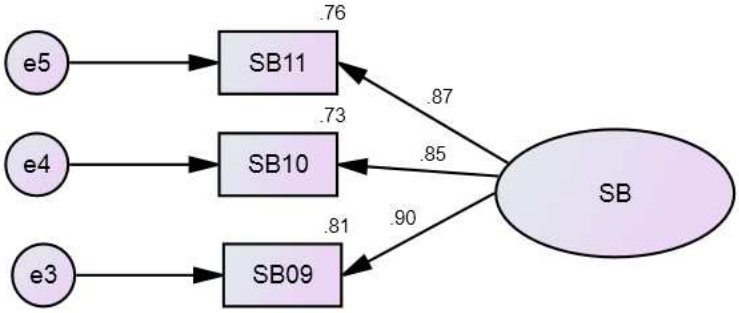
The initial model for SB consists of five observed variables as can be seen in Figure 7.16. The table presents the results of the initial SB model of five items that indicate the model poorly fit the data with a p-value of 0.000 and unacceptable AGFI scores. Furthermore, the SMC value for SB07 was less than the threshold value of 0.50.



GOF index	X^2/df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	5.004	.000	.0103	.0009	0.986	0.971	0.924

Figure 7.16 Proposed one-factor congeneric model of SB

Further analysis, MIs suggest covarying the error of SB08 with the other two error items SB09 and SB10. This implies that SB08 lacks specificity. Therefore, items SB07 and SB08 were dropped and the respecified SB measurement model is shown in Figure 7.17.



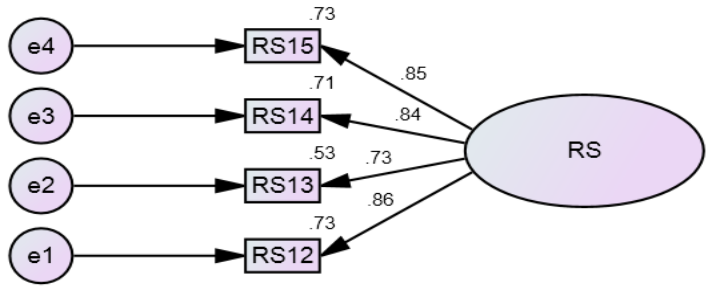
GOF index	X^2/df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	2.703	.100	.0067	.0074	0.998	0.993	0.972

Figure 7.17 Final one-factor congeneric model of SB

The respecified SB measurement model had an acceptable fit against all the selected fit measures and all the measurement items met the minimum acceptable threshold value for establishing convergent validity. Therefore, the one-factor model for SB was accepted.

7.5.7.3 One-factor congeneric measurement model of RS

The proposed one-factor congeneric model for RS comprises four observed variables as can be seen in Figure 7.18. The model diagnosis starts with examining the factor loadings and SMC values. Further, Table 7.18 provides the GOF statistics including X^2/df, p-value, RMSEA, SRMR, CFI, TLI and AGFI.



GOF index	X^2/df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	1.641	0.178	.041	.0122	0.998	0.996	0.978

Figure 7.18 Final one-factor congeneric model of RS

Based on Figure 7.18, all statistics of one-factor congeneric measurement models met acceptable absolute fitness measures with X^2/df value of 1.641 and p-value of 0.178. Furthermore, recommended RMSEA, SRMR, CFI, TLI and AGFI values are at 0.41, 0.0122, 0.998, 0.996 and 0.978 respectively. Hence, the one-factor congeneric model of RS was accepted.

7.5.7.4 Full measurement model for EIT

In the previous sub-sections 7.5.6.1–7.5.6.3, the one-factor congeneric models of the three factors that constitute EIT were individually tested and validated. This sub-section measures all the three factors together and thus forms the construct of EIT. Figure 7.19 presents the

initial full first-order measurement model of EIT. Table 7.16 summarises the results of GOF and construct validity tests.

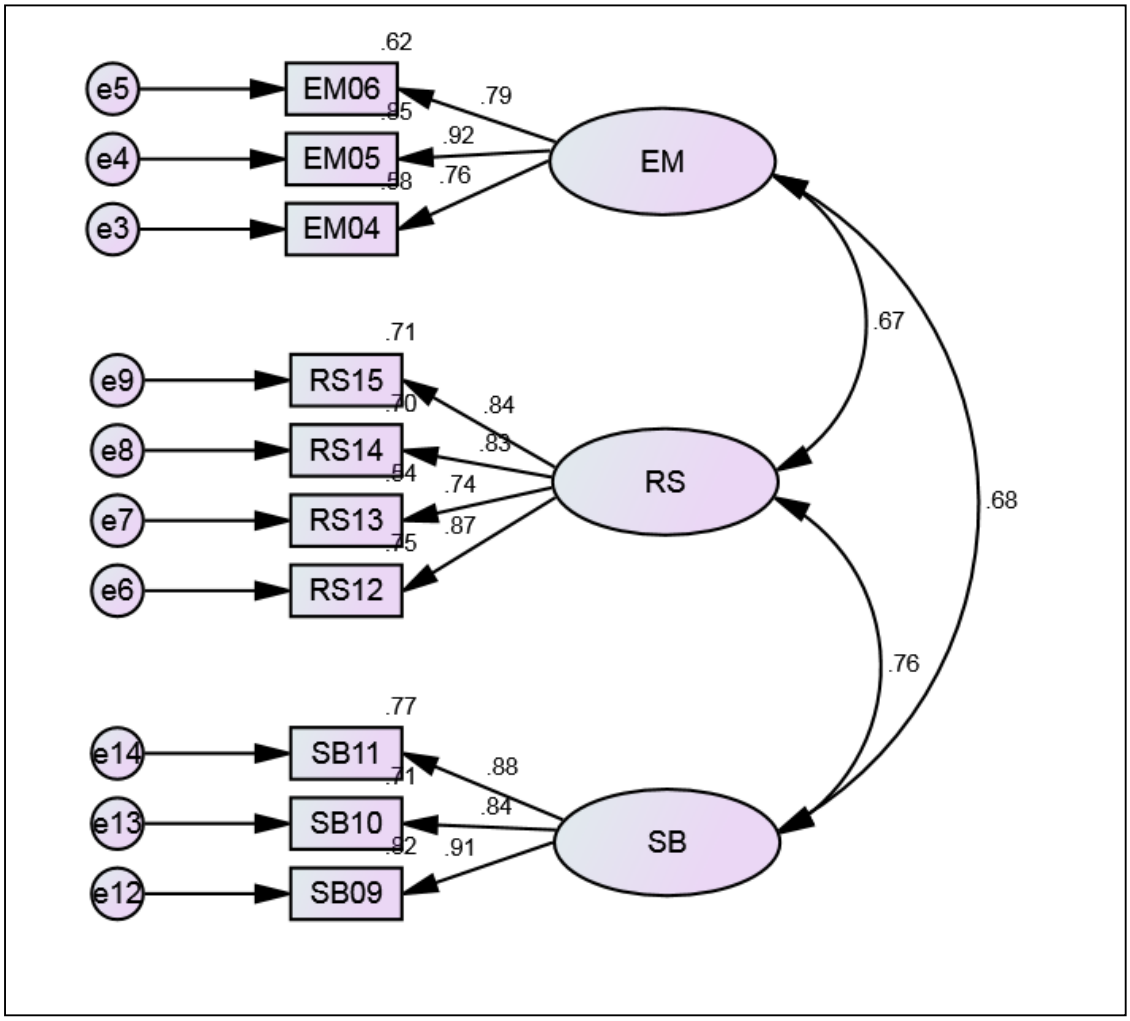


Figure 7.19 Proposed full first-order measurement model of EIT construct

Table 7.16 Statistics for proposed full first-order measurement model of EIT construct

Factors	Items	Estimate	SMC	CR	AVE	GOF indices		
						Absolute	Incremental	Parsimony
EM	EM04	0.76	0.58	**0.870**	**0.691**	X^2/df =7.515	CFI=0.921	PCFI=0.716
	EM05	0.92	0.95			P-value=0.000	IFI=0.921	PNFI=0.708
	EM06	0.79	0.62			RMSEA= 0.131	TLI=0.898	
RS	RS12	0.87	0.75	**0.892**	**0.674**	SRMR=0.546		
	RS13	0.74	0.54					
	RS14	0.83	0.70					
	RS15	0.84	0.71					

SB	SB09	0.91	0.92	**0.923**	**0.751**			
	SB10	0.84	0.71					
	SB11	0.88	0.77					

Table 7.16 shows that the model was unacceptable. This was because there were several fit indices out of range of the recommended values, X^2/df value of 7.515, RMSEA value of 0.131, CFI value of 0.921 and TLI value of 0.989. The factor loadings were sufficiently high, giving an acceptable value for convergent validity. An examination of the standardised residual covariance discloses that the covariance of EM04, RS12 and RS13 with a few of the other items were not produced well. Hence, the model was respecified without EM04, RS12 and RS13. Figure 7.17 provides the respecified final full first-order measurement model of EIT. Table 7.18, furthermore, presents the fit GOF statistics and the measures for convergent validity. All the fit indices were in acceptable ranges. Further, all factor loadings were supported by the model's convergent validity based on SFL (above 0.7), AVE (above 0.5) and CR (above 0.7). Therefore, the model of EIT was accepted.

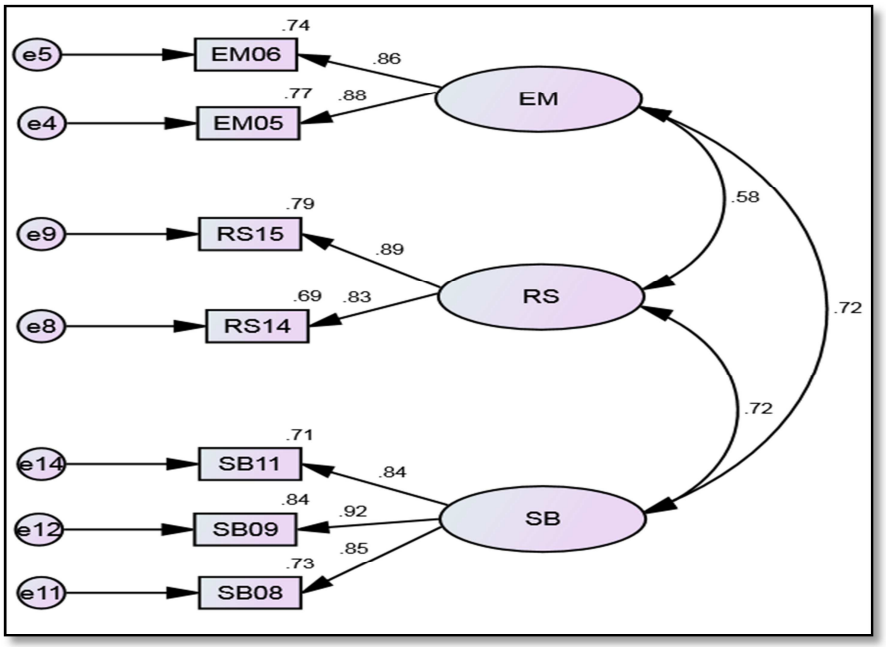


Figure 7.20 Final full first-order measurement model of EIT construct

Table 7.17 Statistics for final full first-order measurement model of EIT construct

Factors	Items	Estimate	SMC	CR	AVE	GOF indices		
						Absolute	Incremental	Parsimony
EM	EM05	0.88	0.77	**0.870**	**0.691**	X^2/df =4.012	CFI=0.977	PCFI=0.651
	EM06	0.86	0.74			P-value=0.000	IFI=0.977	PNFI=0.646
RS	RS14	0.83	0.69	**0.892**	**0.674**	RMSEA= 0.089	TLI=0.965	
	RS15	0.89	0.79			SRMR=0.546		
SB	SB08	0.85	0.73	**0.923**	**0.751**			
	SB09	0.92	0.84					
	SB11	0.84	0.71					

The model fit and convergent validity now established, assessment for validity of the discriminant was conducted and the results can be seen in Table 7.18. Based on the results, discriminant validity was supported. This was because, in all cases, the AVE values were greater than the MSV and ASV (Hair et al. 2006).

Table 7.18 Discriminant validity of the EIT full measurement factor model

	CR	AVE	MSV	ASV	RS	EM	SB
RS	0.848	0.737	0.521	0.430	0.858		
EM	0.861	0.755	0.518	0.429	0.582	0.869	
SB	0.904	0.760	0.521	0.520	0.722	0.720	0.872

7.5.7.5 The EIT as a second-order construct

The research hypothesis of this study is based on the EIT construct, which is a higher order construct. Hence, this section assesses the construct validity of the EIT construct at second-order level. Figure 7.21 shows the second-order factor model of the EIT construct. Table 7.19 provides GOF statistics and the measures for assessing the convergent validity of the EIT.

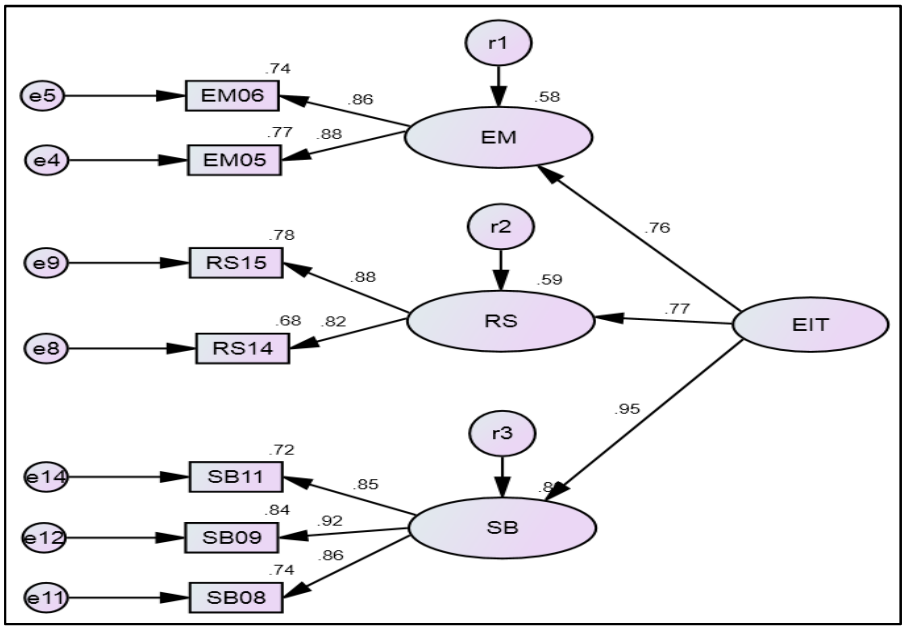


Figure 7.21 Final eecond-order measurement model of the EIT construct

Table 7.19 GOF and validity measurement for final full model of second-order EIT construct

Factors	Items	Estimate	SMC	CR	AVE	GOF indices		
						Absolute	Incremental	Parsimony
EM	EM05	0.878	0.771	**0.870**	**0.691**	X^2/df =4.280	CFI=0.976	PCFI=0.604
	EM06	0.862	0.743			P-value=0.000	IFI=0.977	PNFI=0.600
RS	RS14	0.825	0.680	**0.892**	**0.674**	RMSEA= 0.093	TLI=0.962	
	RS15	0.882	0.777			SRMR=0.546		
SB	SB08	0.858	0.737	**0.923**	**0.751**			
	SB09	0.917	0.840					
	SB11	0.848	0.720					

The results in Table 7.19 indicate that all of the GOF values were acceptable and that convergent validity was supported based on the values of AVE and CR. Hence, the second-order CFA model of the EIT construct was accepted.

7.5.8 Full measurement model

Once all constructs in the measurement were validated individually for first-order and second-order factors of the research model, which is used to ensure the uni-dimensionlity and construct validity of each construct included in the research model, a structural model can

then be validated and tested and is presented as a significant stage of analysis in this study. The aim of the structural model is to specify which latent constructs directly or indirectly affect the value of the other latent constructs in the model. Therefore, this section discusses the full structural model in order to answer the research questions described in Chapter 1.

As can be seen in Figure 7.22, the proposed full model of CFA measurement of this study consists of three first-order factor models including ITQ, ITH and EP, and two second-order factor models including BPD and EIT.

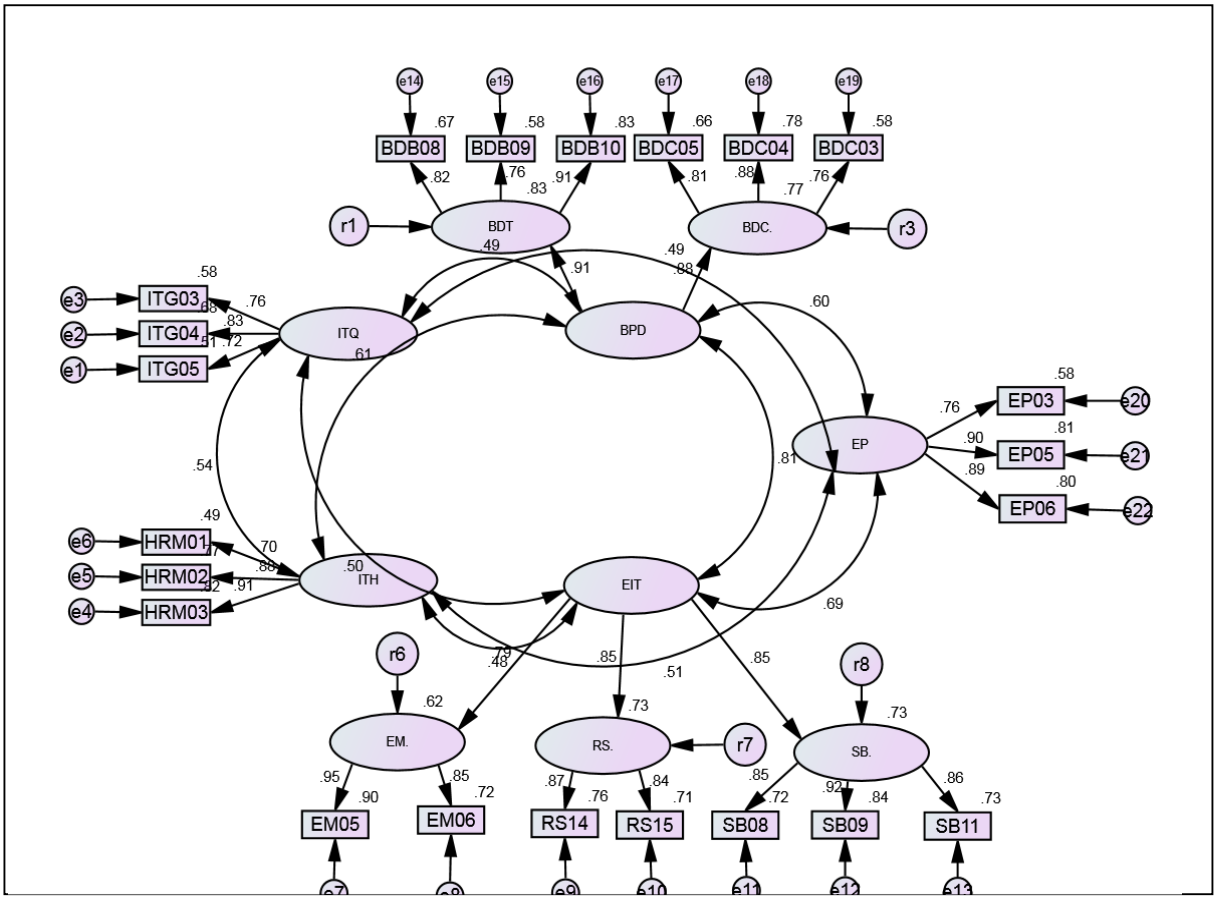


Figure 7.22 Initial full model of CFA measurement

Table 7.20 provides the proposed full model CFA measurement model. Based on the results, the model was unacceptable. This was because all the incremental fit indices were out of the acceptable range. Therefore, the model needed to be respecified in order to obtain a more parsimonious model.

Table 7.20 Statistics for proposed full model of CFA measurement

GOF index	X^2/df	P-value	RMSEA	SRMR	CFI	TLI	AGFI
	3.667	0.000	.084	.0122	0.913	0.900	0.817

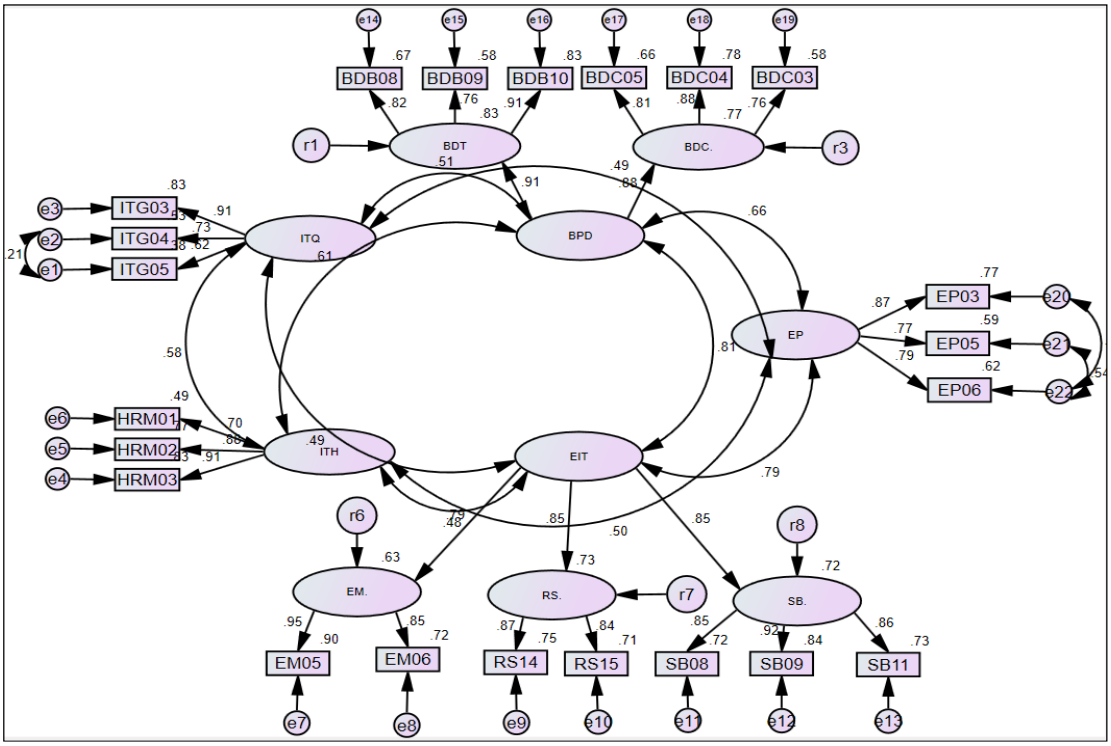


Figure 7.23 Final full model of CFA measurement

Table 7.21 displays the comparison fit indices for the four structural models. Comparing the fit indices for the four corresponding GOF statistics tested as described above, the result confirmed that the rectified full model 2 provides the most parsimonious model.

Table 7.21 Comparison of fit indices

Model	**X^2/df (P)**	**RMSEA**	**CFI**	**TLI**	**AGFI**	**GFI**	**PCFI**	**PNFI**
Initial	3.667	0.084	0.913	0.900	0.817	0.816	0.772	0.750
Rectified full model 1	3.398	0.080	0.924	0.908	0.827	0.827	0.776	0.748
Final full model 2	3.636	0.056	0.935	0.920	0.887	0.860	0.765	0.742

Once validating that the full measurement model meets the GOF fit indices, this study then performed discriminant validity. As already mentioned, the purpose of discriminant validity is to examine the extent to which conceptually related constructs are indeed different (or not identical). It shows that a construct is exclusive and captures several phenomena that other constructs do not. Discriminant validity is analysed through comparison of the AVE estimates for each factor with the squared inter-factor correlation estimates associated with that factor (Hair et al. 2006, 778; Hair et al. 2010, 710). If AVE is consistently higher than the squared inter-construct correlations of the construct, discriminant validity is supported (Straub, Boudreau and Gefen 2004; Hair et al. 2006, 810). The discriminant validity analysis results in Table 7.22 show that the AVE and CR values are greater than the recommended values, which are 0.5 and 0.7 respectively.

Table 7.22 Discriminant validity for full measurement model

	CR	AVE	MSV	ASV	ITQ	ITH	BPD	EIT	EP
ITQ	0.800	0.577	0.335	0.269	0.760				
ITH	0.871	0.696	0.368	0.297	0.579	0.834			
BPD	0.889	0.799	0.663	0.433	0.514	0.607	0.894		
EIT	0.872	0.695	0.663	0.439	0.487	0.482	0.814	0.833	
EP	0.853	0.659	0.626	0.388	0.489	0.500	0.660	0.791	0.812

7.6 Summary

The aim of this study is to investigate the relationship between environmental performance and IT capabilities such as IT infrastructure quality, IT human resources competence, business process digitisation and environmental IT competence. Specifically, this chapter has aimed to ensure the validity and reliability of the measurement model that is the foundation for the structural model discussed in the next chapter. Thus, the measurement model involved rigorous validation procedures including content validity, reliability assessment and construct validity through both EFA and CFA. In the EFA, the finding shows that there were several deleted items that did not meet the factor extraction criteria including factor loading.

Appendix 4 provides the results of the five EFA models in establishing factorial validity and represents an initial specification of the measurement model in this study.

In CFA, the convergent validity of a construct is assessed using one or a combination of the following measures: goodness of fit (GOF) measures; squared multiple correlation (SMC), which is a function of the size of the standardised factor loadings (SFL); average variance extracted (AVE); and construct reliability (CR). The result of the assessment is to provide the measurement items for individual constructs, which was discussed from sub-sections 7.5.2 to 7.5.5. In the final full factor measurement, the model needed to be respecified in order to obtain a more parsimonious model. However, in the final full measurement model, no item of construct was dropped based on the respecified model.

Now, the measurement instrument underlying the research model has been determined to be valid and reliable. The next chapter will identify the final conclusions from the hypotheses, research framework and research problems. The next chapter will also draw the implications for both practice and theory; discuss the limitations of this study; describe the directions for future research; and identify the final conclusions.

Chapter 8
Research findings and discussion

8.1 Introduction

Chapter 7 provided the statistical findings that examined the hypotheses identified in Chapter 4. In this chapter, the purpose is to provide and discuss the core findings of the study. The chapter presents the results of the data analysis to answer the research questions discussed in Chapter 1. This research posits that the Indonesian ICT industry can use its IT infrastructure quality and IT human resources competence can to improve business process digitisation and then develop its environmental IT competence and overall environmental performance. Furthermore, IT infrastructure quality and IT human resources competence have a negative impact on environmental IT competence. The findings also encounter that business process digitisation has a negative relationship with environmental performance.

This chapter consists of the brief introduction in Section 8.1, then Section 8.2 explains the structural model fit and hypothesis testing. Section 8.3 provides a discussion of the findings associated with the foundation of the relationship between IT capabilities and organisational environment performance for this research. A summary of the chapter is given in the last section.

8.2 Structural model fit and hypothesis testing

A structural model aims to establish how well the observed variables of a hypothesised construct associate with one another. In this study, the structural model is shown in Figure 8.1. The factors and measurement items are adopted from the results of the measurement model using CFA in Chapter 7. The analyses of the hypothesised structural model were conducted by testing the hypothesised model that specifies the seven causal relationships as shown in Table 8.1. Figure 8.1 presents the full structural model that consists of IT infrastructure quality (ITQ), IT human resources competence (ITH), business process

digitisation (BPD), environmental IT competence (EIT) and environmental performance (EP). Therefore, the validity and acceptability are used to evaluate and analyse the structural model of this study.

The validity and acceptability of the structural model can be assessed in terms of (1) model fit, that is, GOF indices; (2) comparing factor loadings of the structural model to those of the underlying measurement model; (3) the magnitude of variance explained, that is, R2; and (4) the size, direction and significance of the estimated structural parameters.

As can be seen in Figure 8.1, the full structural model of this study has 22 items. Furthermore, the validity and acceptability are measured through the four criteria outlitned in Table 8.1. The first is Chi-square including X^2, *df* and X^2/df values. The second measurement is absolute fit indices including RMSEA and SRMR values. The next is incremental fit indices such as CFI, IFI and TLI values. And the last measurement is parsimony fit indices including PCFI and PNFI values.

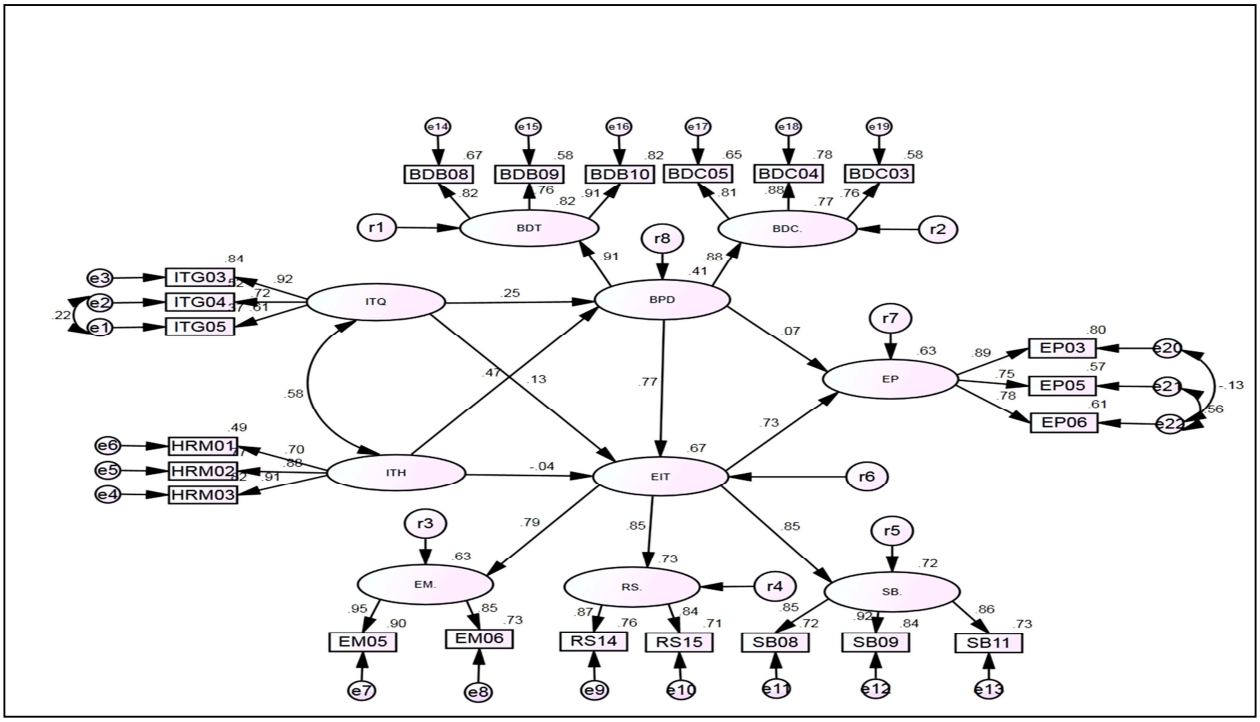


Figure 8.1 Full strucutural model of the research

Table 8.1 Model fit statistics for full structural model

GOF index	X^2	*df*	X^2 / *df*	RMSEA	SRMR	CFI	TLI	IFI	PCFI	PNFI
	665	195	3.414	.056	.0540	.939	.920	.940	.779	.755

The model's normed Chi-square (x^2/DF) is within the acceptable range. All the incremental fit indices also meet the lower threshold value of 0.92 and the model is acceptable in terms of CFI, IFI and TLI. The model's absolute fit index value is also within the recommended range in terms of RMSEA. SRMR value is less than 0.08, which is generally considered a good fit (Hu & Bentler 1999). Moreover, the model's parsimony fit indices values are acceptable in terms of PCFI and PNFI, which show relatively higher values than the corresponding measurement model. Hence, the full structural model as indicated in Figure 8.1 is supported and accepted in terms of the selected and most widely reported fit indices in the SEM literature.

Second, the loading estimates of the structural model are compared against the loading estimates of the corresponding measurement model. The structural model is expected to show similar loadings to those of the measurement model (Hair et al. 2006, 857). As can be seen in Appendix 3, all of the loading estimates of the structural model show change and the maximum change in standardised loadings is 0.01, which is not above the 0.05 limit (Hair et al. 2006, 855). This indicates the existence of parameter stability among the measured items in the two models, which provides further support for the validity of the structural model.

The third evaluation of the structural model's validity is assessed through the extent of the variance in overall environmental performance, the ultimate dependent (endogenous) variable, which the model explains. As can be seen from Figure 8.1, the model explains 63% of the variance in overall environmental performance, which is very good (Chin 1998, 323). This result further supports the validity of the structural model.

The fourth set of criteria for assessing the validity of the structural model is investigating the size, direction and significance of the structural parameter estimates. Table 8.2 presents the structural path estimates.

Table 8.2: Hypotheses testing for initial hypothesised structural model

Hypothesised path				Standardised estimates	CR	P
H1	Business process digitisation	←	IT infrastructure quality	0.25	3.437	***
H2	Ecological competence of IT	←	IT infrastructure quality	0.159	2.707	0.7
H3	Business process digitisation	←	IT human resource competence	0.529	8.046	***
H4	Ecological competence of IT	←	IT human resource competence	–0.063	–0.940	0.347
H5	Ecological competence of IT	←	Business process digitisation	0.754	8.024	***
H6	Environmental performance	←	Business process digitisation	0.053	0.586	0.558
H7	Environmental performance	←	Ecological competence of IT	0.782	7.759	***

*** p<.001, ** p<.01, *p<.05

As can be seen in Table 8.2, the results indicate that H1, H3, H5 and H7 are statistically significant in the hypothesised direction. This is because these hypotheses have T-values above 2.00. Thus, these hypotheses are supported. Hypotheses H2, H4 and H6 are unacceptable because there is no statistical fit.

8.3 Discussion of findings

The use of IT capability in improving environmental performance is relatively new to the field of information system research. This research has the main objective to investigate the relationship between IT capabilities including IT infrastructure quality, IT human resources competence and business process digitisation, environmental IT competence and

organisational environment performance. Therefore, the research questions and objectives posed in Chapter 1 are answered through testing the proposed framework and set of hypotheses that were described in Chapter 3. The main research question of what IT capabilities are used for improving organisational environment performance in the Indonesian ICT industry was derived from related literature, as discussed in Chapter 3. For the purpose of the research, two capabilities of IT have been identified as critical capabilities in developing business process digitisation and environmental IT competence associated with organisational environment performance. Therefore, the next section discusses the findings based on the hypotheses mentioned in Chapter 3 and the research questions described in Chapter 1.

8.3.1 IT infrastructure quality, business process digitisation and environmental IT competence

In this study, the IT infrastructure quality is hypothesised as business process digitisation and environmental IT competence, as discussed in sub-sections 5.1.1 and 5.1.2.

8.3.1.1 IT infrastructure quality and business process digitisation

This study has a proposed theoretical framework that has associated a relationship between IT capabilities and environmental performance. In this case, one of the capabilities of IT is IT infrastructure quality, which is drawn from RBV theories as discussed in Chapter 3. It might be used to improve environmental performance through business process digitisation.

IT infrastructure quality is hypothesised to influence business process digitisation positively. On average, 94% of the respondents indicated their agreement that IT infrastructure quality achieved some improvement in their business process digitisations in order to improve environmental performance. Specifically, 91.5%, 95% and 91.5% of respondents believed that the adoption of server virtualisation, storage virtualisation and desktop virtualisation would significantly assist their organisations to conduct business process digitisation thoroughly. These descriptive findings indicate that the adoption of virtualisation

technologies including server, storage and desktop virtualisations builds a well-integrated platform that allows Indonesian ICT organisations to run a virtual business online like conducting real-time business transactions via communications and computer networks. This was also evident in Vazquez et al. (2011) study, which found that with an increase in virtual technologies, organisations have opportunities to build business processes effectively and efficiently.

The correlation between IT infrastructure quality and business process digitisation is positive and significant with $r=0.514$ and $P<0.01$. Furthermore, the structural analysis and hypothesis testing finding as can be seen in Section 8.2 present empirical support that IT infrastructure quality has a significant positive effect on business process digitisation with $\beta=0.25$ and $P=0.001$. Thus hypothesis 1 as mentioned in Chapter 4 (*IT infrastructure quality has a significant impact on digitalisation of business operations)*, is supported at a 99% confidence interval. This finding suggests that the critical components of IT infrastructure quality, such as adopting of server virtualisation, storage virtualisation and desktop virtualisation, lead to improved business process digitisation as manifested in term of a significant reduction in the work steps, processing costs and processing times of ICT organisations in a developing economic country such as Indonesia.

Indonesia as one of the largest countries in the world is one of the world's most vulnerable countries to natural disasters. This is because Indonesia is located on the Pacific Ring of Fire that is subject to the constant risk of volcanic eruptions, earthquakes, tsunamis and floods. In the last 15 years, Indonesia has endured devastating natural disasters that have resulted in the deaths of hundreds of thousands of people and have had destructive effects on the country's infrastructure (Indonesia 2012). Furthermore, this also affects the economic and business environment in Indonesia. Based on the World Bank (2011), the economic impact of the 2004 earthquake in Aceh was estimated at US$4.5 bn. Likewise, in 2006, the earthquake in

Yogyakarta caused an economic impact of US$3.5 bn. The regional economic impact of recent disasters can be seen in Table 8.3.

Table 8.3 Estimated annual losses caused by major natural disaster in Indonesia 2000–2009

Year	2000	2001	2002	2004	2006	2007	2009
Economic losses US$ million	300	100	500	4500	3500	1800	2500

Source: World Bank

Surprisingly, virtual technologies including server, storage and desktop virtualisation have been found to be the best technologies for disaster recovery in business processes because of their high resource utilisation, high availability, and recovery management and dynamic infrastructure (Sindoori, Pallavi & Abinaya 2012). Disaster recovery is the process in business operations of organisations that can recover data after any catastrophic events occurs. The finding is also consistent with Gmach and Holcomb's (2004) study finding that these technologies when implemented in organisational business processes with more empowerment showed significant improvement in reducing process recovery. This current finding also agrees with Kovar (2008), Hoopes (2009) and Delahunty's (2011) study findings; that is, that virtualisation technologies are essential infrastructure in business processes when disasters occur because they are easy to set up and configure in problem areas.

The finding above also addresses several of the issues faced by ICT organisations, including the electricity supply. Even though Indonesia is one of the world's largest exporters of coal and natural gas, the Indonesian government struggles to address electricity supply problems caused by inadequate infrastructure and a complex regulatory environment, such as regulation of natural gas and coal supply using power plants (Administration 2013). Thus, most islands in Indonesia, such as Sumatra, Borneo, Sulawesi and West Papua, have electricity supply issues. With these virtualisation technologies, ICT organisations have solutions for operating

their business activities through placing their information and database systems with overseas or domestic internet service providers that have the capacities to overcome these problems for operating business processes. The finding is consistent with that of Marston et al. (2011) that the concept of virtualisation technologies embraces the ideas encapsulated in green computing, since not only are the computing resources used more efficiently, but further, the computers can be physically located in geographical areas that have access to no electricity supply while their computing power can be accessed long distances away over the internet. This current finding also agrees with those of Wittow and Buller (2010) and Kloch at al. (2011); that is, that virtualisation technologies allow organisations to access their data anywhere and anytime through the internet to deliver computer performance required business activities including telecommunications and transactions.

Regarding the implementation of virtualisation technologies including server, storage and desktop virtualisation in Indonesian ICT organisations, the Indonesian government through the Ministry of Telecommunication and Informatics has released electronic information and transaction regulations as guidelines and references for the use of virtualisation technologies in its business operations. This regulation has been made to encourage organisations to develop and use IT in their business transactions, as mentioned in Chapter 5, Article 17-22 of the electronic information and transaction regulations:

"This Law allows opportunities of Information Technology usage to state administrators, Persons, Business Entities, and/or the public".

"Information Technology usage must be implemented in a proper, responsible, effective, and efficient manner in order that the public can reap as much benefits as possible".

With this regulation, the Indonesian government is facilitating information technology and electronic transaction usage in accordance with the provisions of prevailing laws and regulations. Further, the government will protect the public interest from any type of threat as

a result of misusing electronic information and an electronic transaction that offends order, in accordance with the provisions of law and regulations as described in Chapter 9, Article 40 of the electronic information and transaction regulations.

8.3.1.2 IT infrastructure quality and environmental IT competence

In terms of the relationship between IT infrastructure quality and environmental IT competence, the results of the SEM analyses found that IT infrastructure quality has a significant negative effect on environmental IT competence. This is shown from the correlation between IT infrastructure quality and environmental IT competence with $r=0.514$ and $P<0.01$. Furthermore, the structural analysis and hypothesis testing finding as seen in Section 8.2 present empirical support that IT infrastructure quality has a significant negative effect on environmental IT competence with $\beta=0.159$ and $P=0.7$. Thus hypothesis 2 as mentioned in Chapter 4 (*IT infrastructure quality has a significant impact on environmental IT competence)* is not supported. This finding also shows that the critical components of IT infrastructure quality do not help organisations to develop their environmental competence.

As described earlier, IT infrastructure quality has a negative impact on environmental IT competence. This current study finding deviates with that of Molla et al. (2012), who found that IT infrastructure quality can be used to embed influence to build environmental competence in organisations. However, the finding of the current study concurs with that of Bose and Luo (2011) that IT infrastructure quality including virtualisation technology requires business processes as a mediating factor for developing green IT competence, as can be seen in Figure 8.2.

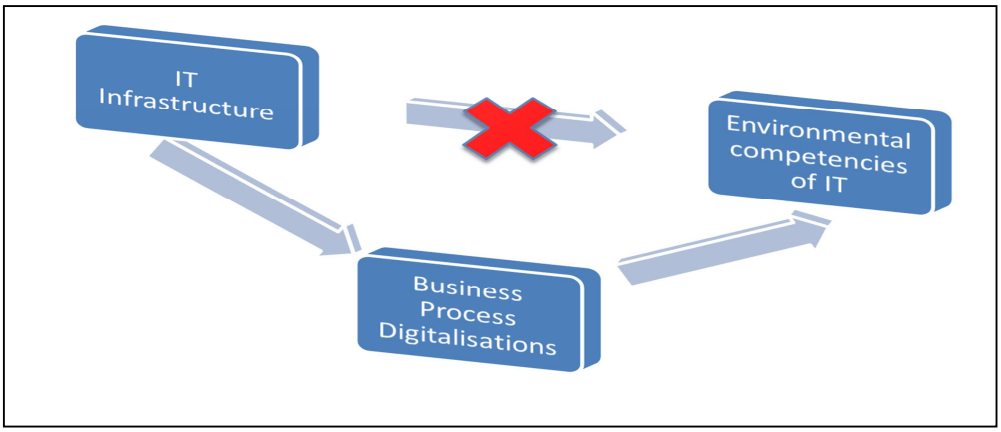


Figure 8.2 Developing environmental IT competence

The success of developing environmental IT competence will heavily depend on organisations' use of their IT infrastructure in conducting business processes. IT infrastructure provides organisations with the green abilities to perform environmentally friendly business processes in order to accommodate stakeholder demands. For example, generating environmental competence in organisational business activities can be aided by adopting virtualisation technologies in business processes that can delivery environmentally friendly services. Additionally, virtualisation technologies will help organisations and their business partners to collaborate in business operations to decrease energy consumption and travel costs. Therefore, to build environmental IT competence, organisations have to place their IT infrastructure including virtualisation technologies into their business processes as mediating factor, which will be discussed in Section 8.3.3.

This finding is also consistent with Indonesian circumstances. Based on sustainability reports (PT Telekomunikasi 2012), ICT organisations integrate their IT infrastructure with core business through improved operational efficiency and the paperless office concept. Through these techniques, organisations can measure the financial benefits obtained from adopting the technologies. For example, adopting virtualisation technologies reduces operational costs in business activities and will improve revenue over the long term. Therefore, the financial

implications are that significant financial investment is needed to obtain potential business opportunities in order to secure the long-term sustainability of an organisation's business.

In summary, the discussion above shows that Indonesian ICT organisations can use their IT infrastructure quality to improve their business process digitisation in order to develop environmental IT competence. This can be seen from the hypothesis testing result, which revealed that there is a significant impact of IT infrastructure quality on business process digitisation. However, the finding shows that there is a negative impact of IT infrastructure quality on environmental IT competence. Therefore, the Indonesian ICT industry does not need environmental IT competence as a mediator between IT infrastructure quality and environmental performance.

8.3.2 Competence of IT human resources, business process digitisation and environmental IT competence

In this study, IT human resources competence has been hypothesised as business process digitisation and environmental IT competence, as discussed in sub-section 5.2.1.

8.3.2.1 Competence of IT human resources and business process digitisation

Despite the fact that ICT organisations have implemented virtualisation technologies in their business operations, the capacity of IT human resources is also considered to be an organisation capability for managing IT resources in business operations. In this research, the findings show that organisations need IT human resources with knowledge and experience in environmental management system standards (EMS) (e.g., ISO 14000), government regulations and the standardisation of IT equipment. These capacities are required to enable organisations to build business operation systems to meet the demands of stakeholders, business partners and government regulations.

As indicated in the conceptual framework seen in Chapter 4, the current study created a hypothesis associated with IT human resources competence and business process digitisation.

IT human resources competence was hypothesised to influence business process digitisation positively. On average, 90.1% of the respondents indicated that they had witnessed a high degree of IT human resources competence as part of IT infrastructure quality to achieve some improvement in their business process digitisations in order to improve environmental performance. Specifically, 96.3%, 86.5% and 87.3% of survey respondents respectively agreed that knowledge of environmental government regulations, management system standards and standardisation of IT equipment are of high importance, respectively. Therefore, this finding indicates that IT human resources competence may develop and build well-integrated systems such as e-auctions and e-procurement (Dwi Utari 2010), which allow organisations to conduct business process digitisation effectively and efficiently to meet government regulations and management system standards.

The correlation between IT infrastructure quality and business process digitisation is positive and significant with $r=0.607$ and $P<0.01$. Furthermore, the structural analysis and hypothesis testing finding as seen in Section 8.2 present empirical support that IT infrastructure quality has a significant positive effect on business process digitisation with $\beta=0.529$ and $P=0.001$. Thus hypothesis 3 as mentioned in Chapter 4 (*IT human resources competence has a significant impact on digitisation of business operations)* is supported at a 99% confidence interval. This finding suggests that the critical components of IT human resources competence, such as thorough knowledge of environmental government regulations, management system standards and standardisation of IT equipment, lead ICT organisations to understand the implementation of their business process digitisation in order to comply with government regulations and customer needs.

The finding above is consistent with that of Molla et al. (2008) about the importance of IT human resource competence in the standardisation of IT equipment used in business process digitisation to develop and improve environmental performance in an organisation. Likewise,

the above finding supports that of Cooper and Molla (2012) regarding the importance of employee knowledge of environmental regulation to achieve effective re-engineering of business processes. The current finding is also consistent with those of Adela, Marie-Claude and Richard (2008) and López-Gamero, Molina-Azorín and Claver-Cortés (2010), which show that regulatory requirements play significant roles in influencing the implementation of business process digitisation. The finding also agrees with Butler (2011) that organisations have a need for systematically analysing, interpreting and integrating the impact of new and existing regulations on IT operations.

This current study also lends support to findings about the standardisation of IT equipment competence. For example, Cooper and Molla (2012) argue that the IT human resources of an organisation need competence in national and international regulations associated with standardisation of IT equipment in terms of energy consumption, electronic waste and emissions. This current finding is also consistent with those of Köhler and Erdmann (2004) and Murugesan (2008) regarding building coercive and normative institutional pressures that can influence IT organisations to develop their know-how and skills to respond to pressures from government and international independent organisations. IT professionals within organisations and intergovernmental institutions often use influential power in relation to professional practice, which may have implications for learning and adopting standardisation of IT equipment (Molla & Abareshi 2011).

The current study finding endorses prior studies on the relationship between competence of environmental management standards of IT human resources and business process digitisation, which have been found to have a direct effect on each other. Cooper and Molla (2012) find that environmental management system standards such as ISO 14000 are required by IT personnel of an organisation for identifying business processes to raise the awareness of stakeholders including suppliers, customers and competitors.

Likewise, this current finding also agrees with Cooper and Molla (2011) that ICT professionals should operationalise environmental management system standards and these can be used as the basis for policies and planning of key practices to be adopted in the business processes of an organisation. Molla et al. (2009) examine IT and sustainability and find that organisations should have governance capability in IT personnel as a standard administrative process for meeting regulatory reporting and documentation requirements and to help organisations ensure compliance with environmental laws and policies and reduce the associated costs, efforts and risks. This finding is consistent with RBV-based studies in management system standard competence as a unique factor that cannot be easily imitated by other organisations, which can lead to better understanding of how the routines and procedures of business processes are shaped (Darnall & Edwards 2006; Prajogo 2011).

IT human resources of Indonesian ICT organisations are concerned about climate change relating to global warming, which is caused by CO_2 gas emissions. This can be found from the Widjaja, Mariani and Imam (2011) study. In this study, the finding shows that IT human resources strongly believe that IT equipment can reduce the impact of business operations on the natural environment (Widjaja, Mariani & Imam 2011). Further, the finding also reveals that IT professionals agree that knowledge about environmental issues is important to be implemented in business operation practices. Therefore, IT human resources in Indonesian ICT organisations have a significant role in their organisations to lead changes towards green IT.

The role of IT human resources of Indonesian ICT organisations can be seen in their competence to adopt government regulations in business operation practices. For example, Telkom has consistently implemented international standard (ISO) quality management systems. Telkom intends to improve its system of sustainable government through intensified

implementation of other international standards, including ISO 26000 (Social responsibility) and ISO 27000 (Information security management systems).

8.3.2.2 Competence of IT human resources and environmental IT competence

Chapter 4 Section 4.4.2 mentions that *"IT human resource competence has a significant impact on environmental IT competence"*. However, the results of the SEM analyses found that IT human resources competence has a significant negative effect on environmental IT competence. This is shown from the correlation between the competence of IT human resources and environmental IT competence with $r=0.514$ and $P<0.01$. Furthermore, the structural analysis and hypothesis testing finding as seen in Section 8.2 present empirical support that competence of IT human resources has a significant negative effect on business process digitisation with $\beta=-0.063$ and $P=0.347$. Thus the fourth hypothesis as mentioned in Chapter 4 is not supported. This finding also shows that the critical competence of IT human resources does not aid organisations to develop their environmental competence. In other word, the current finding study reveals that the development of environmental IT competence in organisations might be built through business process digitisation where the competence of IT human resources is embedded in that process.

The finding of this current study is in line with that of Cooper, Vanessa A and Molla, Alemayehu (2012) who found that there is a need for business processes in developing environmental IT competence in organisations. The first is acquisition and assimilation, and then second is transformation and exploitation. Acquisition and assimilation are techniques for organisations to establish their business processes to acquire and assimilate the competence of IT human resources, which are likely to develop favourable environmentally friendly business processes through embedding sustainability in their IT personnel and managerial resources. Transformation and exploitation are methods utilised by organisations to transform green knowledge by including environmental regulations, management system

standards (ISO) and standardisation of IT equipment, which are more likely to be exploited through embedding sustainability in their services and business processes.

In Indonesian ICT circumstances, the competence of IT human resources in environmental government regulations, management system standards (ISO) and standardisation of IT equipment can help organisations as guidelines in business processes to select suppliers, raw material and products with the objective of minimising the environmental impact of their business activities (PT Bakrie Telecom 2012). For example, PT Telkom has implemented the standardisation of IT equipment in its business processes to facilitate the development of governance process and documentation systems in order to develop environmental capabilities. Further, ICT organisations have identified 'green' suppliers based on government reports and international independent organisations addressing the environmental issues for building environmental business operations. Therefore, a combination of IT human resources competence and business process digitisation is required for the Indonesian ICT industry to develop environmental IT competence of IT in their organisational business operations.

8.3.3 Business process digitisation, environmental IT competence and environmental performance

Business process digitisation is hypothesised as environmental IT competence and environmental performance, as discussed in sub-sections 5.5.1 and 5.5.2.

8.3.3.1 Business process digitisation and environmental IT competence

Business process digitisation was hypothesised to influence environmental IT competence positively and environmental performance negatively. In terms of the relationship between business process digitisation and environmental IT competence, the correlation between them with $r=0.814$ and $P<0.001$ are positive and significant. Further, the structural analysis and hypothesis testing finding presented statistical support that business process digitisation has a

significant positive effect on environmental IT competence with $\beta=0.725$ and $P<0.001$. Therefore, hypothesis 6 stated in Chapter 4 (*business process digitisation has a significant impact on environmental IT competence*) is supported at the 99% confidence interval and 100% of the respondents indicated that they agreed that digital communication is important for developing and improving environmental competence of an organisation, and 78% showed the importance of business process transactions in their business process digitisation in order to enhance the environmental competence of an organisation.

The finding of above hypothesis test results indicates that adopting adequate digital communications such as tele-conferencing technology and tele-presence technology, and deploying right-sizing communication equipment based on organisation type and size, and implementing enterprise resource planning, e-procurement and environmental management systems all have a significant positive effect on the environmental competence of organisations including emission management, sustainability behaviour and resource stewardship.

The above finding is consistent with 'green IS' and 'green IT' literature that associated a relationship between business process digitisation and environmental competence of organisations. For example, Hart et al. (2003) identify the technologies that enable minimal impact of business activities on the natural environment through connecting all stakeholders including suppliers, customers, government and non-governmental organisations. Adoption of teleconference and tele-presence technologies (Molla 2008 and Loos et al. 2011) and adoption of right-sizing communications equipment (Molla et al 2009) have also been identified as the relevant technologies that matter most to the environmental competence of an organisation. This current study finding is also consistent with that of Loos et al. (2011) who found that organisations need IT such as teleconference technology that contributes to

sustainable business processes in developing environmental capability through reducing transportation emissions and costs.

The importance of information systems including enterprise resource planning, e-procurement and environmental management systems has also been recognised by a few researchers in the IS literature. For instance, Murugesan and Gangadharan (2012) find that organisations are obligated to deal with data on energy and raw material consumption, on discharge and on emissions. Environmental management systems, thus, are required by organisations to meet and comply with multiple stakeholders: supply chain partners, regulatory authorities, consumer organisations, unions, insurance companies and the community, through providing material and product information, process and workflow information, supply chain information and information about waste.

In term of Indonesian conditions, organisations require the digitisation of business communications and transactions to ensure the development of environmental IT capacity. Adopting enterprise resource planning (ERP) systems, including e-procurement and environmental management systems, can facilitate the sharing of information across all business functions within the organisation and also manage connections with outside stakeholders. Successful adoption of ERP in an Indonesian ICT organisation is influenced by the adequacy of IT human resources and IT infrastructure to support its business environment (Candra 2014). This is also supported by open-source software houses that provide ERP systems tailored to the Indonesian business culture.

From the analysis stage, this shows that business process digitisation consists of three factors for developing environmental IT competence in organisations. They are: adoption of teleconferencing technologies, tele-presence technologies and right-sizing communications equipment. Teleconferencing and tele-presence technologies are appropriate for Indonesia as

the fourth largest country in the world (Ministry of Communication and Informatics 2010). Therefore, these technologies are required by organisations including ICT organisations to communicate and interact with their business units and partners on different islands. Furthermore, these technologies also can help organisations to develop 'green offices' with reduced transport costs and less energy consumption. This study has also shown that organisations can consider other types of communications technology that can be used in many different business environments to reduce operating costs, office space and the size of the workforce.

8.3.3.2 Business process digitisation and environmental performance

In terms of the relationship between business process digitisation and environmental performance, this study has a sixth hypothesis which proposed that "*business process digitisation has a significant impact on environmental IT competence"*. The results of the SEM analyses found an non-significant relationship between business process digitisation and environmental performance including environmental management systems, environmental information disclosure and environmental reputations. This finding does not support hypothesis six and the notion that environmental performance can be driven by business process digitisation. Thus, it is concluded that increased business process digitisation use does not improve environmental performance. Six validated measurement items from two dimensions including business process transactions and business digital communications were unable to describe a significant portion of the variance in business process digitisations. This is a clear indication of the impact of business process digitisation on environmental performance. It means that increased business process digitisation usage in organisations does not improve their environmental performance. It is also evidence that business process digitisation is indirectly predicting the environmental performance of organisations.

The above findings confirm that business process digitisation, including digital communications and digital business transactions, is not a critical factor for improving the environmental performance of organisations. This is inconsistent with several previous studies in green IT research, which found that the use of IT can mitigate the impact of the business operations of an organisation in order to improve environmental performance (Dao, Langella & Carbo 2011; Sayeed & Gill 2008). However, this current finding is supported by those of Hilty et al. (2006), Berkhout and Hertin (2004), Berkhout and Hertin (2004) and Plepys (2002), who state that the improvement of ITC equipment leads to increased consumption of ICT products and services, which has numerous environmental implications on different levels including energy consumption, end-of-life hardware and human behaviour. Therefore, there need to be policies, procedures and systems as guidelines in the use of ITC equipment in business operations in order to improve the environmental performance of organisations (Molla & Abareshi 2012).

8.3.4 Environmental IT competence and environmental performance

Environmental IT competence was hypothesised to influence the environmental performance of an organisation. The correlation between environmental IT competence and environmental performance is positive and significant with $r=0.791$ and $p<0.001$. The structural analysis and hypothesis testing finding also provide statistical support that environmental competence has a significant impact on environmental performance with $\beta=0.782$ and $p<0.001$. Thus hypothesis 7 (*environmental IT competence has a significant impact on environmental performance)* is supported at a 99% confidence interval. It favours the implementation of emission management (reusable and disposal IT equipment policies), utilisation of IS functions to change employees towards sustainability behaviour, and adoption of IT resource stewardship that provides information about IT life management and reusable designs.

The current finding endorses previous environmental performance studies that have identified the effects of environmental IT competence on environmental performance. Chou and Chou (2012) found that organisations must create environmental policies and procedures to guide employees' working behaviour and methods. Reusable and disposal IT equipment policies are required as part of organisations' social responsibility to deal and meet with local government and international independent organisations (Vazquez et al. 2011). This finding is in line with that of Chou (2013), who states and conceptually argues that environmental policies cover the work that an organisation has done to support environmental management systems in daily business operations. This finding is also consistent with RBV-based studies in IS, which found that environmental policies are embedded in a bundle of green capability to enable and support environmental initiatives across the significant areas of sourcing, operations and services in order to improve the environmental reputation of organisation (Molla, Cooper & Pittayachawan 2009).

In terms of sustainability behaviour, the current research has also revealed that organisations need to develop environmental IT competence through sustainability behaviour. The finding shows that the sustainability behaviour of employees is influenced by the capabilities of IS that can build and change their commitment to environmentally friendly work practices and promote the choice of environmentally sustainable courses of actions. This finding is related to that of Gholami et al. (2013), who found that IS adoption has a significant relationship with environmental performance. This is also consistent with Butler and McGovern (2009) argument about IS having the ability to help organisations provide an annual sustainability report that is required by local government and global regulators. Likewise, the finding supports the theoretical finding of Tom (2011) regarding the importance of the ability of IS adoption to improve the environmental reputations of organisations.

The finding of a relationship between environmental IT competence and environmental performance implies the importance of resource stewardship for organisational environmental performance in business operations. In this case, organisations in reducing the impact of their business activities on the natural environment should implement and adopt IT equipment that has information regarding end of IT life management. With this information, organisations can organise environmentally friendly disposal of IT in business practices (Molla et al. 2011). For example, Dell computers provide information systems to facilitate customers in recycling and disposing of their product in an environmentally friendly manner (Loos et al. 2011). Thus, many organisations in developed countries including Australia, New Zealand and the USA recycle and dispose of IT in an eco-friendly manner (Molla et al. 2011). The finding of current study also reveals that the adoption of applications designed to be reusable plays a significant role in improving environmental performance. This is in line with Byrd and Turner (2000), who found that reusable applications module are widely used in new systems development to reduce the operational costs.

This current research finding is supported by the Indonesian ICT industry circumstances. For example, Handayani and Rolanda (2010) state that several Indonesian ICT organisations including Indosat, Intel Corp and Bakrie Telecom have started to provide system information that can help customers to dispose of and recycle their products in order to mitigate CO_2 emission production in their business activities. Furthermore, Bakrie Telecom as a member of the Global e-Sustainability Initiative has provided an innovative program to collect used handsets for recycling, which can play a role in preserving the environment (PT Bakrie Telecom 2012). Moreover, Bakrie Telecom has also created an environmentally friendly supply chain system to ensure that every product is made in a manner that is both social and environmentally responsible. Therefore, a procedure for IT equipment disposal can reduce the impact of the business on the natural environment. This trend can be seen in the budget

allocations of ICT organisations for taking steps in the next three years to reduce their carbon footprints (Widjaja, Mariani & Imam 2011).

The findings also indicate adoption of IT equipment that has information about the management of the end of IT life to meet and comply with domestic and international regulators. The Indonesian government through the Ministry of Telecommunication and Informatics has encouraged ICT organisations to pay more attention to international regulations such as the European Union's Waste Electrical and Electronic Equipment Directive for reinforcing brand value and creating competitive organisations in the business market and also improving their environmental performance (Ministry of Telecommunication and Informatics 2012). Thus, PT Telkomsel has modernised the IT infrastructure used for operational facilities with new energy-efficient appliances based on the evolution of a radio access network single system with lower energy consumption (Telkomsel 2010).

8.4. Summary

The purpose of this chapter has been to discuss how the core findings of this study answer the research questions proposed for investigation. Based on selected GOF indices, comparison of GOF indices of the structural model and the corresponding full measurement model, the magnitude of variance results and the significance of the hypotheses, the study has found that the model is valid and that four hypotheses were accepted, and concluded that:

1. IT infrastructure quality has a significant positive effect on business process digitisation (H1).
2. Competence of IT human resources has a significant positive effect on business process digitisation (H3).
3. Business process digitisation has a significant positive effect on environmental IT competence (H5).

4. Environmental IT competence has a significant positive effect on environmental performance (H7).

From the findings above, these indicate that environmental performance in the Indonesian ICT industry may be influenced by IT infrastructure quality, competence of IT human resources, business process digitisation and environmental IT competence. This current study finding also shows that IT infrastructure quality and competence of IT human resources cannot be used directly to improve environmental performance, as found by previous research. However, IT infrastructure quality and competence of IT human resources require business process digitisation and environmental IT competence as mediating variables to improve environmental performance, as can be seen in Figure 8.3.

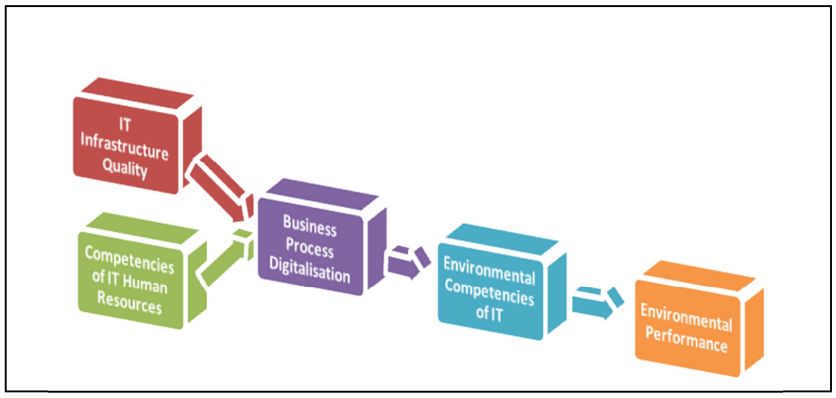


Figure 8.3 Process of environmental performance improvement

As illustrated in Figure 8.3, this can be simplified for easily understanding how IT capabilities can help an organisation to improve its environmental performance. This starts from IT infrastructure quality and competence of IT human resources used to support business process digitisation; next, it develops environmental IT competence; and then it can improve the environmental performance in an organisation.

The findings, however, do not support the notion that IT infrastructure quality and competence of IT human resources have a significant effect on environmental IT competence. Therefore, the second and fourth hypotheses are rejected and it is concluded that in

developing environmental IT competence, business process digitisation may be required as a link between IT infrastructure quality and competence of IT human resources, and environmental IT competence development. In addition, the sixth hypothesis also shows that there is no relationship between business process digitisation and environmental performance. Thus, this hypothesis is also rejected and it is concluded that the improvement of environmental performance requires policies, procedures and systems as guidelines in the use of ITC equipment in business operations.

The findings of this study also provide further evidence that the RBV and its complementary competence perspective provide valuable insights into assessing the environmental performance of the Indonesian ICT industry. The study shows that environmental performance emerges not only from IT infrastructure quality and competence of IT human resources, but also from required business process digitisation and environmental IT competence developed.

The next chapter will identify the final conclusions from the hypotheses, research framework and research problems. It will also draw the implications for both practice and theory; discuss the limitations of this study; describe the directions for future research; and identify the final conclusions.

Chapter 9
Contributions, limitations and conclusions

9.1 Introduction

This chapter presents a summary of the critical findings of the dissertation in a manner that answers the research questions and outlines the contributions, limitations and areas for further study. It also gives the final concluding remarks. The objectives of this chapter are to summarise the conclusions and contributions from the research findings, and to highlight the possible significant implications for theory and management to improve the environmental performance of organisations in the Indonesian ICT industry. Furthermore, this chapter also provides a discussion of the recommendations for researchers, regulators and practitioners who are interested in the improvement of organisational environmental performance in the future.

There are six sections in this chapter. It starts with Section 9.1 introducing the objectives of this chapter, followed by the conclusions and contributions based on the conceptual framework, methodology and measurement, and research questions in Section 9.2. Section 9.3 provides the theoretical and managerial implications of the research findings. The limitations of this research and guidelines for future research are described in Section 9.4 and 9.5. This chapter is concluded by an overall summary in Section 9.6.

9.2 Conclusions and contributions of research findings

In this section, the conclusions and contributions from the research finding are divided into three main perspectives: research framework, statistical methodology and measurement, and research problems.

9.2.1 Conclusions and contributions based on the research framework

This study has investigated the relationship between IT capabilities and environmental performance. This current research encapsulates the ideas of two theories, RBV and natural-RBV, in a new research background. The main research question that underpins this research is: what are the critical factors of IT capabilities for improving environmental performance in the Indonesian ICT industry? To address this research question and achieve the research objectives, a comprehensive review of potential theories and theoretical literature was done; all relevant directions towards identifying the predictors of IT capabilities were consolidated in Chapter 3.

The previous research findings on the environmental performance effects of IT capabilities are mixed and mainly relate to the ICT sector context. Research studies focusing on the use of IT capabilities to improve environmental performance in the ICT industry are relatively few. Furthermore, most studies of environmental performance that is related to the use of IT capabilities were in the context of developed countries; their major focus has also been limited to exploring the applicability and suitability of IT infrastructure and IT human resources (see Chapter 3). From those studies, most have been based on limited case evidence and the generalisability of the findings to ICT organisations has yet to be tested.

- To discover whether the implementation of IT capabilities by ICT organisations contributes to business process digitisation and then development of environmental capabilities of IT and end improvement of environmental performance, and to provide explanations of how this is so, this research set forward the following as its main research question: '**what are the critical factors of IT capabilities for improving environmental performance in the Indonesian ICT industry?**' To understand the extent to which IT capabilities practices have improved environmental performance and determine the

factors that contribute to environmental performance, the main research question was further deconstructed into the following four sub-research questions:

- What are the factors of ***IT infrastructure quality*** which affect ***business process digitisation*** and ***environmental IT competence*** in the Indonesian ICT industry*?*
- What are the factors of ***IT human resources competence*** which affect ***business process digitisation*** and ***environmental IT competencies*** in the Indonesian ICT industry*?*
- What are the factors of **business process digitisation which affect *environmental performance*** and ***environmental IT competence*** in the Indonesian ICT industry?
- What are the factors of ***environmental IT competencies*** *which affect* ***environmental performance*** in the Indonesian ICT industry?

This section provides a summary of how these questions were addressed in this study.

Research question 1: what are the factors of IT infrastructure quality which affect business process digitisation in the Indonesian ICT industry?

In addressing this research question, first the IT capabilities literature including green IT literature was reviewed. The review revealed that business process digitisation can be assessed at the business process level and the overall organisational operations level (Ijab et al. 2010; Loos et al. 2011). Further, the review identified that there were different perspectives on the determining factors of business process digitisation, of which RBV was found to be the most promising for conceptually linking IT infrastructure quality and its competence in ICT organisations with the development of business process digitisation (Molla 2008; Molla et al. 2012; Molla, Cooper & Pittayachawan 2009).

Second, the review of the IT infrastructure quality literature presented in Chapter 3 identified the appropriate perspectives regarding the determining factors for successful business process digitisation. In this case, virtualisation technologies were the selected indicators of IT

infrastructure quality that can aid ICT organisations to perform business process digitisation. These include server, storage and desktop virtualisation. In relation to ICT organisation circumstances, the three identified constructs also addressed several issues that are faced by ICT organisations such as electricity supply and natural disaster.

Table 9.1 Factors of IT infrastructure quality

No.	Factors	Supported prior studies
1.	• Adoption of server virtualisation	Miller and Pegah (2007), Sindori et al. (2013), Marston et al. (2011), Kloch et al. (2011), Wittow and Buller (2010), Gmach and Holcomb (2004)
2.	• Adoption of storage virtualisation	Chaudhuri, Dayal and Narasayya (2011), Marston et al. (2011), Kloch et al. (2011), Wittow and Buller (2010), McKendrick (2010), Molla et al. (2008), Gmach and Holcomb (2004)
3.	• Adoption of desktop virtualisation	Kloch et al. (2011), Wittow and Buller (2010), Mann (2009)

Third, to understand and recognise ICT organisation circumstances, this study utilised secondary data including annual and sustainability reports. The findings have highlighted the importance of the use of virtualisation technologies as solutions for ICT organisations to conduct their business processes in the Indonesian situations. As stated earlier, Indonesia has two significant issues, electricity supply and natural disasters, as challenges for ICT organisations. With the electricity supply issue, the ICT organisations that are located in Sumatera, Borneo, Sulawesi and Papua need to enhance use of virtualisation technologies in order to mitigate the effects of the issue. This finding was also supported by those of Marston et al. (2011), Wittow and Buller (2010) and Kloch et al. (2011), who state that virtualisation technologies are necessary for meeting and interacting with organisations' stakeholders and providing information that can be accessed by them anywhere and anytime through the internet. With the natural disasters issue, virtualisation technologies can not only be placed anywhere that is far away from natural disaster ranges, but can also be accessed by

organisations' stakeholders anytime and anywhere even if the organisations are affected by natural disasters. Furthermore, those technologies are also needed by ICT organisations for disaster recovery because of their high resource utilisation, recovery management and dynamic infrastructure.

Fourth, to support and expedite the use of IT equipment including virtualisation technologies in business operations, the Indonesian government has released the electronic information and transaction regulations as guidelines and references for the use of virtualisation technologies in its business operations. With this regulation, the Indonesian government is facilitating information technology and electronic transaction usage in accordance with the provisions of prevailing laws and regulations. Further, the government will protect the public interest from any type of threat as a result of misusing electronic information and electronic transactions that offend order, in accordance with the provisions of law and regulations as described in Chapter 9, Article 40 of the electronic information and transaction regulations.

In overall terms, IT infrastructure quality creates the necessary conditions for the continuous development of business process digitisation (competence) for enhancing the delivery of business services to stakeholders. Furthermore, it has an important effect on administration and service delivery processes through meeting the circumstances of Indonesia, including the issues of electricity supply and natural disasters. Therefore, IT infrastructure quality does really matter to business process digitisation in Indonesian ICT organisations.

Sub-research question 1: what are the factors of IT infrastructure quality which affect environmental IT competence in the Indonesian ICT industry?

Research question 1 addresses the effects of IT infrastructure quality on environmental IT competence. The findings are that IT infrastructure quality does not significantly affect environmental IT competence. This finding is supported by the structural analysis and statistical hypothesis testing, which show that IT infrastructure quality has a significant negative effect on environmental IT competence. Therefore, it can be concluded that

increases in the use of IT infrastructure quality may not improve an organisation's environmental IT competence.

One important caveat to the above conclusions, however, must be made. The development of an organisation's environmental IT competence in the Indonesian ICT industry depends largely on how well the organisation embeds and uses its IT infrastructure in its business process digitisation to deliver environmentally friendly services to suppliers and customers. This finding also reveals that organisations can easily measure the financial benefits obtained from adopting the technologies that they embed in business process digitisation.

To summarise, IT infrastructure quality is not directly a significant factor for developing environmental IT competence in organisations. Organisations need business process digitisation as a mediating factor that can be utilised to evoke the green capabilities of IT infrastructure and then develop environmental competence of the organisations.

Research question 2: what are the factors of IT human resources competence which affect business process digitisation in the Indonesian ICT industry?

Research question 2 is similar to research question 1, which enquires about the critical factors of IT human resources competence of organisations in conducting business process digitisation to deliver services to partner. This question empirically examines the effects of these indicators of IT human resources competence on business process digitisation. There is one developed hypothesis (H3) designed to answer this research question.

To address this research question, the indicators of the constructs that made up the research framework were defined. The findings of the measurement model included the congeneric factor, multifactors and a full model analysis, as discussed in Chapter 7, and concluded that there are three identified factors of IT human resources competence related to business process digitisation: knowledge of environmental government regulations, management system standards and standardisation of IT equipment. This finding is also supported by the

hypothesis testing that IT human resources competence is significantly and positively related to business process digitisation. Therefore, it can be concluded from the analysis that increasing the competence of IT human resources increases business process digitisation.

As discussed in Chapter 7, the three factors of IT human resources have an acceptable fit and have factor loading above the recommended value of 0.7. The factor of knowledge of environmental government regulations has a factor loading value of 7.0, that of the knowledge of management system standards is 0.88 and knowledge of the standardisation of IT equipment is 0.91. Furthermore, in the full model of CFA measurement, the factor loading value of these factors is within the acceptable range. Therefore, these factors can be concluded as critical factors of IT human resources competence for supporting business process digitisation.

Table 9.2 Factors of IT human resources competence

No.	Factors	Supported prior studies
1	Knowledge of environmental government regulations	Cooper and Molla (2012), Butler (2011), López-Gamero, Molina-Azorín and Claver-Cortés (2010), Adela, Marie-Claude and Richard (2008)
2	Knowledge of management system standards	Cooper and Molla (2012), Cooper and Molla (2011), Prajogo (2011), Molla et al. (2009), (Darnall & Edwards (2006)
3	Knowledge of standardisation of IT equipment	Cooper and Molla (2012), Molla & Abareshi (2011), Molla et al. (2008), Murugesan (2008), Köhler & Erdmann (2004)

The importance of these factors for successful business process digitisation in an organisation is supported by much prior literature. For example, the importance of knowledge of government regulations of IT human resource competence is consistent with Cooper, Vanessa A and Molla, Alemayehu (2012) and Murugesan, S. (2008). Furthermore, the importance of knowledge of management system standards is related to the studies of Molla, Cooper and Pittayachawan (2009), Molla et al. (2011), Molla et al. (2012) and Cooper and Molla (2012).

The importance of knowledge of standardisation of IT equipment is relevant to the studies of Köhler and Erdmann (2004) and Molla and Abareshi (2012).

In the Indonesian context, concerns about IT human resources in environmental performance in ICT organisations can be found in the study of Widjaja, Mariani and Imam (2011), which shows that IT human resources have a significant role in improving the environmental performance in their organisations. It can be proved by the role of IT human resources in using their capabilities to adopt government regulations and international system standards in business operation practices.

In conclusion, despite the fact that IT can help Indonesian ICT organisations to provide successful business process digitisation, IT human resources competence also plays a significant role in building the business process digitisation of organisations. Their role can be seen in how they embed their competence in business process digitisation.

Sub-research question 2: what are the factors of IT human resources competence which affect environmental IT competencies in the Indonesian ICT industry?

Sub-research question 2 addresses the effect of IT human resources competence on environmental IT competence in Indonesian ICT organisations. The findings are that IT human resources competence does not significantly impact on environmental IT competence in organisations. This is proved by hypothesis four with β=-0.063 and P=0.347. Therefore, IT human resource competence should not be directly employed as a significant factor for developing environmental IT competence in an organisations. It means that the development of environmental IT competence in an organisation might be built through business process digitisation where the competence of IT human resources is embedded in that processes.

From the measurement model including congeneric factors, multifactors and the full model analysis as discussed in Chapter 7, the study reveals that the factors of IT human resources

competence including environmental regulations, management system standards and standardisation of IT equipment competence should not be used in developing environmental IT competence.

This finding contrasts with prior studies that stated that IT human resources competence including environmental regulations, management system standards and standardisation of IT equipment aid organisations to develop their environmental performance. This might be because most prior research was conducted in developed countries where environmental regulations are important knowledge for IT human resources as a competence in meeting government requirements to enhance the reputation. Furthermore, the government regulations encourage organisations to be ecologically responsive in order to avert negative public attention or financial penalties. In Indonesia, implementation regulations are often ignored by organisations. They are not concerned about the financial penalties that might be applied to them if they do not meet government requirements.

In terms of management system standards like ISO 140001 Environmental Management Systems, these are guidelines for whole organisations in developed countries to improve their environmental performance and also to allow quicker and more flexible information access. However, in developing countries like Indonesia, through the Ministry of Environment and National Standardisation Agency the ISO 14000 environmental certificates are most proposed and applied in mining organisations. For Indonesian ICT organisations, the ISO 14000 is only a suggestions from the government for reducing the impact of their business operations on the natural environment.

In conclusion, as mentioned in sub-section 9.2.3, IT human resources can be used to aid Indonesian ICT organisations to develop successful business process digitisation through embedding their competence including environmental regulations, management standards and

standardisation of IT equipment into business process digitisation in order to develop and improve environmental competence. Therefore, the competence of IT human resources cannot be used to develop environmental competence of organisations because of the Indonesian circumstances. In this case, the researcher emphasises that there is a need for building business process digitisation to develop and improve environmental competence.

Research question 3: what are the factors of business process digitisation which affect environmental performance in the Indonesian ICT industry?

Research question 3 addresses the effects of business process digitisation on the environmental performance of organisations. The findings reveal that business process digitisation does not significantly affect the environmental performance of organisations. This is proved by hypothesis four with $\beta=0.586$ and $P=0.558$. Therefore, business process digitisation has not been a significant factor for improving the environmental performance of organisations. It can be concluded that successful business process digitisation may not improve organisations' environmental performance.

From the finding above, this study concludes that the practicality of an organisation in the Indonesian ICT industry depends largely on how capable business process digitisation is of developing environmental competence and then improving overall environmental performance. Hence, the finding confirms that there is an indirect effect of business process digitisation on environmental performance. The finding also implies to practitioners that to improve environmental performance, Indonesian ICT organisations need to develop a high level of environmental IT competence. For that purpose, organisations need to ensure business process digitisation is embedded in IT infrastructure quality and competence of IT human resources.

Sub-research question 3: What are the factors of business process digitisation which affect environmental IT competence in the Indonesian ICT industry?

The findings of this study revealed two sets of factors, business digital communications and business digital transactions, that influence environmental IT competence. These factors are summarised in Table 9.3 and discussed below.

Table 9.3 Factors of business process digitalisation

No.	Constructs	Factors
1	Business digital communications	• Adoption of teleconferencing technologies • Adoption of tele-presence technologies • Adoption of right-sizing communication equipment
2	Business digital transactions	• Adoption of enterprise resource planning • Adoption of e-procurement • Adoption of environmental management systems

The first set of factors that influence organisational environmental competence are related to business digital communications, including adoption of teleconferencing technologies, tele-presence technologies and right-sizing communication equipment. These important factors ensure business operations are more environmentally friendly. For example, the adopting of teleconferencing and tele-presence can build environmental IT competence related to emission and travel cost reduction. Therefore, business digital communications enable people and organisations to communicate and coordinate with their partners in ways that are environmentally friendly.

The second set of factors that influence organisational environmental competence are related to business digital transactions, including adoption of enterprise resource planning, e-procurement and environmental management systems. With these factors, organisations are enabled to share their services and infrastructure in whole business operations. Therefore, the business processes in an organisation will be integrated, automated and informed to make it more environmentally friendly.

Research question 4: what are the factors of *environmental IT competence which affect environmental performance* in the Indonesian ICT industry?

Question 4 attempts to determine the factors of environmental IT competence that affect environmental performance. This question has been obtained through an extensive review of the literature in Chapter 3. From resource-based view (RBV) and natural-RBV perspectives, feasible environmental IT competence may require organisations to develop their internal resources and capabilities such as emission management, sustainability behaviour and resource stewardship.

From the measurement model including congeneric factors, multifactors and the full model analysis as discussed in Chapter 7, the study reveals that the factors of environmental IT competence in individual constructs are summarised in Table 9.4 and discussed below.

Table 9.4 Factors of environmental IT competence

No.	Constructs	Factors
1	Emission management	• Implementation of reusable IT equipment procedures • Implementation of IT equipment disposal procedures
2	Sustainability behaviour	• Ability of IS functions to build the commitment of employees to environmentally friendly work practices in an organisation • Ability of IS functions to promote the choice of environmentally sustainable courses of actions • Ability of IS functions to change employees' behaviour towards environmentally friendly work practices in an organisation
3	Resource stewardship	• Adoption of IT equipment that has information about end of IT life management • Adoption of applications designed to be reusable

From the finding above, this study concludes that the improvement of environmental performance in Indonesian ICT organisations is influenced by how well organisations develop their environmental IT competence in managing CO_2 emissions through implementing procedures including reusable IT equipment and IT equipment disposal

procedures. Furthermore, organisations also need to build the environmental competence of their information systems to develop the sustainability behaviour of employees. For example, environmental competence in IS functions is used to build the commitment of employees to environmentally friendly work practices in an organisation. Furthermore, the capability of IS functions is utilised to promote the choice of environmentally sustainable courses of action and to change employees' behaviour towards environmentally friendly work practices in an organisation.

In terms of resource stewardship, organisations need to pay attention to the IT equipment implemented. In this case, organisations have to ensure that IT equipment has information about end of IT life management. It will make it easier for organisations to dispose of them and then improve their overall environmental performance. In addition, organisations also need to ensure that applications adopted are designed to be reusable for further applications. Therefore, organisations can reduce operational costs and time in developing applications and then can improve their environmental performance.

9.3 Contributions of the study

By developing and validating the theoretical model and accompanying measurement instruments for assessing the effects of IT capabilities on environmental performance in Indonesian ICT organisations, this study contributes to research, theory and practice from several perspectives. This section highlights these contributions.

9.3.1 Contributions to research and theory

The study contributes to research and theory. First, this study was conducted on public ICT organisations in a developing country context. As indicated in the literature review, there have only been a handful of IT capability studies that have addressed aspects of the relationship between IT capabilities and environmental performance in a developing country.

This study also contributes by building a conceptual model integrating the capabilities of IT including IT infrastructure quality, IT human resources competence, business process digitisation and environmental IT competence variables in a framework linked with environmental performance. The study also tested, validated and provided empirical support for the proposed theoretical model. The study shows not only the adoption and implementation of IT capabilities in Indonesian ICT organisations, but also the outcome and impact. These represent original contributions to both theoretical and empirical research into IT capabilities in the Indonesian ICT industry.

Second, the development and validation of the integrated theoretical model and measurement instruments to validate the environmental performance effect of IT capabilities is also an original contribution to the IS literature. The integrated model is original, as it has associated insights from the theories of RBV, natural-RBV and its complementary competence perspective, and the environmental performance of organisations. From the IS literature, the model has adopted IT capabilities for specific resources (IT infrastructure quality and IT human resources competence), business process digitisation, environmental IT competence and outcome measures. From the IS literature, environmental performance measures and indicators were drawn. The RBV theory provided the underlying logic for integrating the various IT capabilities and environmental performance perspectives into a single cogent framework and for theorising the linkage between the various IT capabilities-related variables and environmental performance. The usefulness of RBV for understandin the environmental performance of ICT organisations is well recognised. Nevertheless, RBV has not been extensively utilised to investigate the role of IT capabilities, outcomes and effects in the environmental performance of ICT organisations. Instead, most IT capability studies in the IS literature are atheoretical. It can be concluded that the integrated model that embraces IT infrastructure quality, IT human resources competence, business process digitisation and

environmental IT competence is superior in its explanatory power both at the process level and at the overall environmental performance level. Therefore, this study breaks new theoretical ground regarding investigation of the relationship between IT capabilities and environmental performance in IS research.

The third contribution of the study to research and theory is that through developing the integrated model, the study has verified the applicability and relevance of most previous findings of IS studies, especially the investigation of the environmental performance effect of IT capabilities in Indonesian ICT organisations. As such, the current study provides further empirical evidence and support for the IT capabilities pragmatic view that is described in Chapter 3. Consistent with the pragmatic view, the findings of the current research substantiate and reinforce the IS studies that acknowledge the applicability of IT infrastructure quality, IT human resources competence and business process digitisation practices to ICT organisations by taking into account the unique circumstances of the latter such as the development of environmental competence of an organisation. The findings show that ICT organisations require not only IT infrastructure quality and IT human resources competence, but also applicability of business process digitisation and development of environmental IT competence as critical success factors for improving environmental performance.

Fourth, the research emphasises the role of business process digitisation and environmental performance as link constructs between IT infrastructure quality and IT human resources competence, and environmental performance. Business process digitisation is a set of skills, systems and technologies that enhances the critical capabilities of IT infrastructure and competence of IT human resources that further develop environmental IT competence and enhance the overall organisational environmental performance. Furthermore, environmental IT competence is a significant factor identified, which is used for improving environmental

performance. This is because the factor consists of procedures including reusable IT equipment and disposal of IT equipment procedures, as guidelines for building the green capabilities of an organisation. Furthermore, environmental IT competence might be used to build, promote and change the behaviour of employees to work in ways that are more environmentally friendly. In addition, the importance of environmental IT competence can be used as resource stewardship in organisations. As a result, business process digitisation and environmental IT competence as significant organisational capabilities for connecting IT infrastructure quality, IT human resources competence and environmental performance are revealed in this research. They are used to integrate, build and reconfigure an organisation's capabilities in addressing its environmental performance.

This research contributes to theory by providing further empirical support for the application of RBV and its complementary competence perspective to the domain of IT capability. RBV provides a theoretical lens for investigating the various IT capability perspectives and theorising on the relationship between IT capability and the environmental performance of organisations. Appropriate IT capabilities such as IT infrastructure quality and capable IT human resources support business process digitisation and can then develop environmental IT competence in a changing business environment. Environmental IT competence as a significant organisational ability for connecting business process digitisation and environmental performance is revealed in this research. It is used to integrate, build and reconfigure an organisation's capabilities in addressing its environmental performance.

Another way in which this study contributes to research and theory is by providing further empirical support for the application of RBV theory and its complementary competence perspective to the domain of IT capabilities. RBV theory provided a theoretical lens for integrating the various IT capabilities perspectives seamlessly and theorising the linkage between BPR and public sector organisation performance. Prior studies of IT capabilties in IS

in general and in Indonesian ICT organisations in particular have mainly been based on models derived from critical success factors. As such, they have lacked a cogent theory that links IT capabilities with environmental performance. In this regard, this study has addressed an important research gap by using RBV and its complementary competence perspective in the domain of IT capabilities.

Sixth, through assessing the organisational environmental performance impact of IT capabilities on business process digitisation and environmental IT competence, this research has provided the first empirical evidence that IT infrastructure quality and IT human resources competence positively contribute to the business process digitisation of Indonesian ICT organisations. The second piece of statistical evidence shows that business process digitisation has a positive impact on environmental IT competence and overall improvement of the environmental performance of organisations. The current study has also complemented and extended prior IT capabilities findings that measured environmental performance with IT infrastructure capabilities only, IT human resources competence only, or the business process level only, or with environmental competence development measures and overall environmental performance measures.

Finally, yet importantly, even though the empirical data comes from the Indonesian ICT industry, the integrated model can be generalised to all ICT organisations outside Indonesia subject to a slight finetuning of some items of the measurement instrument.

9.3.2 Contributions to practice

This study contributes to IT capability practice in at least three ways. The first contribution is to reveal the role of IT capability in ICT organisations, where it influences their environmental performance and is a factor to take into consideration in their IT capability practices. Understanding these mechanisms and factors enables practitioners to become more successful in their IT capabilities undertakings. Specifically, to realise a change with business

process digitisation and environmental IT competence with a significant organisational environmental performance impact, the study recommends for IT practitioners who are undertaking IT capabilities implementation in the Indonesian ICT industry context to ensure that:

- Top management is offering continued support and commitment to IT capabilities by implementing and adopting reusable IT equipment and IT equipment disposal procedures.
- The IT human resources to be employed have adequate knowledge of environmental government regulations, management system standards and standardisation of IT equipment knowledge.
- The competences of IT human resources should be embedded in business process digitisation in order to develop and build environmental IT competence in Indonesian ICT organisations.
- Virtualisation technologies as part of IT infrastructure quality should be maximally used in organisational business operations to develop IT competence in Indonesian ICT organisations.
- Managing CO_2 emissions can be conducted by implementing procedures for reusable IT equipment and IT equipment disposal.
- IS competences can be used for promoting, changing and building the sustainability behaviour of employees in ICT organisations.
- Adopting IT equipment that has information about end of life management and applications that can be used more than one time can be utilised as resource stewardship in ICT organisations.

Overall, the findings of the current study imply that Indonesian ICT organisations can improve their environmental performance by: understanding the mechanisms and factors of IT infrastructure quality to become more successful in their IT capability undertaking,

especially in re-engineering their business processes, developing the knowledge and skills of IT human resources with environmental regulations, management system standard and standardisation of IT equipment to re-engineer business processes and developing environmental IT competence and then improving the overall environmental performance of ICT organisations.

9.4 Limitations of the study

This purpose of this study has been to identify and validate the critical factors of IT capability in the environmental performance of organisations through the mediating effect of business process digitisation and environmental IT competence. To be as comprehensive as possible, the study took into account possible IT capability and process-related factors related to environmental performance.

However, the research has five limitations. First, this research focused only on the ICT industry in Indonesia and not the manufacturing industry as a whole. It may raise questions about the limited external validity and could limit the potential of the findings to be more generally applied. A study within a single industry can eliminate problems associated with the effects of industry differences.

Second, several items utilised to design the instrument were taken from developed countries' literature and the instrument was pilot assessed and validated based on data from ICT organisations in Indonesia as a developing country where technical, organisation and human resources competences are relatively lower rather than in developed countries. Therefore it is likely that the instrument would have looked slightly different if the items had been drawn from the mainstream IT capability literature and if it had been piloted and validated in a developed country.

Third, another limitation relates to the type of research – this was a cross-sectional study, which is descriptive in nature. Furthermore, RBV and natural-RBV theories were adopted as a lens for addressing the issues regarding the relationship between IT capabilities and environmental performance. Therefore, there is a need for future research to be conducted with different theories such as institutional theory to understand different perspectives of IT capability and environmental performance.

Fourth, the survey respondents were all IT managers. As such, their responses could lack the required level of impartiality, that is, they may have had a tendency to assess the IT capability of their organisations favourably.

Fifth, this study followed rigorous validation procedures including measurement purification, content validity and construct validity through both exploratory and covariance-based confirmatory factor analysis techniques using AMOS. However, these procedures resulted in several items being dropped from the study. This has implications for future study, including the need to validate and revalidate the proposed model and its measurement instruments with ICT organisations in developing countries other than Indonesia.

9.5 Directions for future research

This study has developed a model that provides a relationship between IT capabilities and environmental performance with identified critical factors of constructs, but several areas for future research remain. The current research focused on ICT organisations including communications organisations, computer hardware and software organisations, and internet service providers in a developing economy, Indonesia. The results could be different with other country classification groups considered, such as underdeveloped countries and developed countries. Several opportunities for future research spring from the results of this study. It would be interesting to extend this research to other developed or developing

countries which offer attractive remunerations and incentives for foreign investment. Future research should also explore and compare the factors of IT capabilities impact on environmental performance in other countries such as Malaysia, India, Thailand and Singapore.

Future researchers are encouraged to explore whether the final IT capabilities and environmental performance model of this study holds in other industry contexts. As discussed in Chapter 3, the factors of each construct in IT capabilities were identified for environmental performance, which might be suitable for improving the innovation capability of the electronics industry. Therefore, the implications might show differences in contexts where the identified factors of IT capabilities are tested in industries with the adoption of environmental procedures and appropriate IT equipment.

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Appendices

Appendix 1 List of initially generated items

Appendix 1.1 IT infrastructure quality

Appendix 1.2 IT human resources competences

Competence	**ITEMS**	**REFERENCES**
Technical	IT personnel are skilled in computer network systems	Bharadwaj 2000
	IT personnel are skilled in a specific programming language (e.g. web based applications)	
	IT personnel are skilled in operating systems	
	IT personnel are skilled in data communications	Bryd and Turner 2000
	IT personnel are skilled in data management	
	IT personnel are skilled in emerging technologies	
	IT personnel are skilled in server consolidations and virtualisations	Molla 2008 2009 Sayeed 2008 Mann 2008
	IT personnel are skilled in desktop virtualisations	
	IT personnel are skilled in storage virtualisations	
	IT personnel are skilled in data de-duplications	
	IT personnel are skilled in digitised communications	
Managerial	IT personnel are knowledgeable in business functions	
	IT personnel have interpersonal skills	
	IT personnel are knowledgeable about the business environment	
	IT personnel have the ability to plan, organise and lead projects	
	IT personnel have the ability to plan and execute work in collective environment	
	IT personnel are knowledge about environmental management standards	Vanessa 2012
	The strategies of the IT units and the organisation's strategies are well aligned	
	IT personnel understand environmental government	

	regulations	
	IT personnel understand the organisational policies and plans	
	IT personnel are able to interpret business problems and appropriate technical solutions	
	IT personnel are skilled in redesigning business processes to be more environmentally friendly	

Appendix 1.3 Business Process Digitisation

	ITEMS	**REFERENCES**
Digital communications	Adoption of email for internal and external communication	Molla 2009
	Adoption of advanced communication technologies	Mann 2008
	Adoption of the electronic data interchange for formal external communication	Byrd and Turner 2000
	Adoption of teleconferencing technologies	Molla 2009
	Adoption of tele-presence technologies	Mann 2008
	Adoption of instant messaging (e.g. Skype)	Weil and Vitale 2002
	Adoption of websites for publishing basic organisational information including	Molla 2009
	Adoption websites for publishing information about services of the organisation (including	Molla 2012
	Adoption of energy-efficient communication equipment	Murugesan 2008
	Adoption of right-sizing communication equipments	
	Adoption of broadband networks to access the internet (e.g. fibre optics)	Frost 2011
	Adoption of WIMAX technologies for wireless communication	
	Adoption of LAN and WAN for internal communication	
	Adoption of the internet protocol 6	
Digital business transactions	Adoption of enterprise resource planning	Molla 2009
	Adoption of supply chain management systems	Melville 2010
	Adoption of customer services systems	Watson 2011
	Adoption of e-procurement	
	Adoption of human resources management systems	Molla et al 2009
	Adoption of integrated enterprise systems	
	Adoption of online delivery systems	
	Adoption of environmental information disclosure	
	Adoption of automated workflow systems	

	Adoption of document flow systems	
	Adoption of document management /archival systems	

Appendix 1.4 Environmental IT competence

ECO-COMPETENCES	**ITEMS**	**REFERENCES**
Emission management	Availability of the IT vision of an organisation	Molla 2009 Sayeed and Gill 2009
	Availability of the IT goal of an organisation	
	Availability of high degree of consensus among top management about the role of environment IT in an organisation	
	Availability of the IT policy for managing IT resources	
	Availability of environmentally friendly IT purchasing procedures	
	Availability of reusable IT equipment procedures	
	Availability of IT equipment disposal procedures	
	Availability of end of IT life management	
Sustainability behaviour	IS functions are able to deliver information that relates to environmentally friendly work practices in an organisation	Molla 2012
	IS functions are able to build the commitment of employees to environmentally friendly work practices in an organisation	
	IS functions are able to promote the choice of environmentally sustainable courses of actions	
	IS functions are able to educate employees' behaviour reducing the energy consumption	
	IS functions are able to change employees' behaviour to environmentally friendly work practices in an organisation	
Resource stewardship	IT components are easily adopted in business operations	Broadbent 1999 Duncan 1995
	IS functions are easily upgraded in business operations	
	IT components are widely reused in new IT infrastructure	
	IT components are easily shared across business	

	operations	
	IS functions are easily used to communicate among business units	
	IT components are made from non-hazardous materials	
	Power management of IT components	Mann 2008
	Recycling information of IT components	
	Reusable software modules are widely reused in new system development	Byrd and Turner 2000
	Application used in our organisation are designed to be reusable	

Appendix 1.5 Environmental performance

ITEMS	**REFERENCES**
Energy consumption	Moneva and Ortas 2010
CO_2 emission reduction	Jacobs et al 2010
Environmental management	Moneva and Ortas 2010
Environmental initiatives	
Environmental disclosure	
Organisational environment	Elsayed and Paton 2005

Appendix 2 Normality test

Variable	min	max	skew	c.r.	kurtosis	c.r.
ITF01	4	7	–0.251	–1.989	–0.734	–2.911
ITF02	5	7	–0.27	–2.141	–1.077	–4.272
ITG03	4	7	–0.315	–2.503	–0.726	–2.88
ITG04	5	7	–0.199	–1.578	–1.169	–4.639
ITG05	4	7	–0.334	–2.648	–0.728	–2.89
ITG06	5	7	–0.352	–2.795	–0.976	–3.874
HRM01	5	7	–0.269	–2.133	–1.225	–4.864
HRM02	4	7	–0.286	–2.273	–0.923	–3.663
HRM03	4	7	–0.286	–2.273	–0.995	–3.948

HRT04	5	7	–0.303	–2.408	–1.153	–4.576
HRT05	5	7	–0.336	–2.666	–1.219	–4.839
HRT06	5	7	–0.318	–2.526	–1.121	–4.448
BDB12	5	7	–0.329	–2.609	–0.872	–3.46
BDB11	5	7	–0.259	–2.053	–0.897	–3.56
BDB10	3	7	–0.309	–2.45	–0.83	–3.294
BDB09	5	7	–0.29	–2.298	–1.104	–4.383
BDB08	5	7	–0.295	–2.338	–1.162	–4.61
BDC07	5	7	–0.249	–1.979	–1.158	–4.596
BDC06	4	7	–0.376	–2.987	–0.802	–3.182
BDC05	5	7	–0.346	–2.748	–0.907	–3.6
BDC04	5	7	–0.335	–2.655	–1.281	–5.082
BDC03	5	7	–0.318	–2.526	–1.121	–4.448
BDC02	5	7	–0.269	–2.133	–1.225	–4.864
BDC01	6	7	–0.267	–2.118	–1.929	–7.655
EM06	3	7	–0.671	–5.324	0.014	0.057
EM05	4	7	–0.319	–2.535	–0.773	–3.07
SB11	4	7	–0.218	–1.726	–0.729	–2.895
SB10	4	7	–0.439	–3.488	–0.604	–2.395
SB09	4	7	–0.359	–2.848	–0.354	–1.405
SB08	5	7	–0.124	–0.983	–1.183	–4.695
SB07	5	7	–0.196	–1.559	–0.988	–3.92
RS15	5	7	–0.308	–2.441	–0.911	–3.614
RS14	5	7	–0.295	–2.34	–1.265	–5.022
RS13	5	7	–0.329	–2.612	–0.834	–3.311
RS12	5	7	–0.235	–1.865	–0.886	–3.517

EM04	5	7	–0.297	–2.357	–1.176	–4.668
EM03	5	7	–0.324	–2.57	–1.15	–4.564
EM02	5	7	–0.262	–2.081	–0.644	–2.557
EM01	5	7	–0.341	–2.707	–0.67	–2.661

Appendix 3 Comparison of loadings of the structural model and the measurement

			Estimate structural model	Estimate measurement model	Differences
BDC.	<—	BPD	0.88	0.878	0.002
BDT	<—	BPD	0.906	0.91	–0.004
EM.	<—	EIT	0.794	0.794	0
RS.	<—	EIT	0.852	0.854	–0.002
SB.	<—	EIT	0.851	0.851	0
ITG05	<—	ITQ	0.61	0.615	–0.005
ITG04	<—	ITQ	0.72	0.726	–0.006
ITG03	<—	ITQ	0.916	0.909	0.007
HRM03	<—	ITH	0.908	0.909	–0.001
HRM02	<—	ITH	0.878	0.877	0.001
HRM01	<—	ITH	0.701	0.701	0
BDB08	<—	BDT	0.818	0.817	0.001
BDB09	<—	BDT	0.76	0.76	0
BDB10	<—	BDT	0.908	0.908	0
BDC05	<—	BDC.	0.808	0.809	–0.001
BDC04	<—	BDC.	0.883	0.882	0.001
BDC03	<—	BDC.	0.765	0.764	0.001
EM05	<—	EM.	0.947	0.948	–0.001
SB09	<—	SB.	0.916	0.916	0
SB08	<—	SB.	0.851	0.851	0
EP03	<—	EP	0.894	0.875	0.019
EP05	<—	EP	0.754	0.771	–0.017
EP06	<—	EP	0.779	0.786	–0.007
EM06	<—	EM.	0.852	0.851	0.001
RS14	<—	RS.	0.869	0.869	0
RS15	<—	RS.	0.843	0.843	0
SB11	<—	SB.	0.857	0.856	0.001

Appendix 4 EFA Model

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.

Model: BPD

	Component	
	1	2
BDB09	.898	
BDB08	.855	
BDB11	.790	
BDB10	.764	
BDB12	.632	
BDC07		.844
BDC03		.955
BDC05		.831
BDC02		.697
BDC04		.671

Model: EIT

	Component		
	1	2	3
SB07	.745		
SB08	.857		
SB09	.925		
SB10	.872		
SB11	.868		
RS12		.893	
RS13		.790	
RS14		.873	
RS15		.875	
EM01			.812
EM02			.797
EM03			.742
EM04			.774
EM05			.750
EM06			.682

Appendix 5 Questionnaires

Ref No: |__|__|__|__|

Attachment B Statement Letter (Survey)

RMIT University

Information Technology and Logistics

Building 80 Level 9
445 Swanston Street
Australia
GPO Box 2476V
Melbourne VIC 3001
Australia
Tel. +61 3 9925 5969
Fax +61 3 9925 5624
• www.rmit.edu.au

INVITATION TO PARTICIPATE IN A RESEARCH PROJECT

Dear Participant,

My name is Darius Antoni, and I am a PhD candidate in the School of Business Information Technology and Logistics, RMIT University, Australia. I hereby kindly invite you to participate in a research project that aims to investigate the relationship between IT capability and the environmental performance in the Indonesian information and communication technology organizations. This research is supervised by Professor Hepu Deng and Dr Ferry Jie.

Your participation into this research project will involve in answering a short survey, which should not take more than 15 minutes of your time. The survey consists of questions related to your experience and knowledge of using IT for improving the environmental performance of your organization. There are no apparent or hidden risks of participating in this research. You may choose not to answer any particular questions. Your participation in this research is totally voluntary and you may withdraw from this study at any time.

The data collected through the survey will be analysed for my thesis and the results may appear in publications. The results will be reported in a manner that does not enable you and your organization to be identified; thus your anonymity will be protected.

If you have any queries regarding this project please contact my supervisor Professor Hepu Deng (phone +61 3 9925 5823, email: Hepu.Deng@rmit.edu.au). Further, if you have any complaints regarding this project please contact the Chair, RMIT Business College Human Ethics Advisory Network, GPO Box 2476V, Melbourne, 3001.(phone +61 3 9925 5596, email : bchean@rmit.edu.au)

I very much appreciate your support on this.

Yours faithfully,

Darius Antoni

Attachment C Survey Questions

SECTION 1: DEMOGRAPHIC DATA

Please tick (√) for all questions below

1	What is your job title?	☐ CEO/President ☐ Director ☐ Manager ☐ Supervisor ☐ Others (please indicate) _____	
2	In what business areas is your organization involved?	☐ Computer hardware and peripheral Information technol ☐ Telecommunications ☐ IT training and consultants ☐ Software IT solutions ☐ Others (please indicate)_____	
3	How long have you been in the workforce?	☐ 1-5 years ☐ 6-10 years ☐ 11-15 years ☐ 16-20 years ☐ >20 years	
4	How long have you been working for your current organization?	☐ 1-5 years ☐ 6-10 years ☐ 11-15 years ☐ 16-20 years ☐ >20 years	
5	How many employees does your organization have?	☐ 1-50 employees ☐ 51-100 employees ☐ 101-250 employees ☐ 251-500 employees ☐ 501-1000 employees ☐ >1001 employees	
6	What is your gender?	☐ Male	☐ Female
7	Please specify your age range.	☐ <=30 years old ☐ 31-40 years old ☐ 41-50 years old ☐ 51-60 years old ☐ >60 years old	

8	Please indicate your level of education	☐ High school ☐ Diploma / Advanced diploma ☐ Bachelor degree ☐ Master degree ☐ Doctoral degree ☐ Others (please specify)~~_____~~
9	Please indicate your level of proficiency in the use of information technology	☐ Low ☐ Average ☐ High

SECTION 2: IT INFRASTRUCTURE QUALITY

To what extent do you think the following **IT infrastructure quality is important** in your organisations?

Please rate your responses according to the following scale.

[7= highly important……..1= Not important at all]

No	IT infrastructure equipment	7	6	5	4	3	2	1
1	Modularisation of information systems	☐	☐	☐	☐	☐	☐	☐
2	Standardisation of information system and reports	☐	☐	☐	☐	☐	☐	☐
3	Adoption of server virtualization	☐	☐	☐	☐	☐	☐	☐
4	Adoption of storage virtualization	☐	☐	☐	☐	☐	☐	☐
5	Adoption of desktop virtualization	☐	☐	☐	☐	☐	☐	☐
6	Implementation Radio Frequency identification (RFID)	☐	☐	☐	☐	☐	☐	☐

SECTION 3: IT COMPETENCIES OF IT HUMAN RESOURCES

To what extent do you think the following **IT human resources competencies are important** in your organisations?

Please rate your responses according to the following scale.

[7= highly important……..1= Not important at all]

No	IT human resource competencies	7	6	5	4	3	2	1
01	IT personnel have knowledge about government regulations	☐	☐	☐	☐	☐	☐	☐
02	IT personnel have knowledge about the environmental management system standard (e.g. ISO 14000)	☐	☐	☐	☐	☐	☐	☐
03	IT personnel have knowledge about to identify the standardization of IT equipment (e.g. energy star and electronic product environmental assessment tool)	☐	☐	☐	☐	☐	☐	☐
04	Computer network system competencies of IT personnel to connect all organization's resources together	☐	☐	☐	☐	☐	☐	☐
05	Server consolidation and virtualization competencies of IT personnel	☐	☐	☐	☐	☐	☐	☐
06	Emerging technology competencies of IT personnel to learn a new technology used for business operations	☐	☐	☐	☐	☐	☐	☐

SECTION 3: BUSINESS PROCESS DIGITALISATION

To what extent do you think the following **Business Process Digitalisations are important** in your organisations**?**

Please rate your responses according to the following scale.

[7= highly important……..1= Not important at all]

No		7	6	5	4	3	2	1
01	Adoption of email for internal and external communication	☐	☐	☐	☐	☐	☐	☐
02	Adoption of broadband communication networks for delivering high bandwidth applications (e.g. imaging and video conferencing)	☐	☐	☐	☐	☐	☐	☐
03	Adoption of teleconferencing technologies to provide integrated video and audio to connect users anywhere in the world through the internet access	☐	☐	☐	☐	☐	☐	☐
04	Adoption of tele-presence technologies for connecting organizational resources through the use of video, audio and on-screen drawing capabilities to enable multi-party conferencing in real-time, independent of location.	☐	☐	☐	☐	☐	☐	☐
05	Adoption of rightsizing communication equipment for adapting the multiple unique environment in order to reduce operation costs and workforce	☐	☐	☐	☐	☐	☐	☐
06	Adoption of WIMAX technologies for wireless communication	☐	☐	☐	☐	☐	☐	☐
07	Adoption of LAN and WAN for linking domestic and international business operation	☐	☐	☐	☐	☐	☐	☐
08	Adoption of the enterprise resources planning to facilitate the flow of information between all business functions inside the boundaries of the organization and manage the connections to outside stakeholders	☐	☐	☐	☐	☐	☐	☐
09	Adoption of e-procurements to provide the purchase and sale of supplies, work, and services	☐	☐	☐	☐	☐	☐	☐

	through the internet as well as other information and networking systems							
10	Adoption of environmental management systems to provide sustainability reports for stakeholders including government	☐	☐	☐	☐	☐	☐	☐
11	Adoption of document management /archival systems to track and store electronic documents	☐	☐	☐	☐	☐	☐	☐
12	Adoption of the electronic data interchange for transferring electronic documents or business to business partners	☐	☐	☐	☐	☐	☐	☐

SECTION 4: ENVIRONMENTAL COMPETENCIES OF IT

To what extent do you think the following **Environmental Competencies of IT are important** in your organisations**?**

Please rate your responses according to the following scale.

[7= highly important……..1= Not important at all]

No		**7**	**6**	**5**	**4**	**3**	**2**	**1**
01	Implementation of the IT vision of an organization	☐	☐	☐	☐	☐	☐	☐
02	Implementation of the IT goal of an organization	☐	☐	☐	☐	☐	☐	☐
03	Availability of top management support	☐	☐	☐	☐	☐	☐	☐
04	Implementation of environmentally friendly IT purchasing procedures	☐	☐	☐	☐	☐	☐	☐
05	Implementation of reusable IT equipment procedures	☐	☐	☐	☐	☐	☐	☐
06	Implementation of IT equipment disposal procedures	☐	☐	☐	☐	☐	☐	☐
07	Ability of IS functions to deliver information that relates to environmentally friendly work practices in an organization	☐	☐	☐	☐	☐	☐	☐

08	Ability of IS functions to build the commitment of employees to environmentally friendly work practices in an organization	☐	☐	☐	☐	☐	☐	☐
09	Ability of IS functions to promote the choices of environmentally sustainable course of actions	☐	☐	☐	☐	☐	☐	☐
10	Ability of IS functions to educate the employees' behaviour reducing the energy consumption	☐	☐	☐	☐	☐	☐	☐
11	Ability of IS functions to change the employees' behaviour to environmentally friendly work practices in an organization	☐	☐	☐	☐	☐	☐	☐
12	Adoption of green-designed IT equipment	☐	☐	☐	☐	☐	☐	☐
13	Adoption of IT equipment made from non-hazardous materials	☐	☐	☐	☐	☐	☐	☐
14	Implementation of power management procedures	☐	☐	☐	☐	☐	☐	☐
	Adoption of low-energy IT equipment	☐	☐	☐	☐	☐	☐	☐
15	Availability of IT life-cycle information	☐	☐	☐	☐	☐	☐	☐
16	Adoption of reusable IT equipment	☐	☐	☐	☐	☐	☐	☐

SECTION 5: ENVIRONMENTAL PERFORMANCE

To what extent do you think the following **Indicators of Environmental Performance are important** in your organisations**?**

Please rate your responses according to the following scale.

[7= highly important……..1= Not important at all]

No	**Environmental performance indicators**	7	6	5	4	3	2	1
01	Energy consumption	☐	☐	☐	☐	☐	☐	☐
02	CO2 emission reduction	☐	☐	☐	☐	☐	☐	☐
03	Environmental management system	☐	☐	☐	☐	☐	☐	☐
04	Environmental initiatives	☐	☐	☐	☐	☐	☐	☐
05	Environmental disclosure	☐	☐	☐	☐	☐	☐	☐
06	Organizational environment reputations	☐	☐	☐	☐	☐	☐	☐

Appendix 6 Ethics approval letter

RMIT UNIVERSITY

Business College Human Ethics Advisory Network (BCHEAN)

Building 108, Level 11
239 Bourke Street
Melbourne VIC 3000

GPO Box 2476V
Melbourne VIC 3001
Australia

Tel. +61 3 9925 5555
Fax +61 3 9925 5624

Notice of Approval

Date:	4 December 2012
Project number:	1000467
Project title:	*Investigating the Relationship between IT Capability and Organisational Environment Performance in Indonesia Telecommunication Industry*
Risk classification:	Low Risk
Principal Investigator:	Professor Hepu Deng
Student Investigator:	Mr Darius Antoni

Project Approved: **From: 27 November 2012** **To: 28 February 2015**

Terms of approval:

1. *Responsibilities of the principal investigator*
   It is the responsibility of the principal investigator to ensure that all other investigators and staff on a project are aware of the terms of approval and to ensure that the project is conducted as approved by BCHEAN. Approval is only valid while the investigator holds a position at RMIT University.
2. *Amendments*
   Approval must be sought from BCHEAN to amend any aspect of a project including approved documents. To apply for an amendment submit a request for amendment form to the BCHEAN secretary. This form is available on the Human Research Ethics Committee (HREC) website. Amendments must not be implemented without first gaining approval from BCHEAN.
3. *Adverse events*
   You should notify BCHEAN immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.
4. *Participant Information and Consent Form (PICF)*
   The PICF must be distributed to all research participants, where relevant, and the consent form is to be retained and stored by the investigator. The PICF must contain the RMIT University logo and a complaints clause including the above project number.
5. *Annual reports*
   Continued approval of this project is dependent on the submission of an annual report.
6. *Final report*
   A final report must be provided at the conclusion of the project. BCHEAN must be notified if the project is discontinued before the expected date of completion.
7. *Monitoring*
   Projects may be subject to an audit or any other form of monitoring by BCHEAN at any time.
8. *Retention and storage of data*
   The investigator is responsible for the storage and retention of original data pertaining to a project for a minimum period of five years.

Regards,

Professor Roslyn Russell
Chairperson
RMIT BCHEAN

Appendix 7 Confirmation of candidature letter

RMIT UNIVERSITY

Business Research Office

Building 80
Level 7
445 Swanston Street
Melbourne VIC 3000
Australia

18 June 2012

Darius Antoni
3/175 Blyth St
BRUNSWICK EAST
VIC 3057
Australia

Confirmation of Candidature: Darius Antoni, 3308096
PhD (Business Information Systems) (R), DR077 Program (Full-Time)

Dear Darius

I am pleased to advise you that your application for admission to candidature for the above program has been confirmed.

The commencement date of your program is 28 February 2011. Your thesis is due to be submitted to the School of Graduate Research, via your senior supervisor and the School of Business Information Technology & Logistics, no later than 28 February 2015. Please note that this date constitutes maximum period of candidature.

The program and courses you should be enrolled in are:

Program: PhD (Business Information Systems) (R)

Courses: INTE1146A PhD Thesis A & INTE1146B PhD Thesis B (Semester 1 & 2 Thesis Codes)

You are required to re-enrol during the specified enrolment period at the end of each year until your thesis has been examined.

The College of Business wishes you well in your research program and please feel free to contact me on 9925 1390 if you have any queries.

Yours sincerely

P Erasmus

Priyanka Erasmus
Research Administration Officer
School of Business IT & Logistics
College of Business Research Office

CC: Prof Nilmini Wickramasinghe/Prof Shams Rahman, Deputy Heads Research, School of Business IT & Logistics
Prof Hepu Deng, Senior Supervisor, School of Business IT & Logistics
Dr Ferry Jie, Second Supervisor, School of Business IT & Logistics
Student File

Notification to Research Committee
Of Approval of Higher Degree by Research:

PhD (Business Information Systems) (R)
DR077

RMIT Business

Candidate's Name:	Darius Antoni
Student Number:	3308096
Program:	PhD (Business Information Systems) (R)
School:	Business Information Technology & Logistics
Thesis Title:	Investigating the Relationship between IT Capability and Organizational Environment Performance in the Indonesian Telecommunication Industry
Senior Supervisor:	Prof Hepu Deng
Second Supervisor:	Dr Ferry Jie
Research Methods Required:	ISYS 2446: PX, Sem 1 2011
Commencement Date:	28 February 2011
Course Load:	Full-Time
Maximum Completion Date:	28 February 2015
Intellectual Property Agreement:	N/A
Ethics Approval:	Ethics application to be submitted
Ethics Approval Date:	TBA
College Approval Date:	15 June 2012

Appendix 8 Completion seminar

RMIT UNIVERSITY

SGR-250

School of Graduate Research
Milestone Review Form

Section 1. Candidate details

This form is being used for assessment of the following milestone review:

☐ **Confirmation of Candidature** ☐ **Mid Candidature** ☒ **Completion Seminar**

Student ID: 3308096

Candidate name: Darius **Antoni**

School: Business IT and Logistics Program code: DR077RTS

Thesis/project title: Investigating the gree capabilities of information technology for improving green supply chain management

Senior/Joint Senior Supervisor(s): Dr Ferry Jie;

Associate Supervisor (s): Dr Ahmad Abareshi

Study load:	Full-time
Commencement Date:	28 February 2011
Expected date for this review:	27 February 2014 (includes any approved postponement)
Maximum completion date:	28 February 2015
Leave of absence to date:	0 days

To be completed by HDR Administrator:

Has there been a change in enrolment/ program?	☐Yes ☒No	Provide details here: e.g. Full-time to part-time, upgrade or downgrade	
Research methods/strategies course	☒Completed 8/07/2011	☐Exemption granted	Currently enrolled ☐
Other research coursework	☐Completed Click here to enter a date.	☐Exemption granted	Currently enrolled ☐

Section 2. To be completed by Senior/Joint Senior Supervisor

2.1 Mandatory preparation for the milestone review

a) Are there any mandatory training requirements for this candidate? Yes ☐ No ☒
List those that have been undertaken (e.g. health and safety training) and any that are still required.

b) Are there any Intellectual Property ownership considerations for the research? Yes ☐ No ☒
If 'Yes' provide details.

c) Is ethics approval required for the research? Yes ☒ Pending ☐ Not required ☐

Ethics approval number if available 1000467

d) Has the candidate received formal induction into the school, college and university research environment and the academic and administrative requirements of the degree? Yes ☒ No ☐

e) For the **Confirmation of candidature** review only

What is the Primary FOR code for this research? (6 digits) _____

What are the additional FOR codes? (optional) _____

2.2 Candidature background information

a) Has the candidate attended or participated in any research seminars, conferences since the last milestone review? Yes ☒ No ☐

List the event and the type of participation

Paper publications and presentation

1. Antoni, Darius and Jie, Ferry (2012). *"The Relationship between Information Technology and Organisational Environment Performance"*: A conceptual framework, 3th Annual International Infocomm technologies in Competitive Strategies (ICT) Conference Proceedings.
2. Antoni, Darius (2013). Conceptual framework of Information Technology Capability on improvement of organisational environment performance. Paper presented at Information Technology and Business Application (ICIBA) 2013 Palembang, Indonesia
3. Antoni, Darius and Jie, Ferry (2013). *"Investigating the critical capabilities of informations technology for developing ecological competencies of organisations"*., 11th ANZAM operations, Supply Chain and Service Mangemen Symposium.
4. Antoni, Darius. *Critical success factors of IT capability for improving environmental performance in the Indonesian ICT Industry*. Presented at HDR Panel Discussion Presentation, Research Day Program 2013on 11th October 2013, Organised by School of Business IT and Logistics, College of Business, RMIT University, Melbourne

b) Has there been any interruption to candidature since commencement, or the last milestone review?
E.g. supervisor absence, change of supervisor, delay due to lack of equipment, materials or any other reason?
If yes, please provide details below:

No

c) Have research objectives appropriate for this stage of candidature been met? Yes ☒ No ☐

Has the candidate:

Made satisfactory progress in the period under review Yes ☒ No ☐

Produced a realistic timetable and plan for the project Yes ☒ No ☐

If 'No', please indicate what measures have been discussed with the candidate to improve performance.

_____

_____

d) Has the needs analysis form required updating since its initial completion? Yes ☐ No ☒

If yes, please provide a summary of whether the change in needs has impacted on progress.

_____

_____

e) Have all the listed milestone components been provided? Yes ☒ No ☐

If no, please explain.

_____

_____

f) For a **Completion Seminar** review – when is the proposed submission date for the candidate: 30 /11 / 2014

Section 3. Criteria used by Review Panel to assess candidature progress at milestone reviews

The criteria for assessing candidature progress at a milestone review are listed in the *Higher Degree by Research candidate progress management instruction* and the *Guide for candidature milestone review submissions.*

3.1 Australian Quality Framework (AQF) learning outcomes

In addition panels are requested to look for evidence that the candidate is in the process of developing the type of knowledge and skills required by a graduating doctoral candidate (level 10) or Masters by research candidate (level 9) under the Australian Quality Framework (AQF). These are summarised below:

(SGR to delete whichever table is not relevant to this candidate)

AQF level 10 criteria	
Summary	Graduates at this level will have systematic and critical understanding of a complex field of learning and specialised research skills for the advancement of learning and/or for professional practice
Knowledge	Graduates at this level will have systemic and critical understanding of a substantial and complex body of knowledge at the frontier of a discipline or area of professional practice
Skills	Graduates at this level will have expert, specialised cognitive, technical and research skills in a discipline area to independently and systematically: • engage in critical reflection, synthesis and evaluation • develop, adapt and implement research methodologies to extend and redefine existing knowledge or professional practice • disseminate and promote new insights to peers and the community • generate original knowledge and understanding to make a substantial contribution to a discipline or area of professional practice
Application of knowledge and skills	Graduates at this level will apply knowledge and skills to demonstrate autonomy, authoritative judgement, adaptability and responsibility as an expert and leading practitioner or scholar

AQF level 9 criteria	
Summary	Graduates at this level will have specialised knowledge and skills for research, and/or professional practice and/or further learning
Knowledge	Graduates at this level will have advanced and integrated understanding of a complex body of knowledge in one or more disciplines or areas of practice
Skills	Graduates at this level will have expert, specialised cognitive and technical skills in a body of knowledge or practice to independently: • analyse critically, reflect on and synthesise complex information, problems, concepts and theories • research and apply established theories to a body of knowledge or practice • interpret and transmit knowledge, skills and ideas to specialist and non-specialist audiences
Application of knowledge and skills	Graduates at this level will apply knowledge and skills to demonstrate autonomy, expert judgement, adaptability and responsibility as a practitioner or learner

Section 4. Review panel attendees, recommendation and report

Members of review panel (minimum of four including Chair)	Name:	Title: e.g. Dr, Professor
Chair of Panel*:	Konrad Peszynski	Dr
Senior or Joint Senior Supervisor/s:	Ferry Jie / Ahmad Abareshi	Dr / Dr
Associate Supervisor/s (if applicable):		
Independent member:**	Geoff Stokes	Professor
Other panel members (if applicable):		
Date of milestone review:	19 / 2 / 14	

* Chair of Panel will normally be School HDR Co-ordinator or equivalent or their delegate, normally a member of the School Research or HDR Committee

** Independent member - independent of the supervisory team. This person must be registered as a Category 1 supervisor.

4A – the Review Panel recommends to the School of Graduate Research:

☑ ~~Confirmation of Candidature~~ / Satisfactory progress

☐ **Confirmation of Candidature – subject to minor amendments / Minor amendments necessary**

a) The Review Panel recommends the amended Confirmation of Candidature documentation be reviewed by _____ (Name of panel member with delegated authority) 4 weeks after candidate receives their classification letter from the SGR.

☐ **Candidature not confirmed / Unsatisfactory performance – Major amendments necessary***

☐ a) The Review Panel recommends that ONLY the written documentation is revised as per section 4B and reviewed by _____ (Panel Chair) 8 weeks after candidate receives their classification letter from the SGR.

☐ b) The Review Panel recommends that ONLY the written documentation and presentation are revised as per

section 4B and re-presented to a Review Panel 8 weeks after candidate receives their classification letter from the SGR.

☐ c) The Review Panel recommends that BOTH the written documentation and presentation are revised as per section 4B and re-presented to a Review Panel 8 weeks after candidate receives their classification letter from the SGR.

**If this classification is approved, the candidate will be also recommended for development of a Candidate Action Support Plan (CASP) and placed 'at risk'.*

4B – Panel feedback

Below, or on a separate appended sheet, provide a summary of the panel's feedback, and comments in support of the recommendation in 4A.
List any specific required amendments to the Candidate's written material and/or oral presentation.
This section should also be used to highlight any other candidature issues.

This box expands

Please see attached.

The Senior/Joint Senior supervisor is responsible for providing the candidate with detailed guidance and feedback on how to address the comments and requirements of this section.

Section 5. Endorsement and approval

Panel chair endorsement

Chair of Panel signature: _____ Date: 19/2/14

Chair - Please check below before forwarding documentation to School HDR administrator:

☑ Sections 2, 3, 4A, 4B and 5 of this form have been completed
☑ The recommendation has been discussed with the candidate
☑ The candidate's written material is attached to this form. **Do not** include draft thesis, draft ADR/exegesis, chapters or published papers when forwarding the material to the SGR.

This signed form, together with candidate's written material, should be forwarded to the School of Graduate Research for approval. The School of Graduate Research will formally advise the candidate of the outcome of the Review.

School of Graduate Research use

☐ **Recommendation approved** ☐ **Recommendation not approved:**

Actions to be taken:

Dean, SGR (or nominee) _____ Date: / /

Additional reviewer _____