Enablers affecting the adoption of Business Intelligence: a study of Thai small and medium-sized enterprises

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ABSTRACT

Complexities in making effective and timely business decisions in highly competitive markets have driven many organisations to adopt data-driven, decision-making processes using Business Intelligence (BI) applications. Despite these applications being suited for use in most organisations regardless of size, only larger enterprises have reached a stage of maturity in BI use, while small and medium-sized enterprises (SMEs) still lag behind. Although there is a rich body of literature on information technology (IT) adoption and implementation, literature relating to BI adoption, especially in the SME context, remains limited. This study addresses the lack of a research framework for examining the current state of BI adoption and the identification of factors influencing decisions for BI adoption in SMEs. To address this research gap and support the adoption rate of BI in SMEs, the study develops a comprehensive research framework for categorising SMEs into different levels of BI adoption and explores the enabling factors that influence BI adoption in SMEs. In order to classify organisations into different BI levels, this study applies the information evolution model (IEM) used widely by practitioners to evaluate the levels of BI adoption in organisations. In investigating factors involved in adoption decisions, the study employs a multiple-perspective framework based on three adoption models, including the diffusion of innovation (DOI) theory, the technology-organisation-environment (TOE) model, and the information systems adoption model for small business. The developed research framework contains eleven enabling factors covering four characteristics: technological innovation, environment, organisation, and owner-managers.

This study employed a quantitative methodology through a survey technique. The survey questionnaire was developed based on previous similar studies and relevant literature, and was reviewed by five BI market specialists. The sample was randomly selected from publicly accessible lists obtained from the Thailand Office of Small and Medium Enterprise Promotion (OSMEP) database. Empirical data were collected by using self-administered questionnaires, and data analysis was based on 427 SMEs in Thailand. The analysis used descriptive statistics and inferential statistics, including multinomial logistic regression and the Kruskal-Wallis (K-W) test.

The findings revealed interesting insights into an understanding of BI-adoption decision-making among Thai SMEs. From the five levels of BI adoption based on the IEM model, respondents were categorised into the three lower levels, namely Operate, Consolidate and Integrate – indicating that Thai SMEs are at an early stage of BI technology adoption. From the eleven factors, analysis indicated that seven are important in the decision-making in BI adoption. These factors are: relative advantage, complexity, observability, competitive pressure, vendor selection, organisational resource availability, and owner-managers' innovativeness.

The findings of this research can contribute to a better understanding of BI adoption in the context of SMEs, particularly in the developing countries of South East Asia, and specifically Thailand. This empirical investigation can lead to a more comprehensive research model for providing guidance to the Thai government, IT providers and relevant agencies encouraging Thai SMEs to adopt BI technologies. Moreover, the study model can provide a tool for future research in the adoption of relevant technologies. Furthermore, as this research has been conducted in the context of Thailand, further comparative research is needed in other regions of the world to determine the extent to which BI adoption in SMEs is affected by cultural, economical, political, and technological patterns.

DECLARATION

"I, Waranpong Boonsiritomachai, declare that the DBA thesis entitled ***Enablers affecting the adoption of Business Intelligence: a study of Thai small and medium-sized enterprises*** is no more than 65,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work".

Signature[redacted]…

Waranpong Boonsiritomachai

28 January 2015

DEDICATION

To my angel father Peera

To my great mother Arunee

To my wonderful brothers, sister, nephew and friends

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LIST OF ABBREVIATIONS

Abbreviations	Details
AIS	Accounting Information System
BI	Business Intelligence
BIMM	Business Intelligence Maturity Model
CBIS	Computer Based Information System
CEO	Chief Executive Officer
CIO	Chief Information Officer
CRM	Customer Relationship Management
DM	Data Mining
DOI	Diffusion of Innovation
DSS	Decision Support System
DW	Data Warehouse
EDI	Electronic Data Interchange
EIS	Executive Information Systems
ERP	Enterprise Resource Planning
ES	Enterprise System
ICT	Information Communication Technology
IEM	Information Evolution Model
IS	Information System
IT	Information Technology
MIS	Management Information Systems
OLAP	On-line Analytical Processing
OSMEP	Office of Small and Medium Enterprises Promotion
RFID	Radio Frequency Identification
SCM	Supply Chain Management
SMEs	Small and Medium-sized Enterprises
TAM	Technology Acceptance Model
TOE	Technology Organisation Environment

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CHAPTER 1: INTRODUCTION

1.0 Background

With the advance of information technology (IT), increased competition, greater flexibility of products and more demands from customers, firms are now required to operate their businesses in highly complex and dynamic environments. Organisations that survive and succeed in these market conditions need to make decisions in a timely, effective and appropriate manner (Habjan & Popovic 2007). However, many organisations are faced with the challenges of data overload where small subsets of large amounts of data are key to the overall evaluation of information (Patterson, Roth & Woods 2001). For example, the International Data Corporation reported that digital data growth was up by 48% in 2012, with 90% of information being unstructured. As a result of this type of data complexity, many businesses are now challenged to understand and analyse the wide range of information involved (Gens 2011). However, as many business users lack access to the information they need, many tend to make decisions based on instinctive knowledge that can result in loss of productivity, reduced agility in the marketplace, and flawed decision-making (Hilgefort 2010). In this situation, it is important to seek ways to provide useful information that supports decision-makers and adds value to business organisations.

In order to increase efficiency, many organisations have implemented IT systems in their business operations to collect, combine, access, and analyse massive amounts of data. One such analytical tool is business intelligence (BI) technology that turns data into information and then into knowledge (Golfarelli, Rizzi & Cella 2004). BI technology supports firms not only in driving performance improvement throughout their enterprises (Hill & Scott 2004), but also assists in forecasting by analysing historical data (Marjanovic 2007). For example, in conducting a survey among 2,053 chief information officers (CIO) covering 36 industries in 41 countries, Gartner Research (2013) found that BI technology is often a first priority in technology investments. This finding agrees with O'Brien and Kok (2006) and Kimball et al. (2008) who found that BI technology had reached a stage of maturity that is widely used in all levels of the business world.

Demand for BI technology has continually grown even at a time when the demand for many IT products has decelerated (Wixom et al. 2011). Recently, the International Data Corporation (IDC 2013) reported that the BI market had grown by 8.7% in 2012, while the total software market and total information communication technology (ICT) markets had grown by only 2.9% and 3.6% respectively. BI technology is therefore expected to continue to grow, albeit at single digit rates, over the next few years (IDC 2013). However, despite BI technology being normally considered as reserved for larger firms, the current demand for BI is not restricted to firm size (Cheung & Li 2012). Indeed, both small and medium-sized enterprises now have as much need for BI utilisation as the larger companies (Abzaltynova & Williams 2013).

The European Commission (2008) claimed that more than 95% of enterprises fall within the SME group as the main driver of the world's economy. As SMEs employ the majority of workers, they contribute to the economic growth of most countries, and are thus widely recognised as vital to economic development and expansion (Soriano & Castrogiovanni 2012) . As of July 2006, the World Bank reported that nearly 140 million SMEs in 130 countries were employing 65% of the overall labour force (World Bank 2006). As a result, the majority of governments support the growth of SMEs as a priority via the creation of various programs, including technical support, training, regulatory provisions and policy interventions (Coad et al. 2014). However, even though SMEs are often supported by governments, most SMEs underestimate the value of IT innovations by limiting them to administrative tasks rather than complex business operations (Ramdani, Chevers & Williams 2013). As a result, SMEs have lagged in the BI uptake despite being an important part of enterprise decision support for over two decades (Wirtschaft et al. 2010). A possible reason for this delay could be the complexity of BI that can lead to high maintenance and implementation costs (Puklavec, Oliveira & Popovič 2014) which the majority of SMEs cannot afford (Talati, McRobbie & Watt 2012). Conversely, from the perspective of BI vendors, BI applications are now more diverse, flexible, cheap and less complex than in the past (LogicXML 2009), offering targeted products that are specially tailored for SMEs with financial and resources constraints (Abzaltynova & Williams 2013).

1.1 Research problem

While there is a body of literature on the adoption and implementation of BI and other decision support systems in large organisations (Shen, Hsu & Peng 2012; Chaveesuk 2010; Hawking, Foster & Stein 2008; Ramamurthy, Sen & Sinha 2008; Hannula & Pirttimaki 2002), research focusing on SMEs is limited despite them being the primary drivers for national economic development. Although a trend towards developing BI and decision support tools for SMEs is continually increasing, they have been slow to invest in BI (Vetana Research 2010). For the most part, SMEs still use desktop spreadsheets as the tool for generating data analysis. Even though these spreadsheets are simple to set up, easy to use and efficient in producing fast results, they are basically prototyping tools designed for individual productivity rather than enterprise application (Jain & Kanungo 2013). As a result, errors in data entry can be used repeatedly, resulting in increasingly substantial accumulated errors (Bishop & McDaid 2008). This poor quality of accumulated data can affect future decision-making and lead to negative consequences for the business (Haug, Zachariassen & Van Liempd 2011).

In addition, a review of the current research indicates that the majority of studies in BI are conducted for developed countries, especially in Europe, America and Australia (Chaveesuk 2010; Elbashir, Collier & Davern 2008; Hawking, Foster & Stein 2008; Ramamurthy, Sen & Sinha 2008; Hill & Scott 2004). The current available literature has rarely explored the use of BI in developing countries such as South East Asia, even though IT spending in these areas is growing dramatically. According to the International Data Corporation specialising in IT, global IT spending was predicted to increase by around seven per cent a year reaching US$1.8 trillion in 2012 (Gens 2011). IT spending in ASEAN (Association of South East Asian Nations) would rise by around fifteen per cent to reach US$55 billion by 2012. For example, Indonesia was estimated to increase IT spending by around eighteen per cent in 2012 (up from US$11.5 billion in 2011) and Thailand estimated to increase by around eleven per cent in 2012 (up from US$10 billion in 2011) (IDC 2011). Contrast this with other parts of the world such as Europe and the US where IDC forecasts were that IT spending in Europe would increase by less than one per cent, whereas in the US it would increase by five per cent in 2012 (Dignan 2012). From these spending trends, it is important to further the understanding of BI implementation in developing countries, especially in South East Asia.

As research on the adoption of BI technology and the technologies related to decision support systems by SMEs in the context of developing countries is scarce, there is insufficient knowledge for predicting and explaining the behaviours of SMEs in IT adoption. Thus the lack of understanding of factors influencing the adoption of technologies related to the decision support systems used by SMEs in developing countries forms the basis of the present study, with the main problem being to address the lack of any research framework designed to examine the adoption of BI in SMEs in the context of a developing country. In this study, the developing country of Thailand has been selected to examine the situation of BI adoption in SMEs, and the major questions to be addressed are:

1. What is the state of BI adoption in Thai SMEs?
2. What are the enabling factors affecting the adoption of BI in Thai SMEs?
3. What enabling factors are the most important in BI adoption by Thai SMEs?

1.2 Research aim and objectives

The general aim of this research is to identify the enablers affecting the adoption of BI in SMEs in Thailand.

The three specific objectives are to:

1. investigate the current state of BI adoption by Thai SMEs
2. explore the enabling factors affecting the adoption of BI in Thai SMEs
3. develop a model suited to identifying the enablers of BI adoption in Thai SMEs.

In attempting to meet the aims of this research, the theoretical research model is formulated based on the classical diffusion of innovation (DOI) theory (Rogers 1995), the technology-organisation-environment (TOE) model (Tornatzky & Fleischer 1990), and the information systems adoption model for small business (Thong 1999). The resulting new research model is used to determine which factors affect the adoption of BI in Thai SMEs. The proposed model will be presented in Chapter 6.

1.3 Contribution to research knowledge

BI technologies have experienced particularly high growth as vendors continue to report considerable profits (Gartner Research 2006). Recently, the International Data Corporation

(IDC 2013) reported that worldwide investments in BI increased from US$10.53 billion in 2011 to US$11.35 billion in 2012, and estimated to reach US$17.1 billion by 2016. This increasing investment in BI is consistent with the findings of Gartner's CIOs surveys in 2013 that reveal BI as leading the list of the top ten technology priorities organisations need to adopt (Gartner Research 2013). However, few research studies have investigated the critical factors that affect decisions to adopt or implement BI systems. Although there are many guidelines available, usually from an IT industry, most rely on anecdotal reports. This is not surprising as the study of BI technologies is a relatively new area and has been driven primarily by the IT industry and its vendors (Jagielska, Darke & Zagari 2003). Consequently, this research intends to shed more light on the enabling factors that influence decisions to adopt BI technologies to provide an understanding of the key factors that influence the use of BI technologies. These key factors enable BI stakeholders to optimise their scarce resources and efforts by focusing on the significant factors that are more likely to increase BI adoption. In particular, this study will contribute to a wider and deeper knowledge about the successful adoption of BI technologies by organisations for both practitioners and academic researchers in the following areas:

1. Only a limited number of publications with empirical evidence has been published on the use of BI technologies in SMEs, especially in developing countries. Furthermore, previous research into BI has focused mainly on innovation adoption in large organisations and in the context of developed countries such as Australia (Chaveesuk 2010; Hawking, Foster & Stein 2008), Ireland (Hill & Scott 2004) and Taiwan (Shen, Hsu & Peng 2012). Therefore, this study will add to existing knowledge by investigating the adoption of BI in SMEs in Thailand, a developing country. This will contribute to the increasing global understanding of innovation adoption among SMEs, and be of use not only in the Thai context, but also add to the knowledge base for application in other developing countries.

2. This study employs a multiple-perspective framework based on three prominent adoption models, namely the DOI theory, the TOE model, and the information systems adoption model for small business. This integration of multiple theoretical and research models could be of great benefit to guide future research in a growing area of academic inquiry, and has the potential to be applied as a research tool in technological innovation research to examine determinant factors in the adoption of other technological innovations.

3. The model developed by the study categorises organisations into different levels of BI adoption based on the information evolution model (IEM) proposed by SAS Institute (Davis, Miller & Russell 2006). Due to the broad BI field that has evolved from simple to complex technologies, this IEM model has been widely used by practitioners to evaluate their level of BI adoption. Organisations with a high maturity level of BI tend to have characteristics that are distinct from those with a lower BI maturity. As there are limited studies using empirical evidence to test the accuracy and reliability of the IEM model, this study will further contribute to the body of knowledge by including this aspect in the model. Additionally, as only limited numbers of studies have categorised organisations into different levels, the development of a new research model will provide researchers with another example of the use of the IEM model for studying technological innovation factors related to different levels of BI adoption in organisations.

1.4 Significance of the study

Past researchers have studied the adoption of BI among large organisations and shown that they have received both financial and operational benefits from BI adoption. For example, Eckerson (2003) showed how an automobile manufacturer increased returns on investment (ROI) in a financial BI solution by identifying repossessed vehicle loans more quickly. Anderson-Lehman et al. (2004) revealed that Continental Airlines utilised BI to support their business processes, ranging from revenue management to flight operations and fraud detection. Having implemented BI for only six years, Continental Airlines realised more than US$500 million in cost savings and revenue generation. However, despite these examples, published advantages of BI adoption in SMEs have so far remained limited.

This study identifies the benefits of adopting BI technologies for SMEs in Thailand by:

1. extension of the knowledge of analytical tools in business organisations to help fill the knowledge gap in BI adoption and give owner-managers of SMEs a better understanding that assists in developing positive attitudes towards BI. Owner-managers will also be encouraged to become more proactive in the adoption of BI to increase

their chances of success in business decisions through improving productivity and increasing competitiveness.

2. provision of a clearer understanding of SMEs' attitude and behaviours towards BI adoption for both governmental and private agencies wanting to increase the use of BI in SMEs. They will be able to design appropriate policies and initiatives that accelerate BI diffusion and introduce pertinent technologies into SMEs. As a consequence, this study will assist in enabling relevant agencies to allocate resources more efficiently.

3. application of a theoretical framework from innovation theory to model and empirically evaluate the adoption of BI by Thai SMEs and identify the key determinants of BI adoption in Thai SMEs. This will provide information on the current BI adoption rate among SMEs and add valuable material to those desiring to undertake academic research on the adoption and diffusion of innovations in the context of SMEs.

1.5 Scope of the study

This study involves the use of a quantitative methodology to investigate enabling factors impacting the adoption of BI technologies in the context of SMEs. Its scope is limited to SMEs using the definition (based on number of employees) approved by the Thailand Ministry of Industry. In addition, the study focuses on technological diffusion at the organisational level rather than the individual level. Therefore, key participants in the study were the owner-managers of SMEs who have an important role in the enterprise and are generally engaged with organisational decision-making.

1.6 The structure of the research

This section provides an overview of the nine chapters of this thesis as follows:

Chapter 1 introduces the background information of the study along with the research problem and research questions. The chapter also outlines the objectives of this study together with its knowledge contributions, research significance and scope, ending with the structure of the dissertation.

Chapter 2 presents a review of literature related to IT, including the implementation of IT as a main competitive advantage in organisations, and the value chain and strategic opportunities in implementing IT. The chapter concludes by providing the significance of IT in increasing firm performance.

Chapter 3 reviews the literature regarding multiple aspects of BI. It provides definitions of BI, the evolution of BI systems, key components of BI systems, benefits of BI, and barriers to its widespread use. Classification levels of BI from prior research studies are then discussed before selection of the IEM as the primary model used to categorise organisations into different levels of BI adoption in this study. The details of IEM are also provided in this chapter.

Chapter 4 provides the background of SMEs and their definition and characteristics. The chapter then provides a critical review of the implementation of BI in SMEs. This is followed by a discussion on the situation of IT in Thai SMEs.

Chapter 5 reviews and examines the theoretical foundations and literature relating to technological innovation. Since the research uses multiple perspectives to understand the adoption of technological innovation in the context of SMEs, three prominent adoption models, including DOI theory, TOE model, and the information systems adoption model for small business, have been reviewed. This has revealed a total of eleven enabling factors impacting on the adoption of technological innovation which are then discussed in detail.

Chapter 6 proposes a theoretical framework comprised of enabling factors that are expected to influence the adoption of BI in Thai SMEs. The chapter reviews similar research in the area of technological adoption in order to formulate and summarise the research hypotheses.

Chapter 7 describes and justifies the research methodology and methods used in this research. The development of research instruments, the test for validity and reliability of the research instruments, and sampling procedures are then presented. This chapter also discusses the ethical considerations pertaining to data collection methods.

Chapter 8 presents the data analysis and results. It begins by describing the processes used for administering the questionnaire, followed by reporting the overall response rates and evaluation of non-response bias. The procedures used for data preparation are explained before evaluating the research measurement model. Next, the demographic profile of respondents, characteristics of responding organisations and proportion of BI adoption among respondents are presented using descriptive statistics. Inferential statistics, including multinomial logistic regression and the Kruskal-Wallis test are employed to test the research model and research hypotheses. A summary of all findings is presented in this chapter.

Chapter 9 interprets and discusses the statistical results in greater detail for providing better insight into the study's findings. Both the theoretical and practical research implications are then discussed. Limitations of the study and recommendations for further future work are also suggested in this chapter.

1.7 Chapter summary

This introductory chapter has endeavoured to present a broad outline of the thesis. A background to the research has been provided, followed by the main research problem and its related research questions. Justifications for the research are then briefly discussed, and research aims, contribution, significance and scope of the study are presented. An overview of the research structure concludes the chapter. The next chapter presents a review of literature related to the context of the study.

CHAPTER 2: INFORMATION TECHNOLOGY AND COMPETITIVE ADVANTAGE

2.0 Introduction

In the field of information technology (IT), business intelligence (BI) is a concept that enables enterprises, including small and medium-sized enterprises (SMEs), to deal with information efficiently and assist them in gaining a strong competitive advantage. In order to understand the relationships between IT, BI and SMEs, this chapter begins with a review of the adoption of IT. The following Chapter Three then reviews BI in the context of technological innovation. Next, Chapter Four reviews the context of SMEs and the adoption of BI in SMEs.

In discussing the role of IT in business and how businesses can gain advantages from implementing IT, the first section in this chapter discusses IT as a competitive advantage. The next section highlights useful frameworks for using IT as a competitive advantage, including two models: the five forces model and the value chain model. A review of strategic opportunities in IT is provided next, and the following section discusses how IT is seen as a resource for increasing firms' performances. Lastly, the chapter concludes with a summary.

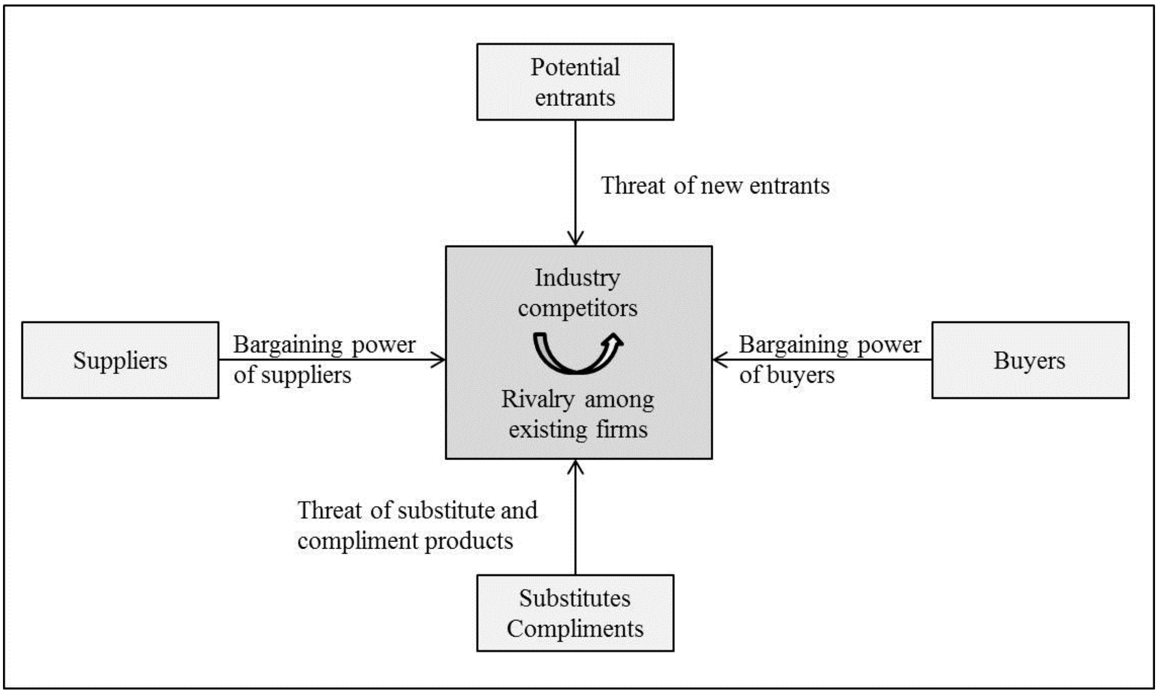
2.1 Information technology as a competitive advantage

The implementation of IT in organisations for creating advantage in increasingly competitive environments has been the focus of numerous studies (Mohezar & Nor 2014; Nguyen & Mutum 2012; Chang, Park & Chaiy 2010; Reimann, Schilke & Thomas 2010; Montanari 2008). For example, a recent study by Mohezar and Nor (2014) found that resources such as technology can serve as a competitive advantage to firms in developing their innovative capabilities in various areas, such as new product and process development, service delivery, capacity planning and market expansion. By meeting customer requirements and inspiring consumer confidence, firms can safeguard their businesses proactively and gain competitive advantage (Montanari 2008). This finding is in line with two studies on the implementation of customer relationship management (CRM) technology by Chang, Park and Chaiy (2010) and Reimann, Schilke and Thomas (2010). Both found that CRM technology can assist firms in understanding their customers and meeting customer needs so as to differentiate themselves from competitors and create competitive advantage. Firms that utilise CRM technology as a strategic approach by combining customer knowledge with technological infrastructure found that it can help firms generate customised offerings on an individual basis to enhance and maintain quality relationships with the market (Nguyen & Mutum 2012).

Since its adoption in the early 1980s, IT as a competitive advantage among corporations has increasingly become an imperative (Cash & Konsynski 1985; Porter & Millar 1985; Ives & Learmonth 1984; McFarlan 1984). For instance, in 1993 Benjamin explained the new trend of IT implementation in firms as a response to unstable economic conditions that created challenging business environments and an 'economic imperative' for IT. Parsons and School (1983) similarly warned that organisations would likely slip behind in the competitive world if they did not take advantage of the rising opportunities offered by IT. These studies were consistent with Ives and Learmonth (1984) claim that under-utilisation of IT could threaten the viability of both information systems and business managers, due to the great array of capabilities it offered at low costs, and improved firms' abilities to use IT. Bakos and Treacy (1986) predicted that as the transaction processing and decision support systems were already in place in many companies, these could form the foundation for many other systems in the creation of competitive advantage. Madnick (1987) further asserted that IT could provide competitive advantage to companies by exploiting 'strategic computing'. He named two factors that contributed to the success of corporations using IT: strategic application and organisational planning, and warned top management to consider all the ways in which these factors linked together when planning for organisational change. He asserted that the creation of a framework for understanding how to integrate IT into corporate structure was of primary importance, as managers could seize opportunities and make competitive advantage possible.

2.2 Framework for using IT as a competitive advantage

The initial framework for developing strategies and analysing competitiveness in firms was proposed by Porter (1980). In Porter's approach, competition in any industry is based on its original economic structure, and not just a superficial game of moving along with participating companies. His framework clarifies the dynamics of competition within an industry as five forces including: threat of entry of new competitors; threat of substitutes; the degree of rivalry between existing competitors; bargaining power of suppliers; and bargaining power of buyers (see Figure 2.1).



Source: Porter (1980)

Figure 2.1: Porter's framework for competitive forces

The main reason for Porter's framework was to understand the nature of 'extended rivalry'. Porter (1980) explained that in order to fully comprehend competition in an industry, a company needs to consider beyond its existing competitors and not ignore suppliers, customers, firms producing substitute products, and possible new entrants. He recommended considerable strategic actions for companies comprising either moderating suppliers or customer power, restraining new competitors into its industry, reducing the opportunities to create product substitution, or gaining a competitive edge against the industry. In coping with five competitive forces, Porter proposed three generic strategies including: differentiate (creating unique products or services); overall cost leadership (emphasising low cost relative to rivals); and niche (concentrating on a specific group of customers, geographic markets, or product line segments). He also suggested that firms should adopt one of these three generic strategies in order to set a competitive position in the marketplace and to maintain that competitive advantage. In the related IT role, Porter and Millar (1985) claimed that IT would impact competition in three ways: 1) it could initiate change in industry structures and rules of competition; 2) it could support the creation of new business processes; and 3) organisations could use IT to outperform their rivals.

Based on Porter's competitive forces framework, Parsons (1983) used this framework to establish checklists for classifying strategic moves through the use of IT and identified six generic categories of opportunities for competitive advantage including: 1) use of value-adding IT-based information to increase customer's switching costs; 2) lessen one's own switching costs against suppliers; 3) creation of product innovation supported by IT in order to preserve one's position or prevent possible substitutes; 4) collaboration with chosen competitors through engagement with IT resources; 5) substitution of IT for labour; and 6) use of information to meet the satisfaction of one's customer base. Porter's competitive forces framework is still highly-relevant and has recently been applied in many research studies in varios areas, including supply chain management (Chen 2011), resource competitive stratigies (Tavitiyaman, Qu & Zhang 2011) and strategic management of network resources (Antero & Riis 2011).

2.3 Framework for a value chain in IT

A second approach to using IT in firms was proposed by Rockart and Morton (1984), who posited the use of a 'value-added chain' to search for opportunities through IT. They defined the value chain as a system of interdependent activities, including production, delivery, marketing and service, with each activity being supported by a group of information-based linkages with suppliers, vendors, and customers. Here, managers first analyse all steps in their business process, from research and development (R&D) and purchasing, to final sales. This analysis can then empower managers to determine the significant points at which IT could best be applied. The concept of using a value chain in IT is also found in Porter and Millar's study (1985) which stated the importance of considering individual parts of the whole organisation to identify potential points for gaining competitive advantage in the value chain. This concept is significant in accentuating the role of IT in competition, separating a firm's activities into the technologically and economically diverse activities in business, called 'value activities'. Porter and Millar stated that value can be measured by the amount that buyers are willing to pay for what the firm offers them. A business will achieve profitability when the value it creates surpasses the cost of performing the value activities.

Each activity in business has both a physical and information component. The physical component comprises all the physical tasks required for the activity, while the information component consists of the acquisition, analysis and distribution of the information required to complete the activity. The information processing components can be simple or complex, depending on the given activities. For example, the processing of insurance claims requires more information and less physical components, while the production of steel heavily involves the physical component (Porter & Millar 1985). Based on Rockart and Morton's study (1984), there are three type of opportunities that lead to competitive advantage including: 1) developing each value-adding function; 2) connecting with suppliers and customers to raise their switching costs; and 3) establishing new businesses through services or products. Bakos and Treacy (1986) suggested that these value-added chains become operationally efficient and functionally effective when strongly associated with internal strategy.

Following Rockart and Morton's study (1984), the concept of value chains has been further developed by subsequent IT researchers (Amit & Zott 2001; Bharadwaj 2000; Shapiro & Varian 1999; Stabell & Fjeldstad 1998; Rayport & Sviokla 1995). For example, Rayport and Sviokla (1995) found that the value chain model explains a sequence of value-adding activities linking a firm's supply side, including inbound logistics, raw materials and production processes, with its demand side, including outbound logistics, sales and marketing. They regarded information as supporting the value chain, explaining that managers apply information that they have accessed on production and logistics to assist them in organising and monitoring the chain. In some cases, businesses can use information as a further source of value in meeting consumer needs.

Federal Express Corporation (FedEx) was one of the world's most renowned examples of the value chain strategy, as discussed in Rayport and Sviokla's study (1995). FedEx used IT to provide tracking services for customers through the company's website. Although FedEx did not charge for this service, it had added value for the customers and ultimately increased loyalty in a competitive market.

Stabell and Fjeldstad (1998) conducted a study based on both Porter's (1980) original value chain framework and Thompson's (1967) typology, and concluded that the value chain framework is appropriate for examining manufacturing and production organisations rather than service-oriented organisations. This is because the chains in service-oriented organisations do not entirely capture the fundamental nature of the value-creation mechanisms of those organisations. Rayport and Sviokla (1995) extended the concept of value chain to a 'virtual' value chain in order to take account of the activities related to information, including a series of collecting, classifying, choosing, combining, and distributing information. They claimed that businesses encounter two worlds: namely, the physical world of resources that managers can see and touch, and the virtual world made up of information. Many organisations use huge-scale IT systems to organise chain activities, both in physical value chains and in procedures that lay the base for virtual value chains. Thus these systems help organisations to perceive physical operations more efficiently through information. Shapiro and Varian (1999) also support the idea of the virtual value chain, and assert that it can enable organisations to develop a clear view of business processes based on the realities of virtual markets and information goods. Amit and Zott (2001) expanded on the virtual value chain concept by adding a resource-based view, strategic networks and transaction cost economics to establish a model explaining value creation in e-business. More recently, Cherif and Grant (2013) conducted a study on real estate internet sites, and found that all sample organisations used the virtual value chain concept to create opportunities for connecting with users by offering a bundle of services through information-based channels.

2.4 Growth of strategic opportunities in IT

Earlier studies, such as that of Porter and Millar (1985), showed that the implementation of IT had the possibility of generating value by supporting differentiation strategies. Similarly, Benjamin (1983) found a strategic opportunities matrix to explain the strategic uses of IT. Both Benjamin (1983) and Madnick (1987) demonstrated how this matrix could be used effectively in organisational strategic planning using an IT perspective. The classic examples of corporations were used to explain this matrix (see Table 2.1).

Table 2.1: Strategic opportunities matrix

		← Internal —— Arena —— External →	
Organisational change		Internal operation	Competitive marketplace
↑ Low	Traditional products & processes	XEROX [1] -- improved field service dispatch system	AMERICAN HOSPITAL SUPPLY [2] -- expanded order-entry system
High ↓	Significant structural change	DIGITAL EQUIPMENT [3] -- automated (“expert system”) for designing computer configurations	MERRILL LYNCH [4] -- merged securities and banking through cash management account (CMA)

Source: Madnick (1987)

Benjamin (1983) first identified that strategic opportunities may occur in internal or external organisations, consistent with Notowidigdo (1984) who divided strategic information systems into internal and external systems. Benjamin found that organisations could benefit directly from internal systems, whereas external systems could have direct benefits not only to the organisation’s customers, but also indirectly benefit the organisation. As an example of internal operation (see Box 1, Table 2.1), Madnick (1987) used the Xerox Company to implement a fieldwork support system to improve individual service-dispatch operations between 1979 and 1982. This system provided key information to customers, including their call history and workloads of technical representatives in their location. At the same time, customer service representatives were able to receive information about the customers, potential problems and the information needed to solve them. This system enabled Xerox to increase customer satisfaction through faster, high quality service and response times.

In 1976 the American Hospital Supply (AHS) offered an example of external relationships with customers and/or suppliers (see Box 2, Table 2.1) by implementing an order entry/distribution system. This system directly linked the majority of its customers located in different areas with

AHS computers, so that they could perform given functions, such as inventory control, by themselves. This system helped reduce costs for both AHS and its customers, allowing AHS to offer pricing incentives across all product lines. Both these examples represent the prevailing low levels of organisational change.

Madnick (1987) used both the Digital Equipment Corporation (DEC) (see Box 3, Table 2.1) and Merill Lynch Corporation (see Box 4, Table 2.1) as examples of high organisational changes facilitated by IT. DEC implemented 'expert systems' in its internal operation in order to improve a highly complex system configuration problem. This expert system was able to assist DEC in assuring that capably designed configurations could be developed for every system in manufacture to reduce the kind of reworking that DEC had faced.

Merill Lynch was used to illustrate a high level organisational change in relation to the external areas (see Box 4, Table 2.1). In 1977 Merill Lynch established a cash management account (CMA) to merge securities and banking by combining a charge card, checking account, and brokerage service in a single product. Implementation of this system required a complex IT interface of communication and data processing between the Merill Lynch brokerage offices and the banks. Benjamin (1983) recorded that after implementing CMA, the accounts of Merill Lynch showed increases at a rate of 5,000 per week.

Although Madnick's concept (1987) of strategic opportunities in the use of IT is still relevant, its application has since become highly complex due to developments in IT and ever-increasing competition in the market. Thus the use of IT for strategic purposes in both the external competitive marketplace and internal operations has been increasingly applied in organisational practice (Mostaghel et al. 2012). As a result, enterprise systems, including enterprise resource planning (ERP), electronic data interchange (EDI), customer relationship management (CRM), supply chain management (SCM) and business intelligence (BI) are now being used in organisations in a wide variety of industries to improve performance and offer novel opportunities to suppliers and customers by increasing transparency between both parties so they are better informed of market opportunities (Hendricks, Singhal & Stratman 2007). For instance, in 2004, carrier service provider DHL equipped its logistics centres with SCM using radio frequency identification (RFID) in replacement of bar-code scanning (Aydin & Sarman 2006). This technology enabled DHL to improve productivity, increase visibility and tracking of products along the supply chain, improve accuracy of inventory forecasting, and decrease labour costs. Also, the technology allowed DHL to offer detailed information to their customers, which then led to higher customer satisfaction. The use of technology by DHL can be perceived as a strategic use of IT as it contributed to DHL remaining competitive in the global market (Ellram, Tate & Billington 2004). However, in the retail industry, department stores such as Macy's in USA also use the internal operations of IT as a business strategy. In 2006 Macy's adopted BI to assess the effectiveness of marketing promotions and inventory strategies. BI helped them to gain critical visibility into the effectiveness of advertised placements and product decisions to increase retail sales. This technology can now aggregate various databases to provide a summary of the effects of promotions on customer buying trends. This enabled Macy's to gain a better understanding of how its advertising campaigns influenced retail sales and how it should appropriately respond to customers' buying trends (Stem 2006).

2.5 IT as a resource for increasing firm performance

Although many information systems (IS) researchers have claimed that IT can be a driver of firm performance and enable firms to achieve competitive advantage, the impact of IT investment on firm performance remains a source of debate (Bhanu & Magiswary 2010). Furthermore, despite many empirical studies having revealed that IT can be used as a good source of organisational performance, others claim that spending more on IT investment may not assist all organisations in increasing performance (Bilgihan et al. 2011; Radhakrishnan, Zu & Grover 2008; Wade & Hulland 2004; Farrell, Terwilliger & Webb 2003; Bharadwaj 2000; Barua, Kriebel & Mukhopadhyay 1995; Mata, Fuerst & Barney 1995).

2.5.1 The resource-based view (RBV) perspective

Barney (1991) and Grant (1996) claim that, based on RBV, firms can consider themselves as a large group of resources which are the main driver of firm performance. For this reason, a given firm must look at its resources when assessing competitiveness. In agreement, Barney (1991) states that in order to achieve competitive advantage, firms need to position themselves strategically based on their VRIN (valuable, rare, inimitable and non-substitutable) resources, rather than products and services derived from those resources. Mahoney and Pandian (1992) studied firm performance based on RBV theory and found that there are differences between organisations in the same industry as well as within the narrower boundaries of groups within industries. This may imply that the effects of individual, firm-specific resources on performance are important in competition.

According to Bhanu and Magiswary (2010), the definitions and classifications of resources in RBV are still problematic for researchers because of ambiguous definitions of firm resources. Researchers have used diverse terms to discuss a firm's resources, including competencies (Hamel & Prahalad 2005), skills (Michael & John 2004), strategic assets (Amit & Schoemaker 1993), assets (Ross, Beath & Goodhue 1996), and stocks (Capron & Hulland 1999). In terms of IT, many researchers have highlighted the potential of the RBV and related theories to provide explanations as to how and why firms can derive strategic value from IT investments (Chen 2005; Bharadwaj 2000; Grant 1996). However, Bharadwaj (2000) asserts that many researchers are still struggling to determine how IT improves firm performance because of the productivity paradox in which increased expenditure on computers does not necessarily lead to productivity improvements.

Previous research has focused on IT's capability to increase firm performance and lead to competitive advantage (Mithas, Ramasubbu & Sambamurthy 2011; Devaraj & Kohli 2000; Tallon, Kraemer & Gurbaxani 2000). For example, Devaraj and Kohli's (2000) study of the healthcare industry in the United States concluded that a consolidation of IT investment with business processes reengineering (BPR) can have a positive impact on productivity. The results of their study showed that IT can also be used as an enabler for BPR. For instance, hospitals can implement new information systems to support patient information at their bedsides, which then improves the efficiency and effectiveness of patient care. These findings imply that IT investment can be a driver in increasing both product profitability and quality. Furthermore, Tallon, Kraemer and Gurbaxani (2000) studied the impact of IT on key business activities by conducting a survey of 304 business executives worldwide and found that strategic alignment of IT investment with business strategy can lead to higher business value. They revealed that IT can have a positive impact on firm performance at numerous points along the value chain when executives are satisfied with their current levels of IT spending and have clear goals in respect to IT investment. Santhanam and Hartono (2003) compared IT leader firms and non-IT leader firms and found that IT leader firms tend to have higher financial performance than others. However, these researchers claim that by implementing IT, performance advantage is confined to the short- and medium-term, because competitors can follow successful companies by copying their IT projects. Mithas, Ramasubbu and Sambamurthy (2011) suggested that from the RBV perspective, IT resources can improve business performance but only when they are accompanied by other resources such as effective firm structure, productive culture, and adequate skills to leverage IT assets for business desires.

2.5.2 IT competencies and capabilities

Christensen, Foss and Knudsen (1996) explain that IT capability is a lower order functional, operational, or technical capacity, whereas IT competency is a higher order capacity of IT management in managing, coordinating and combining IT resources and capabilities to generate value and competitive advantage. Vogel (2005) distinguished between the IT capabilities and competencies of Christensen et al., explaining that IT capabilities are internally focused on firms’ efficiency and reduction in the cost of processes. His findings lead to the transformation of key business processes and practices into IT capabilities that significantly streamline and integrate the value chain, eliminate or reduce redundant or non-value-added processes and drive costs down. However, IT competencies focus mainly on external efficiencies in order to add value for the customer and accumulate knowledge within the firm. Key IT competencies comprise diverse skills touching on several functions of IT, such as business applications, infrastructure, and helpdesk, in order to add value to products or customers, and facilitate IT innovations.

Vogel (2005) conducted a study with 159 IT executive respondents from 100 award winners of the *CIO* magazine to find that IT capabilities are significant drivers of low cost, whereas IT competencies are important drivers of achieving superior customer relations and innovation, leading to competitive advantage for the firm. Moreover, recent research by Bilgihan et al. (2011) in the context of hotel companies found that investments in IT applications can drive superior competencies and capabilities that assist in innovation, lower cost, and customers’ added value and service improvement. These results are consistent with other studies, such as Bhatt and Grover (2005) and Vogel (2005), which found that the implementation of IT technology can help firms build their capabilities and competencies.

2.5.3 Dissenting perspectives

Despite the majority of research findings indicating that IT investment ensures positive improvement in a firm, some empirical studies reveal that spending more on IT investment does not increase firm performance (Chae, Koh & Prybutok 2014; Bilgihan et al. 2011; Masli et al. 2011; Radhakrishnan, Zu & Grover 2008; Wade & Hulland 2004; Farrell, Terwilliger & Webb 2003; Bharadwaj 2000). Weill (1992) conducted a study in the manufacturing industry to examine the connection between firm performance and IT investment. For better understanding about IT investment, he categorised IT investment into two types depending on management's aim: namely strategic IT investment and transactional IT investment. The results of Weill's study demonstrate that transactional IT investment have significance in a firm's performance, whereas strategic IT investment is neutral in the long term and linked with weakly performing companies in the short term. Another study by Loveman (1994) examined the benefits of IT investment in 20 manufacturing firms in the US and found no indication of a positive impact on IT investment on firm output, whereas non-IT inputs contribute positively to firm output.

In adopting the RBV perspective, a study by Bharadwaj (2000) found that investments in IT are uncorrelated with firm performance. He explained that although many enterprises invest money in IT, not all can develop an effective IT capability. However, if enterprises can create unique IT-related capabilities, such capabilities can lead to better firm performance. Similarly, a study by Farrell, Terwilliger and Webb (2003) found that many firms are likely to spend money on IT inefficiently by underinvesting in some areas, particularly in weak financial periods when they miss opportunities to increase productivity, reduce costs, offer greater customer service, or achieve competitive advantage. Conversely, many firms overspend in financially strong periods, buying into hype that promises huge returns on investments in trendy hardware or software solutions or unsuccessfully copying their competitors, resulting in a disenchantment with IT. More recently, Chae, Koh and Prybutok (2014) conducted a study examining the link of superior IT capability with superior business performance, and found that there was none. This result is in line with the explanation by Wang (2010) that unlike the 1990s when proprietary IT prevailed, the 2000s are characterised by more standardised and homogeneous IT due to the rapid adoption of ERP and web technologies. Thus it has become easier for firms to catch up with or even exceed the IT capabilities of their competitors (Masli et al. 2011).

Radhakrishnan, Zu and Grover (2008) suggest that firms can gain advantage over rivals in the marketplace using IT based upon how projects are chosen, deployed, absorbed and used, and what IT can offer to the firm through creating uniqueness, difficulty of duplication, and driving non-substitutable and immobile organisational capabilities. A study by Kowalkowski, Brehmer and Kindstrom (2009) suggests that future firms in the information age will be able to base their success on knowledge of their customers, ways to provide product and service information to their customers, and how they deliver those products and services in an information-based environment.

2.6 Chapter summary

The concept of using IT as a competitive weapon has received attention from many corporations (Cash & Konsynski 1985; Porter & Millar 1985; Ives & Learmonth 1984; McFarlan 1984) especially with regard to increasing IT capabilities at lower cost, and gaining advantage in unstable economic environments. Furthermore, as organisations implement IT in order to gain competitive advantage, understanding the integration of IT in the corporate structure is important (Benjamin 1983). Here, Porter's framework of competitive forces (1980) has been used to explain how IT can generate opportunities for competitive advantage (Parsons 1983). The value chain perspective has also been used to clarify the search for opportunities offered by IT and help organisations to decide which business processes are suitable for applying IT, starting from R&D to final sales (Rockart & Morton 1984). Benjamin (1983) proposed a 'strategic opportunities matrix' to explain how IT could be strategically used in an organisation. Based on this matrix, Madnick (1987) provided classic examples of major organisations to explain each quadrant of the matrix. However, despite numerous approaches established since the 1980s to review the ways IT can enable organisations to gain competitive advantage, contemporary researchers are still debating the impact of IT investments on organisational performance (Chae, Koh & Prybutok 2014; Bilgihan et al. 2011; Bhanu & Magiswary 2010; Radhakrishnan, Zu & Grover 2008; Bhatt & Grover 2005; Vogel 2005). Some have found a strong influence of IT capability and firm performance, whereas others have found none. The majority of these reseachers, however, confirm that as firms are currently doing business in a time when IT is more homogeneous and ubiquitous, they have the opportunity to imitate others easily, meaning that their investment in IT can no longer guarantee increases in competitive advantage – but this depends on their ability to create unique IT-related capabilities (Chae, Koh & Prybutok 2014; Bhanu & Magiswary 2010; Radhakrishnan, Zu & Grover 2008; Bharadwaj 2000). The next chapter will overview the nature and usage of BI in the context of contemporary organisations.

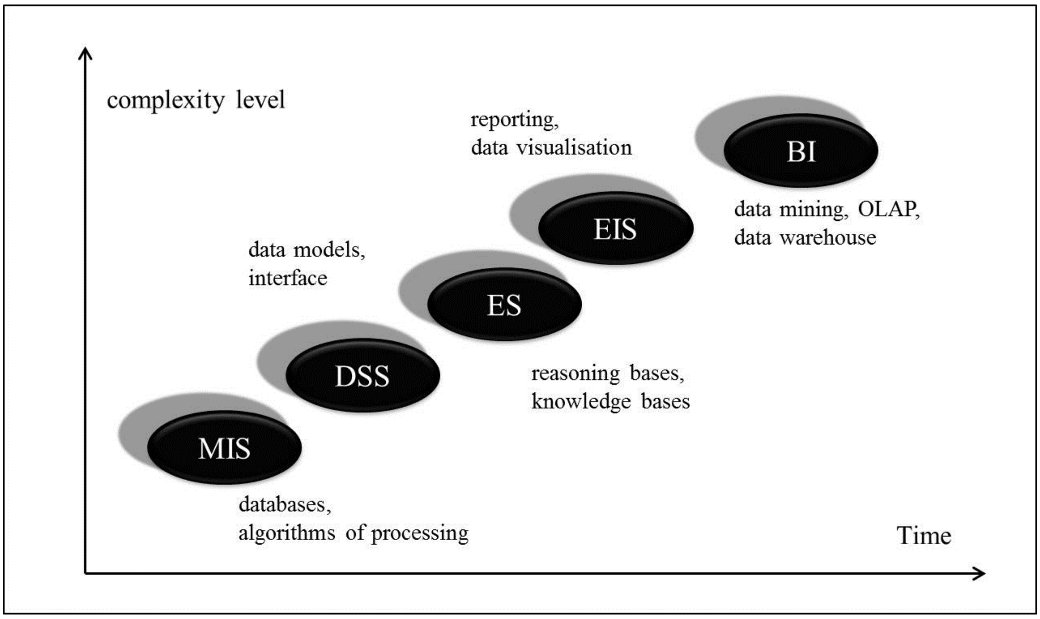
CHAPTER 3: BUSINESS INTELLIGENCE

3.0 Introduction

In order to enable enterprises to handle information in a way that gains advantage in a highly competitive field, the adoption of business intelligence (BI) is the focus of this study. Therefore, this chapter highlights the contexts in which BI has been adopted in organisations. The first section provides an overview of the evolution of BI, followed by definition of the term BI, and its key components. Then the benefits of BI are discussed, followed by barriers to the widespread use of BI systems. The focus of this chapter is directed to the classification of BI adoption levels. A review of BI as a source of competitive advantage is provided, before the concluding remarks in the final section.

3.1 The evolution of business intelligence systems

With respect to BI systems in supporting operational and strategic business decision-making, Bui (2002) claims that BI can be called a decision support system (DSS), an idea supported by other researchers (Azita 2011; Nelson, Todd & Wixom 2005). For example, Azita (2011) states that the understanding of BI systems today is evolving from traditional decision support systems, which started around the 1960s to assist with decision-making and planning. After that, in the late 1980s, data warehouses, executive information systems (EIS), online analytical processing (OLAP) and BI have gained popularity among organisations that seek to increase their decision-making effectiveness. Figure 3.1 demonstrates the development of management information systems with decision support (Olszak & Ziemba 2004).



Source: Olszak and Ziemba (2004)

Figure 3.1: Development of management information systems

3.1.1 Management information systems (MIS)

Pre-1965, building a large-scale information system was very expensive due to the high cost of effective and powerful mainframe systems. Thus the development of MIS was regarded as only suitable only for large companies (Davis & Olson 1985). Gupta (2000) defined MIS as a computer-based system that grants information for decision-making in controlling, managing and planning of the firm's operations, and in this way can help build a synergistic organisation. Additionally, he states that MIS combines a range of components that interact to complete a specific function or purpose of which the main ones are databases and algorithms for systems analysis (Olszak & Ziemba 2004). However, to build applications on top of existing databases, a data-centred approach is applied to systems analysis (Martin 1982). The focus of this approach is on data and the need to create data structures that are sharable throughout the organisation. The processes that use the data structures are of secondary importance because they need to employ data that is already residing in the database. In other words, the data-centred approach treats data as strictly separate from its processing (Miller 1995). This approach is in contrast to the traditional process-centred approach, which focuses on both the flow of transactions and functions to be carried out, with data and process being tightly bound.

The data-centred approach can provide many advantages to the analysis of systems, including reductions in data redundancies and inconsistencies, and increases in the ability of end users to access databases directly when they create their own reports and applications (Martin 1982). However, although MIS can provide predefined managerial reports and summary reports for middle-level management to support tactical decision-making (Power 2007), until the 1970s information provided by MIS was insufficient for the decision-making needs of top managers. This gave rise to the concept of DSS (Tian et al. 2007).

3.1.2 Decision support systems (DSS)

Keen, Morton, Sprague and Whinston, who are considered pioneer scholars in the field, developed DSS in the 1970s (Sprague & Carlson 1982; Keen & Morton 1978; Holsapple & Whinston 1976). DSS is defined as a system that aims to assist decision-makers by offering a diversity of data and assisting them in implementing analytical procedures, operations and models using a rapid, flexible approach (Peppard & Henry 1988). Tian et al. (2007) claim that this model-oriented DSS marks the start of information systems that support managing directors' decision-making. Gupta (2000) adds that DSS is used by managers at the tactical and strategic levels of a company, who require different types of information in solving the semi-structured and unstructured problems they encounter in their professional dealings. Consequently, DSS can be viewed as a set of systems that strengthens personal decision-making styles and meets the needs of individual managers. DSS comprises many components, but the main ones are database, model base and user-system interface (Bolloju, Khalifa & Turban 2002; Walsh 1993; Bui & Jarke 1986).

DSS uses a database management system to store data; a model base to build models that explain the interrelationships between key variables in a particular environment; and a user-system interface to facilitate communication between the user and computer (Turban, Fisher & Altman 1988). Rowley (1999) discusses an example of a DSS geographical information system (GIS). This system is a popular application in the retail industry that helps senior managers in making decisions related to new products, promotion of new store locations, and development of brand images. However, research indicates a decline in the traditional problem-solving capacity of DSS in the 1990s (Claver, Gonzalez & Llopis 2000) due to challenges to DSS, including technologies shifting from database to data warehouse, and the complexity of resulting decision-making situations (Liu et al. 2010).

3.1.3 Executive information systems (EIS)

EIS extends the scope of DSS from use by individuals or small groups to corporate levels (Shim et al. 2002). EIS allows senior managers easy access to information that has been integrated from both internal and external data sources to satisfy their analytical, communication, and planning needs (Pervan & Phua 1997). Due to technological developments around the late 1980s, especially those in affordable and stable networks, client server architectures, graphical user interfaces, and multidimensional data modelling (Arnott & Pervan 2005), EIS can take information from both the external environment and all parts of a firm and present it in a variety of forms. These include key information indicators, critical success metrics, drill down and interactive reports, financial plan information, and competitive information (Power 2007; Elam & Leidner 1995). Thus EIS can provide a valuable approach for executive users (McBride 1997). Furthermore, according to Rockart (1979), the concept of critical success factors (CSF) in EIS can contribute to general information systems' theories widely used among academic researchers and practitioners (Poon & Wagner 2001; Butler & Fitzgerald 1999; Cottrell & Rapley 1991; Rockart & De Long 1988). CSFs are the limited number of factors that must proceed smoothly for an organisation to flourish. They provide a means for top management to understand their own information requirements, and as a result, build information systems that meet those requirements. As EIS will report to managers when a business is not performing well in any critical area, managers can drill down through a report hierarchy to parse the potential sources of the variance (Arnott & Pervan 2005). However, recently BI (e.g. data warehouses) has become an alternative for building data management infrastructure, instead of DSS and EIS (Parker 1994).

In comparing BI systems and previous decision support systems, Turban et al. (2008) claim that although BI systems are truly derived from the concept of EIS, they offer more powerful artificial intelligence capabilities and analytical capabilities that include features such as OLAP, data mining, forecast analytics, notifications and alerts, dashboards and scorecards, end-user query and reporting, and data visualisations. In another view, Arnott and Pervan (2005) point out that the main difference between BI and traditional decision support is the users of the systems. In BI systems, the users are not only confined to top management and decision-makers, but also to all people throughout the firm, including users within the firm such as general managers and department workers, and users outside the firm such as partners, suppliers and customers.

The most profound trends in BI today needs to consider issues that arise from Big Data (Russom 2011). Manyika et al. (2011) defined Big Data as data that exceeds the processing capacity of conventional database systems. Dumbill (2013) stated that the data is ‘too big’, ‘moves too fast’ and ‘too hard’ for analytical processing using traditional database architectures. Madden (2012) further explained that too big means organisations must increasingly deal with petabyte-scale collections of data that come from sources such as click streams, transaction histories, and sensors. Too fast means that not only is data big, but must be processed quickly. Too hard means that data does not fit neatly into existing processing tools or needs some kind of analysis that existing tools cannot readily provide (Madden 2012). Russom (2011) claim that that Big Data can provide massive statistical samples, which can improve analytic tool results. Based on the accepted rule that the larger the data sample, the more accurate the statistics and other products of the analysis. Therefore, many recent generations of BI vendors attempt to include big data analytics in their products. The key benefits that BI can gain from big data analytics are more accurate business insights, to better understand business change, better planning and forecasting and the identification of root causes of cost incursion (Russom 2011). The following section will define the term BI.

3.2 Definitions of business intelligence

Although BI is not a new area of information systems (Vitt, Luckevich & Misner 2002), the term being defined in various ways according to context (Niu, Lu & Zhang 2009). The bulk of BI literature originates from the business world and the IT industry (Gibson et al. 2004; Jagielska, Darke & Zagari 2003), with the various consulting companies and software vendors judging BI as compatible with their products, and promoting their particular connotations (Arnott & Pervan 2005). For this reason, there is currently no commonly agreed definition of BI. Before presenting the definition of BI used in this research, the various definitions and categories of BI will be presented in this section.

The term ‘Business Intelligence’ first appeared in the work of Hans Peter Luhn, a computer scientist for IBM, in 1958. Luhn was recognised as a pioneer in developing BI systems (Prokopova, Silhavy & Silhavy 2011; Varshney & Mojsilovic 2011; Agrawal 2009; Chung, Chen & Nunamaker 2003). He defines BI as 'the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal' (Luhn 1958, p. 312).

BI became widely used after its introduction in 1989 by the analyst Howard Dresner, of the Gartner Group, an IT research company that employs BI in information communication technology (ICT) (Wixom & Watson 2010; Dekkers, Versendaal & Batenburg 2007). He described BI as a group of concepts and techniques to develop business decision-making by extracting and analysing data from databases for strategy formulation (Power 2002). However, some researchers regard BI as replacing the traditional information support systems, such as MIS, DSS, and EIS (Alter 2004; Negash 2004; Petrini & Pozzebon 2004; Thomsen 2003). On the other hand, Popovic, Turk and Jaklic (2010) argue that although sometimes BI is seen as a synonym for the traditional information support systems, there are differences between them. The main distinction is that traditional information support is more application-oriented where data in an organisations is dispersed around various data sources, while BI is a data-oriented approach in which the centre of the architecture presents integral data sources for analytical decision-making (Frolick & Ariyachandra 2006).

The various definitions of BI are derived from the different fields of experts and viewed from several approaches. Table 3.1 summarises some definitions of BI used by key researchers. A comparison of definitions demonstrates that they commonly fall into one of three main categories, namely: the management aspect, the technological aspect and the product aspect. The traditional separation is recognised in this research between the management and the technological aspects in line with Petrini and Pozzebon's observation (2004). The product aspect is also added following Chang's recommendation in order to capture the view of those who see BI from a solution's perspective (Chang 2006).

Table 3.1: Definitions of BI

Author (s)	BI Definitions	Approach
Tyson (1986, p. 9)	'An analytical process by which raw data are converted into relevant, usable, and strategic knowledge and intelligence. Also, BI includes a variety of intelligence such as customer intelligence, competitor intelligence, market intelligence, technological intelligence, product intelligence and environmental intelligence'.	Managerial
Ghoshal and Kim (1986, p. 49)	'An activity within which information about competitors, customers, markets, new technologies, and broad social trends is gathered and analysed'.	Managerial
Kulkarni and King (1997, p. 1)	'A product of analysing business data using business intelligence tools. It emerges as a result of this analysis'.	Product
Brackett (1999, p. 1)	'A series of concepts, methods, and processes that enable the monitoring of economic trends and effective utilisation of business information in strategic and tactical decision-making. The required business information is collected from both internal and external information sources'.	Managerial
Burns (2003, p. 2)	'The use of information systems and transaction databases to provide decision-making support and transform data into intelligence within a rational management framework'.	Technical
Gangadharan and Swami (2004, p. 140)	'The result of in-depth analysis of detailed business data, including database and application technologies, as well as analysis practice'.	Product
Golfarelli, Rizzi and Cella (2004, p. 1)	'The process of turning data into information and then into knowledge'.	Managerial
Negash (2004, p. 178)	'A system combines data gathering, data storage, and knowledge management with analytical tools to present complex internal and competitive information to planners and decision makers'.	Technical
Turban, Aronson and Liang (2005, p. 249)	'A broad category of applications and technologies for gathering, providing access to, and analysing data for the purpose of helping enterprises users make better business decisions'.	Technical
Lonnqvist and Pirttimaki (2006, p. 1)	'Organised and systematic processes by which organisations acquire, analyse, and disseminate information from both internal and external information sources significant for their business activities and for decision-making'.	Managerial
Turban et al. (2007, p. 21)	'An umbrella term that encompasses tools, architectures, databases, data warehouses, performance management, methodologies, and so forth, all of which are integrated into a unified software suite'.	Managerial and Product
Elbashir, Collier and Davern (2008, p. 138)	'A specialised tool for data analysis, query, and reporting (such as OLAP and dashboards) that support organisational decision-making that potentially enhances the performance of a range of business processes'.	Technical
Wixom and Watson (2010, p. 14)	'A broad category of technologies, applications, and processes for gathering, storing, accessing, and analysing data to help its users to make better decisions'.	Managerial and Technical
Isık, Jones and Sidorova (2013, p. 13)	'A system comprised of both technical and organizational elements that presents its users with historical information for analysis to enable effective decision making and management support, with the overall purpose of increasing organizational performance'.	Managerial and Technical
Yusof et al. (2013, p. 318)	'An information obtained to aid the decision making process of a business segment through the transformation of the existing data'.	Managerial

From a managerial perspective, BI is seen as a process that accumulates data integrated from both inside and outside the enterprise, in order to create actionable information to improve the decision-making process. The main focus in this perspective is to generate an informational environment in order to reveal ‘strategic’ business dimensions. An informational environment is created by analysing the data gathered from transactional and operational systems, including from both internal and external sources (Petrini & Pozzebon 2009).

From a technical perspective, BI represents a set of tools, software, solutions and technologies that support the decision-makers in collecting, organising, and accessing heterogenic data from dispersed sources (Olszak & Ziemba 2007; Moss 2004). This perspective is focused not only on the process itself but also the technologies that allow for storing, consolidating, recovering, mining and analysis of corporate data. For instance, Hackathorn (1999) observed that establishing a single corporate BI platform is a challenge because it must represent a convergence between related technologies like data mining, data warehousing and web mining. Moreover, if these technologies are mixed properly, it could reveal the ‘insights’ deeply embedded in the data (Marakas 2003).

From a product perspective, BI is considered a product which emerges from advanced processing of high quality data, information and knowledge, and analytical practices that support decision-making and performance measurement. The source of data in this perspective comprises operational, transactional and legacy systems. These systems could come from their organisation and customers, suppliers, business partners or third parties like government agencies and information service providers (Chang 2006).

Although there are differences among these approaches, they share two common characteristics. The first is the fundamental aspect of BI which includes collecting, storing, analysing and delivering information that is available both internally and externally (Lonnqvist & Pirttimaki 2006). The second is the aim of BI, which is to support the strategic decision-making process of the firm (Marshall et al. 2004). Petrini and Pozzebon (2009) define strategic decisions as those involving the implementation and assessment of organisational objectives, goals, mission, and vision. The definition from Wixom and Watson(2010) is adopted in this study due to its included managerial, technical and product perspective. Also, this definition covers two common characteristics that were disscussed earlier. However, a problem arises when considering the existing definition of BI because it only discusses the process, software and technology components. English (2005) claims that the key component of BI is to understand what is occurring within the firm and what the most suitable action to take in order to reach the firm's goals. Therefore, the human factor is also important because BI cannot be evaluated independent of interpreting its meaning, but must be considered according to information gained from the practical knowledge of users. Furthermore, an earlier study of BI in Finnish companies by Hannula and Pirttimaki (2003) found that more than 75% of responding business managers believed that the human ability to use BI represented a major aspect of its usage. For this reason, the definition of BI in this study adjusts Wixom and Watson's definition (2010) by including the aspect of human ability to use BI. Accordingly, BI in this study is defined as: *a broad category of processes, applications and technologies that are aligned with the approach that users in organisations use information in order to access, collect and analyse data to support the users' decision-making through data analysis, query and reporting.*

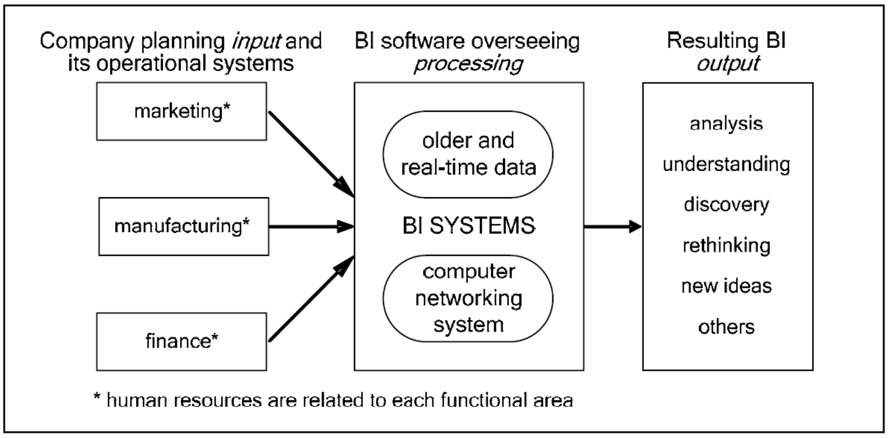
Besides the advantage of the above definition in adding the human resource of enterprise, another advantage of this definition is that it is not too narrow in scope. It does not limit BI to analytical front-end applications, but includes the technologies or process to get data from inside and outside organisations. Furthermore, the use of general terms like 'users' can avoid the limitation to some groups within an organisation, such as managers and executives, because BI facilitates the involvement of personnel at all levels in an organisation to access and analyse data in order to improve business performance, realise undisclosed opportunities or trends, and conduct their responsibilities efficiently (Howson 2007; Arnott & Pervan 2005; Olszak & Ziemba 2003). The next section will explain the key components of a BI system.

3.3 Key components of the BI system

Choo (2002) states that BI systems have to assure that critical information is not lost, information gaps are located and filled, overlapping information management is reduced, and information is processed and integrated more systematically according to the requirements of decision-makers. Therefore, numerous technologies have to be integrated in order to support the components of the BI system. These technologies enable fast access to enriched information for the benefit of analysts, collectors and end users. Olszak and Ziemba (2007) examine the components of BI in technology and claim that a BI system should incorporate the following technologies:

- extraction-transformation-load (ETL) tools that are accountable for transferring data from transaction systems and other sources such as the internet to a data warehouse
- data warehouses that can arrange the space for collecting data from various sources
- online analytical processing (OLAP) which allows users to view and analyse data across multiple business perspectives, and model business problems storing in data warehouses
- data mining tools capable of searching for relationships among the data in large datasets in order to uncover hidden relationships and patterns
- ad hoc inquiry and reporting tools which allow the user to create and utilise various synthetic reports
- presentation applications, such as graphic and multimedia interfaces that facilitate user access to information in a comfortable form.

Olszak and Ziemba (2007) categorise the technologies used in BI systems into two main types: information technologies that are associated with data acquisition along with storing (ETL tools and data warehouse), and information technologies that are involved with analysis and presentation of data (OLAP, data mining tools, ad hoc inquiring and reporting tools and presentation application). Popovic, Turk and Jaklic (2010) also categorise BI systems into two parts:1) data warehousing and 2) access to data, data analysis, reporting and delivery. Goncalves, Santos and Cruz (2010) share the ideas of Olszak and Ziemba (2007) and Popovic, Turk and Jaklic (2010), in that there are two fundamental components of BI systems: data storage and data analysis. For data storage, data mart or data warehouse are usually implemented in BI in order to store large amounts of data. For data analysis, OLAP and data mining tools are implemented in BI systems. OLAP is used for supporting the analysis of data over different perspectives considered in the decision support models; while data mining technology is used for identifying useful models, patterns or trends in data. In Thierauf's study (2001), a BI system is composed of knowledge management systems, online analytical systems, decision support systems, and executive information systems. Thierauf also states that with these components, firms can gain better insight into the current and emerging state of the business and its operations. Thierauf (2001) demonstrates the framework for an effective BI system as shown in Figure 3.2.



Source: Thierauf (2001)

Figure 3.2: Example of an effective BI system

An effective BI system collects data from the operational systems and functions of a company. Then BI software transforms data to enriched information by analysing, discovering, and generating the new knowledge. It should be noted that Thierauf's framework focuses only on internal information sources, which mainly emphasise the data warehousing role. The importance of data warehousing is reiterated by other researchers (Dumitrita 2011; Ranjan 2008; Olszak & Ziemba 2007; Turban et al. 2007; Inmon 2005; Ranjan 2005; Negash 2004; Hannula & Pirttimaki 2003; Thierauf 2001). These researchers claim that data warehouse technology is significant in BI components because it can be perceived as the infrastructure backbone to support a variety of analytical processing and visualisation applications.

3.4 The benefits of BI

The advantages of implementing BI to support business operations are clear, and by utilising BI technology appropriately, a number of benefits can be anticipated (Ko & Abdullaev 2007; Watson & Wixom 2007; Ranjan 2005). Many studies have reviewed the potential benefits of adopting BI in various types of business (Popovic, Turk & Jaklic 2010; Sahay & Ranjan 2008; Ko & Abdullaev 2007; Ranjan 2005; Anderson-Lehman et al. 2004; Eckerson 2003). For instance, automobile manufacturers have increased returns on investment (ROI) using a financial BI solution by identifying repossessed vehicle loans more quickly. Electronics retailers have accrued substantial amounts of money by identifying smaller quantities of out-of-stock items using BI solutions (Eckerson 2003). Similarly, BI has reduced inventory expenses through identifying more accurate information on supplier shipments (Sahay & Ranjan 2008). More recently, Dumitrita (2011) found that BI can also help access more reliable and faster reports, improve decision-making processes, increase the quality of client relationships, increase incomes and cut non-IT expenses. According to Liautaud and Hammond (2000), the benefits from implementing BI are classified into four categories: 1) improving internal communication; 2) leveraging the investment in ERP; 3) rising revenue; and 4) lowering costs.

However, this study divides the benefits of BI into the tangible and intangible. In term of tangible benefits, Davern and Kauffman (2000) claim that IT investment benefits firms on an operational level. For example, companies can invest in more hardware for keeping large amounts of data or invest in new business data processing systems in order to process many tasks faster than before. Such investments have clear quantitative benefits. Companies can process business better and could save on manpower.

3.4.1 Tangible benefits of BI

According to the literature (Hocevar & Jaklic 2010; Popovic, Turk & Jaklic 2010; Sahay & Ranjan 2008; Watson & Wixom 2007; Liautaud & Hammond 2000), the key tangible benefits of BI can be summed up in three categories: (1) time saving; (2) cost saving; and (3) return on investment.

3.4.1.1 Time saving

BI systems can facilitate time saving in finding the information wanted. For example, when end users ask 'What has happened?' BI systems will investigate and examine the importance of historical data and rapidly provide information to end users. This analysis can generate tangible benefits like headcount lowering (Watson & Wixom 2007). Also, the communication time between departments can be reduced, leading to better accountability and efficiency in the organisation. For instance, the finance department is frequently faulted for delaying reports beyond the time expected by managers in other departments. BI systems can enable users to speed up querying and reporting time; therefore, internal requests can be satisfied much faster, thereby improvr relationships among departments (Liautaud & Hammond 2000).

Popovic, Turk and Jaklic (2010) conducted three case studies in Slovenian organisations and found that all three cases proved that end users benefit from the time-saving impact of BI implementation, since before using BI they had spent a lot of time preparing and analysing data. Additionally, their studies show that BI systems can reduce the burden on analytical users, thus allowing the end user to focus on more complex analyses. Ko and Abdullaev (2007) used the TDC, which is Denmark's telecommunication leader, demonstrating that BI has led to an 80% reduction of processing time in this company. Due to the multidimensional cubes in BI technology, the terabytes of data are efficiently stored and summarized, which permit TDC business analysts to comprehend the context of all data, and as a result, make appropriate decisions.

3.4.1.2 Cost saving

Hocevar and Jaklic (2010) claim that the OLAP technology, which is the main component in BI, can help organisations reduce costs in many ways; for example, through analysis of current state and stock turning. This enables a company to reduce stock costs. A firm can also compare the average stock levels with information about production and sales levels by product, and hence adjust their production demand more advantageously, giving rise to fewer products of improper quality and an expired shelf life. Rather than cost savings in business processes, BI systems allow organisations to save money from IT infrastructure. Watson and Wixom (2007) claim that implementing BI can reduce IT infrastructure costs by removing redundant data extraction processes and duplicate data housed in independent data marts across the organisation. The 3M Company is an example of using a data warehouse platform to save the investment in data mart consolidation (Watson, Wixom & Goodhue 2004). In addition, BI technologies enable reductions in IT staff. Without ad hoc access to data, business users must depend on IT staff to respond to their quires. This creates a never-ending job for IT staff. BI technologies offer business users the opportunity to create their own enquires and report, so the firm can redeploy the IT programmers to higher value-added activities. As a result, this can generate cost savings in the headcount, since the sought-after IT staff can be reallocated to projects that add more value to the firm (Liautaud & Hammond 2000).

3.4.1.3 Return on investment (ROI)

Sahay and Ranjan (2008) claim that the integration of BI into a business process can help an organisation complete a major return on investment. Due to the use of effective collection and analysis technology in BI systems, a company can gain insight into the competitive pressure to make the right decisions and scrutinise every aspect of business operations, thus increasing ROI (Ranjan 2008). The study on the financial impacts of business analytics by the International Data Corporation (IDC) shows that ROI for BI installations is substantial. Based on a survey of 43 North American and European firms, IDC indicated that analytics implementations produce a median five-year ROI of 112% with a mean payback of 1.6 years on an average cost of $4.5 million. According to the study, 54% of sample organisations generated ROI starting with 101% or more (Morris 2003). Anderson-Lehman et al. (2004) reveal that Continental Airlines has utilised BI to support their business processes, ranging from revenue management to flight operations to fraud detection. For example, they use BI to design the optimal airfares on the basis that competitive prices for flights to desired places at convenient times are important. After Continental Airlines implemented BI for six years, they realised more than $500 million in cost savings and revenue generation, producing an ROI of more than 1000%. Moreover, BI can help many organisations that have already implemented ERP and CRM systems to justify their ROI. Chou, Tripuramallu and Chou (2005) state that due to the limitation of facilitating the decision support function and providing real-time reports to large numbers of users, many firms are incorporating BI tools. BI use of data collected by ERP, CRM, and other data-intensive applications can make BI systems able to perform a variety of analyses and deliver advanced reporting, which assist users in making timely and accurate decisions (Kumar & Van Hillegersberg 2000). However, many researchers claim that calculating BI systems' effect on ROI is complicated due to the role of BI in providing business comprehension rather than directly connecting to sales or cost saving (Lawton 2006; Gangadharan & Swami 2004). Beside tangible benefits, BI can provide many intangible benefits.

3.4.2 Intangible benefits of BI

According to the literature (Collins, Ketter & Gini 2010; Matei & Bank 2010; Stefanovic & Stefanovic 2009; Power 2008; Ko & Abdullaev 2007; Gibson et al. 2004; Werner & Abramson 2003), BI offers intangible benefits which can be summed up in three categories:

(1) single version of the 'truth'; (2) better strategic plans and decisions; and (3) customer and supplier satisfaction.

3.4.2.1 Single version of the 'truth'

The phrase 'single version of the truth' is usually applied to explain the official repository of data that IT applications are supposed to use (Power 2008). According to the process of BI that integrates data from various systems into one source, many researchers claim that BI can provide the single version of the 'truth' (Matei & Bank 2010; Stefanovic & Stefanovic 2009; Smith & Crossland 2008; Ko & Abdullaev 2007; Gordon et al. 2006). Matei and Bank (2010) explain that many firms have more information systems that are managed by various departments or business units that make efficient coordination difficult, but BI technologies can ensure that firms will access consistent and accurate information to support decision-making. The usage of such instruments allows involved people such as internal users, customers, providers, and shareholders, to share a single standard set of information that is accurate and up to date. Ko and Abdullaev (2007) also assert that although BI stores data in one source for reasons of data consistency, the different users can have a different view of data upon the analyst's preference as BI solutions enable users to create their own queries.

3.4.2.2 Better strategic plans and decisions

Many organisations deploy BI systems in order to improve decision-making(Khan, Amin & Lambrou 2010). BI systems can automate certain decision procedures, such as determining the highest price that can be charged for a product to maintain market share (Collins, Ketter & Gini 2010). Before implementing BI, many firms depend on a single source of information, such as transactional systems, for running their daily operations, and the existing systems can provide only operational reports. This is inadequate for managers' needs, which require ad hoc, forecasting, and superior reports in order to make better decisions. Also, management must explore trends and patterns deriving from their business rules. Due to the component of BI systems which includes OLAP and data mining tools, BI applications are able to analyse the long- and short-term business scenarios based on available and accessible data collected from enterprise information systems. This can help business users acquire more detailed information to create best- or worst-case scenarios for business planning (Chou, Tripuramallu & Chou 2005). Moreover, BI applications can create diverse aspects of business views and reveal meaningful trends and hidden patterns for managers, allowing them to design an effective strategic plan and make suitable decisions (Hannula & Pirttimaki 2003). Anderson-Lehman et al. (2004) cite the example of Continental Airlines to support the idea that BI can improve decision-making, such as ‘what if’ scenarios involving weather and flight cancellations that impact customers. Upper managers can use BI to support their decision in determining the negative effects of their choices.

3.4.2.3 Customer and supplier satisfaction

Customer benefits are the most often addressed in BI research. Many researchers claim that BI systems can provide customer intelligence benefits because organisations can better understand a customers’ buying habits and predict the customers’ needs, which serve to introduce new products and services to meet their expectations (Fuller-Love 2006; Cavalcanti 2005; Marin & Poulter 2004). Hocevar and Jaklic (2010) also claim that BI can empower a firm to monitor an individual customer’s purchases in different units of time, such as by months, quarters and years. This efficient analysis helps optimise relationships with suppliers and arrangements with carriers to improve timeliness and increase customer and supplier satisfaction. Firms also use this analysis to lessen marketing costs by targeting customers more precisely. Moreover, when customers complain about a product or service, BI can detect the causes of the problem by searching the relevant information, enabling a faster resolution of complaints. A timely and appropriate response can also improve customer experience with the firm (Ranjan 2005). Williams and Williams (2003) claim that BI application is also important for the banking industry in order to achieve a customer relationship management strategy because BI applications allow them to categorise highly valuable customers and less valuable customers. Therefore, they will be better informed in how they handle differences in customer value and treat the highly-valued customers preferentially.

Hannula and Pirttimaki (2003) claim that most BI benefits are intangible and the majority of organisations do not examine time savings or cost as a main advantage when investing in BI technologies. This reflects the findings of other researchers, such as Irani and Love (2000), Gibson et al. (2004) and Negash (2004). Irani and Love (2000) claim that BI is one area of IT in which traditional evaluation techniques could perform improperly and inefficiently since most benefits are strategic, and thus are not simply quantifiable. Gibson et al. (2004) state the lack of support by executive management who often consider ROI might result in the failure of perceiving and measuring intangible benefits of BI. Therefore, they suggest that intangible benefits resulting from BI implementation are important.

3.5 Barriers to widespread use of BI

Although BI systems have many advantages, there are barriers to their wider implementation by organisations. There are many barriers such as workforce strategy issues, lack of human and financial resources and technical concerns. However, four main barriers to BI adoption found in a review of previous studies (Khan, Amin & Lambrou 2010; Xu et al. 2009; Sahay & Ranjan 2008; Folinas 2007; Weier 2007) include: (1) data integration and sharing; (2) communicating BI value; (3) complexity of BI; and (4) cost of BI.

3.5.1 Data integration and sharing

BI adopts the concept of a data-centred approach and thus needs to be integrated and shared throughout the organisation. Martin (1987) identified user-related problems caused by users losing control of data they previously 'owned' (Martin 1982, p. 277). This problem can be observed in interdepartment sharing of information within the organisation. As each department stores information in departmental databases that are not connected or shared with other departments (Khan, Amin & Lambrou 2010), interdepartment conflict about data ownership can cause failure in BI implementation and barriers to its adoption (Chiang 2005). The Economist Intelligence Unit (2007) reported that 63% of CEO respondents across 39 countries in Europe agreed that departmental databases remain the biggest obstacle to data sharing. Furthermore, transfers of data from existing systems to the BI systems can contribute to increased costs in BI implementation. This means that data migration and integration between systems, as well as between structured and unstructured data, become the two single most potent barriers to BI adoption (Khan, Amin & Lambrou 2010). For example, the *Business Intelligence Guide* (2009) reported that 40% of costs involved in developing sophisticated analytics and modelling for data warehouses comes from moving data between systems.

3.5.2 Communicating BI value

The *Business Intelligence Guide* (2009) claims that even if BI technologies are highly desired and widely adopted by the market, they suffer from an inability to prove their value. This claim is in line with the results from a survey of 388 business technology professionals conducted by *InformationWeek* (Weier 2007). These results reveal that more than 30% of respondents asserted that BI vendors lack the ability to express the benefits of BI to stakeholders. Moreover, they believed that most organisations regard BI as a software tool that solves specific problems in one business unit rather than the whole organisation. Clearly, these understandings can become barriers when organisations are involved in making decisions about BI adoption.

3.5.3 Complexity of BI

Sahay and Ranjan (2008) claim that BI is a complex system which usually comprises multiple elements including best-of-breed components from various vendors. Furthermore, as these elements frequently do not integrate well, many organisations see the deployment of BI systems as problematic. Alternatively, from an operational users' point of view, Sandu (2008) states that BI is a complex tool which is difficult to learn and to use. Operational workers in functional areas, such as logistics and call centres, frequently lack the essential skills to deal with BI software, as most of these have been designed for analysts and power users. He also states that although there are training programs for new users, the training of large numbers of users can contribute to increased costs in BI implementation. Folinas (2007) also states that the complexity of establishing a BI environment is substantial, because BI needs to extract data from many sources prior to being transformed and loaded into a central repository. This process of setting an environment for BI systems takes time and requires well-trained and dedicated staff.

3.5.4 Cost of BI

Some researchers have indicated that cost is another barrier to BI adoption in many organisations (Xu et al. 2009; Sahay & Ranjan 2008; Sandu 2008). Due to BI being vast and complex, skilled human capital is required, so development and maintenance are expensive. Sahay and Ranjan (2008) claim that the cost of deploying a large data warehouse to support a BI system is still high for many organisations. Furthermore, the cost of ownership (the user licence cost) increases with the number of operational users (Ortiz 2002). Even in companies that have significant resources, they still believe that BI systems are highly priced (Khan et al. 2011). However, the current cost of BI is declining because of the emergence of new technologies that can reduce the complexity of BI systems and the cost of BI implementation, such as Cloud Computing, Open Source Software, and Software as a Service (SaaS). These technologies enable a lower cost of entry for organisations with lower resources (Liyang et al. 2011; Xu et al. 2009; Chen et al. 2007; Dubey & Wagle 2007). For a detailed review of Cloud Computing and SaaS, see Armbrust et al. (2010).

3.6 The levels of BI adoption

BI has been a popular field of research over recent years as it has assisted firms in making better decisions and enhancing their profitability. However, the number of studies on the level of BI adoption is limited (Sacu & Spruit 2010). This section reviews existing studies that have categorised the levels of BI adoption.

A number of researchers categorise the level of BI in terms of technologies and solutions. For example, Gibson and Arnott (2003) proposed five levels: 1) personal decision support; 2) executive information systems; 3) data warehousing; 4) intelligence systems; and 5) knowledge management. McDonald (2004) defined BI levels from the solution perspective, stating that data structure positively impacts the efficiency of BI solutions. His framework comprised four levels: 1) **BI infrastructure** which refers to the process of collecting, integrating and transforming data in order to generate the report for supporting decision-making; 2) **Business Performance Management** (BPM) which refers to the use of data from the previous level (Level 1) to provide feedback based on key performance indicators (KPI) to management; 3) **Decision enablement** which emphasises the use of data from a knowledge repository to generate automatic decisions; and 4) **Business Activity Monitoring** (BAM) which refers to the processes of monitoring changes or trends to assist users in taking the right action. Another study on the adoption of BI in Australian ERP firms by Hawking, Foster and Stein (2008) classified the BI adoption into four levels: 1) **Business information warehouse** which refers to the use of data warehouse; 2) **Advanced planner and optimiser** which refers to the implementation of SCM; 3) **Customer relationship analytics** which refers to the use of CRM; and 4) **Strategic enterprise management** which refers to the use of real-time monitoring applications.

In the paragraph above, it can be noted that the researchers classify BI levels by focusing only from the technological perspective. However, when considering the definition of BI as stated in section 3.2, BI represents not only technologies but also processes that transform data into information and then knowledge.

Other studies have defined BI as not only a technology but also a process that transforms data into information and then knowledge, with the argument that BI involves other entities such as organisational function and human interaction, and have applied the concept of a maturity model to explain the levels of BI adoption (Lahrmann et al. 2010; Najmi, Sepehri & Hashemi 2010; Eckerson 2007; English 2005). As Klimko (2001) explained, maturity models are characterised by sequentially ordered levels with specific requirements at each level. The next section will discuss various BI maturity models.

3.7 Business intelligence maturity models

In the BI context, the commonly used maturity model is the information evolution model (IEM) proposed by SAS, the leading company in business analytics software and services (Davis, Miller & Russell 2006). IEM differentiates organisations into five levels through how information is used as corporate assets: 1) '**operate'** which refers to organisations where information is managed from the individual perspective, 2) '**consolidate**' which refers to organisations where information is managed from the department or functional level perspective, 3) '**integrate**' which refers to the organisation where the information is managed from the enterprise-wide perspective, 4) '**optimise**' which refers to the organisation where information is used to gain insight from their customers, suppliers and partners, and 5) '**innovate**' which refers to the organisation where information is used to sustain business growth and increase revenue (SAS 2009). This maturity model can assist organisations to assess their use of current information resources, to rank themselves on one of the five levels and to drive their business decisions. However, Lahrmann et al. (2010) argue that this model has some limitations, such as not addressing the analytical applications used in each level, and the development process.

The Data Warehouse Institute (TDWI) also proposed the BI maturity model as an approach for most organisations when evolving the BI infrastructure (Eckerson 2007). This model classifies BI into five levels: 1) '**infant**' when individual workers create reports separated from another; 2) '**child**' when knowledge workers in the same department integrate data together; 3) ‘**teenager**’ when the organisation realises the importance of standardisation by keeping data centralised; 4) ‘**adult**’ when the organisation uses BI strategically; and 5) ‘**sage**’ when the organisation turns BI capabilities into a business service to improve basic organisational units. However, Rajteric (2010) argues that TDWI’s BI maturity model focuses more on technical aspects. Lahrmann et al. (2010) also claim that the reliability of TDWI’s BI MM is not addressed.

Sacu and Spruit (2010) used TDWI’s BI maturity model as the basis for their BI development model (BIDM). Most existing models focus on specific concepts, such as data warehousing and OLAP; however, the BI field is broad and constantly evolving, and thus the BIDM addresses this by extending the details of each level from TDWI’s BI maturity model with multiple characteristics, such as data, decision insights, output insights and BI approaches. Sacu and Spruit (2010) classified the level of BI into six stages according to the focus of the organisation: 1) ‘**predefined reporting**’ that focuses on the individual level; 2) ‘**departmental data warehouse**’ that focuses on the department level; 3) ‘**enterprise-wide data warehouse**’ that focuses on the enterprise level; 4) ‘**predictive analytics**’ that focuses on the advanced processes to discover the pattern in data; 5) ‘**operational BI**’ that focuses on the access, analysis and prediction of data in real-time; and 6) ‘**business performance management**’ that applies BI to create a new way of thinking and managing in the enterprise.

Chuah (2010) proposed the Enterprise BI maturity model (EBIMM) based on three key dimensions of BI, including data warehouse, information quality and knowledge process. EBIMM comprises five levels: 1) ‘**initial**’ where organisations focus on day-to-day operations, information quality depends on the skill of the technical specialists, and data is kept in multiple formats; 2) ‘**repeatable**’ where each department defines data management processes, document procedures are set up for implementing quality control activities, and data is kept in an independent data mart; 3) ‘**defined**’ where organisations apply the information management enterprise-wide, information quality processes are developed at the level of the enterprise and data is treated as a corporate asset; 4) ‘**qualitative**’ managed where organisations focus on knowledge management, adequate resources are provided for the quantitative process management activities, and data warehouse can be used to predict their future performances; and 5) ‘**optimising**’ where organisations continually improve their knowledge process management, information quality management and data warehouse.

However, this model does not address the BI applications, such as online analytical processing (OLAP) and data mining, used at each level of the maturity model.

As stated above, it can be noted that different BI maturity models derive from different perspectives and have their associated limitations. They also have repetitive information due to addressing similar concepts despite using different designations, especially in the first three levels of their models. For example, most BI maturity models in the first level focus on the individual despite using different designations, such as '**operate**' in IEM, '**infant**' in TDWI, '**predefined reporting**' in BIDM, and '**initial**' in EBIMM (see Table 3.2).

Table 3.2: Summary of the first five levels in BI maturity models

BI Maturity Model	Name	Concentration Area				
		First Level: Individual	Second Level: Department	Third Level: Enterprise	Fourth Level: Strategy	Fifth Level: Sustainable growth
IEM	SAS (2009)	Operate	Consolidate	Integrate	Optimise	Innovate
TDWI	Eckerson (2007)	Infant	Child	Teenager	Adult	Sage
BIDM	Sacu and Spruit (2010)	Predefined reporting	Department data warehouse	Enterprise-wide data warehouse	Predictive analytics	Operational BI
EBIMM	Chuah (2010)	Initial	Repeatable	Defined	Qualitative	Optimising

Source: Adopted from SAS (2004), Eckerson (2007), Sacu and Spruit (2010) and Chuah (2010)

3.8 Information evolution model (IEM)

In order to address the research question regarding the current state of BI adoption by Thai SMEs, the levels of BI are categorised primarily using the IEM developed by SAS. One of the reasons for using IEM as the primary model is that IEM focuses on the organisations' use of information to drive business, and this is in line with the aim of this study that is for SMEs to realise the importance of BI applications that use information to enhance their business performance. Another reason for choosing IEM is that it is not restricted to the technological perspective but also includes the knowledge process, people and culture, and this is consistent with the definition of BI (see section 3.2). However, as this IEM model does not address the analytical applications, this study adds another dimension, ‘Application’, as derived from Sacu and Spruit (2010) and Eckerson (2007).

This study classifies BI adoption into five levels based on five critical dimensions.

Dimensions:

- **Infrastructure** includes the implementation of technologies, including hardware, software and networking tools, to create, handle, store, distribute and apply information (Davis, Miller & Russell 2006).
- **Knowledge process** includes the role of information in corporate knowledge sharing, the role of information in decision-making and the improvement of information accuracy and quality. All of these can be found in policies, best practices, standards and governance-activities within the organisation (Davis, Miller & Russell 2006).
- **Human capital** includes capabilities, responsibilities, decision-making, training, enterprise goals and improvement of personnel skill-sets related to technological information (Davis, Miller & Russell 2006).
- **Culture** includes the moral, social and behavioural norms of corporate culture in relation to the information flow within an organisation (Davis, Miller & Russell 2006).
- **Application** includes analytic applications that organisations have implemented from basic software programs that generate reports to advanced programs that detect relationships in the data, provide predictive results and generate an automated exception reporting when something unusual occurs (Sacu & Spruit 2010; Eckerson 2007). The following table shows these five dimensions in each level of BI (see Table 3.3).

Table 3.3: The enhanced IEM for BI level classification

Dimension / Level	Infrastructure	Knowledge Process	Human Capital	Culture	Application
Operate	Manual systems of non-networked PCs	Uniquely individual	Motivated by the individual recognition for individual contribution	Everyone for themselves information culture	Basic software programs to generate reports
Consolidate	Functional or departmental systems	Consolidate data and decision-making at the departmental level	Work as team in the same functional or departmental group	Group segregation	Ad hoc query or data mart
Integrate	Enterprise systems	Integrate data across departments	They have a holistic view and contribute to enterprise goals	All of us	Data warehouse
Optimise	Extended enterprise systems by linking across the whole supply chain	Increase the quality of information and using closed-loop feedback processes for improving business performance	They have diverse intellectual skills and can use predictive analysis to increase effectiveness	Widespread access to information by stakeholder and allows communities of interest to share experiences	Data mining or online analytical processing (OLAP)
Innovative	Advanced analytical capabilities for testing new ideas	Use advanced analytics to model the future and minimise risk	They are creative thinkers and can create value to bring the organisation forward	Stimulating new ideas and support creativity	Business activity monitoring (BAM)

Source: Adopted from Davis, Miller and Russell (2006), Eckerson (2007) and Sacu and Spruit (2010)

The levels of BI adoption are based on the five critical dimensions (see Table 3.3) and are defined as follows:

1) **Operate:** This basic level of BI adoption is found in organisations that focus only on general information from day-to-day operations, without long-range plans. These organisations operate in a chaotic information environment where information access, analysis, and implementation are not standardised. Individuals have authority over information usage, and methods of finding and analysing information are limited to individual knowledge (Davis, Miller & Russell 2006).

   Infrastructure in the operational organisation depends on the manual systems or distributed personal computer (Davis, Miller & Russell 2006). Employees normally use simple software programs to generate personal reports or personalised spreadsheet on their computers. Therefore, data could be stored in multiple files and in multiple formats (Eckerson 2007). The organisations at this level normally face the problems of information redundancy (Chuah 2010; Sacu & Spruit 2010).

   The knowledge process in the operational organisation relies on the individual employee. The organisation has no standards, rules or procedures for data management (Chuah 2010). Therefore, employees in the same department could have different ways and approaches to acquire and analyse data, which limits knowledge transfer (Davis, Miller & Russell 2006).

   People (human capital) in the operational organisation need to work autonomously in unstructured environments. The employees often distinguish themselves through subtle internal competition and are motivated by individual recognition for individual contribution. Also, they fear change in the organisation and see change as a threat to the status quo (Davis, Miller & Russell 2006).

   The culture in the operational organisation has an ‘everyone-for-themselves’ information culture, where employees have their own objectives and these objectives are more dominant than the organisation’s objectives. The employees have their own ways to get information that are based on their contacts (Davis, Miller & Russell 2006).

Software applications in the operational organisation are limited to basic software programs that can generate personal reports or personalised spreadsheets (Sacu & Spruit 2010; Eckerson 2007).

2) **Consolidate**: This next level refers to organisations that consolidate information by integrating and storing information at the department level for supporting decision-making. At this level, individual departments have consolidated their own information into data marts to serve the needs of the department (Davis, Miller & Russell 2006).

   Infrastructure in the consolidated organisation uses department-level hardware, networking and software (Davis, Miller & Russell 2006). Data is collected separately among the group of users or departments. Therefore, data will be stored in data marts or a departmental data warehouse that is specific to the subject areas. For example, a data mart for the marketing department would have subjects limited to sales, articles and clients. However, a data marts also support the OLAP technology, and as a result, they allow organisations to visualise information at different hierarchical levels through operations such as roll-up, drill-down and pivot (Sacu & Spruit 2010).

   The knowledge process in the consolidated organisation shifts from the individual to departments. At this level, data management is well-defined in each department but not across departments (Chuah 2010). As a result, employees in the department are able to work in the same way because they follow documented procedures, processes or structures created in their department. However, the problem of mismatched department and enterprise goals can occur due to contrasting needs. Conflict between departments can also occur. Davis, Miller and Russell (2006) state that when two departments try to answer the same question, they often come up with different results.

   People in the consolidated organisation move to support the department rather than the individual (Davis, Miller & Russell 2006). When information is consolidated, it increases data analysis capability and improves employee motivation by stimulating confidence in the system. As a result, the company has more ability to address customer needs (Hatcher & Prentice 2004). At this level, the employees work effectively in teams but the cooperative work across other departments may still a challenge (Davis, Miller & Russell 2006).

Culture in the consolidated organisation is group segregation. Employees are rewarded for contributing to departmental goals, and as a result, they pursue only their department's interests (Davis, Miller & Russell 2006).

Software applications in the consolidated organisation typically include software programs that keep data in standardised formats and allow queries but with limited user views (i.e. the marketing function would have subjects limited to sales) (Sacu & Spruit 2010; Eckerson 2007).

3) **Integrate**: Organisations at this level collect data in a central data warehouse. The data at this level is more accessible and integrated than the departmental data mart. The organisations can gain new knowledge from performing enterprise-wide analysis and bridging the border of separated departments (Eckerson 2007).

Infrastructure in the integrated organisation applies enterprise-wide data warehouse with high availability and integration to support the whole organisation. The volume of data, which is stored in an enterprise-wide data warehouse, is larger than a department data warehouse and it contains not only detailed data, but also aggregated data (Sacu & Spruit 2010). Wu, Barash and Bartolini (2007) stated that although data warehouses incur higher costs and consume a longer period of time to implement compared to data marts, an organisation will gain more benefits, such as a single version of the truth in information, and the possibility of accessing historical, summarised and consolidated organisational data. Chaudhuri and Dayal (1997) claim that data in a data warehouse can present multidimensional views of data to various front-end tools, such as query tools, report writers and analysis tools which can help organisations have various views to support their decision-making.

The knowledge process in the integrated organisation integrates data from various functions and departments and decision-making is from the organisational perspective. At this level, information management concepts are applied and accepted that lead to data management in a standard approach (Chuah 2010) aligned with enterprise goals (Sacu & Spruit 2010). Moreover, organisations mobilise resources from focusing on functional or production groups to market and customer relationships and encourage activities that exploit the value of lifetime relationships (Davis, Miller & Russell 2006).

People in the integrated organisation collaborate well in their group or department, but can also cooperate with other employees in various departments. They have a holistic perspective of the enterprise that helps them understand how their efforts can contribute to company goals (Davis, Miller & Russell 2006).

Culture in the integrated organisation focuses on enterprise-wide performance outcomes. At this level, all employees in the organisation accept information as a corporate asset and it is an important tool to run the business and generate value (Davis, Miller & Russell 2006).

Software applications in the integrated organisation typically include software programs that keep data in a standardised format throughout the enterprise and allow users a multidimensional view of data (i.e. sales data can be viewed by geographical dimension or time) (Sacu & Spruit 2010; Eckerson 2007).

4) **Optimise**: at this level, information in organisations is well-integrated and managed, and organisations begin to find new ways to increase their performance to meet market demands. The organisations will use new technologies for deep analysis in order to better understand the marketplace and their customers compared to their competitors, to better serve their customers (Hatcher & Prentice 2004).

   Infrastructure in the optimised organisation is linked through internal business systems across the supply chain, from back-office functions through to the customer touch points that enhances data exchange and the connection between partners and customers (Davis, Miller & Russell 2006). At this level the technologies are used to uncover the relationships and patterns among data in order to predict behaviour or events. Query and OLAP tools are not sufficient to facilitate organisations to determine the meaningful relationships and patterns of events, and as a result, statistical machine learning, neural computing, robotics, computational mathematics, data mining, and artificial intelligence techniques are implemented in BI systems (Eckerson 2007). Moreover, as firms operate in a constant state of flux, they require the zero latency processes that can operate business activities in real-time (Azvine et al. 2006). Traditional BI is not adequate to support this requirement. Users often have to wait until data is uploaded overnight before accessing the updated data. As a result, real-time BI technology is needed for organisations to collect, integrate and analyse data with zero latency for supporting decision-making (Sacu & Spruit 2010).

The knowledge process in the optimised organisation concentrates on increasing performance efficiency and incrementally developing the quality, timeliness and availability of information. Organisations use the closed-loop feedback processes to ensure continuous evaluation and improvement. Moreover, organisations can apply the entire information value chain to expand new optimised business models. Information about customers, suppliers and markets is integrated in order to analyse and detect patterns and predict future behaviour. This knowledge supports the organisation's understanding of customers' need and enables it to respond immediately (Davis, Miller & Russell 2006).

People in the optimised organisation have more drive, are more diverse and adaptive to new challenges. Employees prefer to embrace creative challenges and new tasks without fear of the task's risk. They use intellectual skills, including predictive analysis, to work with other colleagues in order to improve organisational effectiveness when faced with the rapidly changing market environment (Davis, Miller & Russell 2006).

Culture in the optimised organisation allows employees to continually improve quantitative information. Collaboration and sharing information among departments replace the competition between them. At this level, internal and external information is accessed by stakeholders, such as partners and customers, in order to share common interests and experiences (Davis, Miller & Russell 2006).

Software applications in the optimised organisation typically include software programs that use automated data analysis techniques to extract and identify useful information, detect relationships in the data, provide predictive results, generate multidimensional analysis and make data presentation available (Sacu & Spruit 2010; Eckerson 2007).

5) **Innovative**: organisations at this level seek ways to reinvent and transform their value position for sustainable growth. Cross-industry information is available for employees to access. Also, the organisation can accept failures as a learning experiences, and as a result, welcome new ideas (Davis, Miller & Russell 2006).

   Infrastructure in the innovative organisation is designed with an 'intelligence architecture' that supports organisations responding rapidly and effectively to organisational needs. The combination of advanced analytical tools is implemented for simulating the virtual environment to test and complete new ideas and as a result, can reduce time to market (Davis, Miller & Russell 2006). From Sacu and Spruit (2010) viewpoint, organisations at this level have to apply the concept of business performance management (BPM) in order to create new ways of thinking and managing an organisation. BPM includes not only data warehousing, but also a reactive component which is business activity monitoring (BAM). BAM can support organisations to monitor the time-critical operational processes that allow tactical and operational decision-makers to transform their actions according to the organisation's strategy.

   The knowledge process in the innovative organisation implements advanced analytics to model the future for maximising innovation and minimising risk. In order to stimulate new ideas, organisations encourage and facilitate employees to work collaboratively. Also, organisations monitor, evaluate and document the innovation process and communicate throughout the whole enterprise (Davis, Miller & Russell 2006).

   People in the innovative organisation are creative and proactive thinkers. Although employees at this level have many roles and responsibilities within the organisation, they can rapidly bring the knowledge together in interdisciplinary teams as needed.

Also, they always consider new approaches to leverage the expertise that they believe can create value and move the enterprise forward. The failure of projects is not a challenge for them as they regard them as a learning opportunity (Davis, Miller & Russell 2006).

Culture in the innovative organisation comprises the whole brain thinking. Every idea is encouraged to find new ways to support organisation growth. Thus the organisations design processes to support creativity and the flow of ideas. The revolutionary cultural change is the norm. The organisations stimulate the culture of collaboration and innovation, embedded in all aspects that lead to sustainable and constant success (Davis, Miller & Russell 2006).

Software applications in the innovative organisation typically include software programs that allow users to keep track of the current situation and can generate automated exception reporting when something unusual occurs (Sacu & Spruit 2010; Eckerson 2007).

This enhanced IEM maturity model can assist organisations to assess their use of current information resources and rank themselves on one of the five levels in order to decide their business direction. Therefore, to address the research question regarding the current state of BI adoption by SMEs, the levels of BI are categorised using this enhanced IEM model. The next section discusses BI as a source of competitive advantage.

3.9 BI as a source of competitive advantage

BI is valuable in terms of competitive advantage (Dumitrita 2011; Muntean 2007; Pirttimaki 2007; Ranjan 2005; Gangadharan & Swami 2004). Although the amount of available business information is growing, few firms have the capacity to derive value from it (Petrini & Pozzebon 2004). Gangadharan and Swami (2004) state that BI acts as a source of competitive advantage by transforming operational data into a business asset that drives strategic decisions and bolsters performance for the company and its clients. Similarly, Ranjan (2005) states that information is regularly considered as the second most significant resource of a firm (with personnel as the most valuable asset). Consequently, a firm that can make decisions based on timely and accurate information can improve its performance. Furthermore, Hocevar and Jaklic (2010) claim that managers cannot maintain the competitiveness of their company merely depending on intuition. The process of decision-making in organisations has changed due to new informational needs. Decision-making must be well-facilitated by precise, comprehensive information about certain situations both in the enterprise and in its environment.

According to Porter (1980), the industry in which a company competes is the key element for the business environment. Porter (1980) claims that the nature of competition in a specific industry can be analysed systematically by gathering information about the five competitive forces that are stated in the previous chapter. By analysing that information, a company can assess its weaknesses and strengths relative to the industry and develop its competitive position by adopting one or more of three generic competitive strategies. Pirttimaki's survey (2007) of the top 50 Finnish companies in 2005 demonstrates that BI systems can provide the information covering the areas competitors, a company's own industry and its customers. Competitor information is important in positioning oneself in the competitive field. Macro trends, customers' locations and customers' needs are also significant in order for a company to devise a successful competitive strategy. These results reflect a survey by Global Intelligence Alliance (2005) in which respondents, comprising 287 companies around the world, name three elements (competitors, their own industry, and customers) as the core of intelligence activities that immensely impact business success.

Muntean (2007) highlights the importance of the intelligent use of data by BI that allows a company to transfer masses of obscure data into useful information. Understanding the company's information assets, such as customer databases, supply chain information, personnel data, manufacturing, and sales activity, can help gain insight into the business. The advantages of BI in turning data into information and in leading to more efficient business processes is consistent with the study of competitive advantage by Pisello and Strassmann (2004). These researchers claim that competitive advantages have shifted from individual experts in the use of new technology, to the employee who is able to understand how to implement new technology for improving business processes and how to implement technology for sharing, managing and increasing the level of knowledge.

Ranjan (2005) asserts that BI's information delivery benefits are enormously valuable for competitive advantage. Ranjan (2005) explains that although many organisations have invested in ERP and CRM systems over the last decade, they cannot achieve competitive advantage because of the limitation in information capture by these systems. They necessitate technology that can deliver the right information quickly in order to make operational decisions, such as marketing seasonal merchandise or offering certain suggestions to customers. Moreover, Ranjan (2005) recommends that due to a rapidly changing world, consumers demand faster and more efficient service from businesses. BI systems can facilitate staying ahead of trends and future events.

3.10 Chapter summary

Although the concept of DSS has long been associated with organisations, BI is still a new term in information systems (Vitt, Luckevich & Misner 2002). The definition of BI varies depending on the interpretations of the researcher (Niu, Lu & Zhang 2009) but it is normally classified into one of three main aspects- namely managerial, technological and product (Chang 2006). Two characteristics common to all three aspects and fundamental to BI include (1) collection, storage, analysis and deliver information (Lonnqvist & Pirttimaki 2006) and (2) the supporting of the strategic decision-making process (Marshall et al. 2004). This study defines BI based on the three aspects and additionally includes the human aspect as recommended by English (2005) for a more complete approach to BI.

The evolution of BI can be traced back to the emergence of MIS around 1960 (Azita 2011). MIS helps organisations access information but provide only basic data to support tactical decision-making, which is not sufficient to meet the needs of top management (Tian et al. 2007). As a result, the concept of DSS was developed to assist managers in decision-making at both the tactical and strategic levels (Gupta 2000). The scope of DSS was extended to EIS that aims to support individuals or a small group at the corporate level (Shim et al. 2002). Senior managers can easily access integrated information from internal and external data to satisfy their analytical, communication and planning needs by using EIS (Pervan & Phua 1997). Although BI systems derived from the concept of traditional decision support systems, they have more powerful analytical capabilities (Turban et al. 2008) and the main aim is to support managers at all levels of the organisation (Pirttimaki & Hannula 2003).

Based on reviewing existing studies, the adoption of BI in organisations has both benefits and barriers. Benefits of BI can be classified into tangible and intangible. The key tangible benefits include time saving, cost saving and return on investment. Key intangible benefits include ‘single version of truth’, better strategic plans and decisions, and customer and supplier satisfaction. These key intangible benefits are the main driving factors for BI adoption despite their being difficult to measure. Barriers to BI adoption include data integration and sharing, communicating BI value, complexity of BI and cost of BI.

In the search for competitive advantage, many organisations have implemented BI systems. Organisations use information provided by BI systems to enable them to evaluate their strengths and weaknesses to understand their competitive positioning in adopting competitive strategies. Ranjan (2005) states that information has significant value for gaining competitive advantage. Although many organisations invest in ERP and CRM systems, they cannot gain competitive advantage as these systems are limited to capturing information. BI systems, in addition to capturing also integrate and analyse information which are the tools that provide the right information quickly for making decisions for organisations to stay in competitive positions. The next chapter explains the SMEs concept and discusses the adoption of BI in SMEs.

CHAPTER 4: SMALL AND MEDIUM-SIZED ENTERPRISES

4.0 Introduction

As explained in the previous chapter, BI can be seen as a source of competitive advantage for organisations (Gangadharan & Swami 2004). While most studies of BI adoption have been in the context of large organisations, this study looks at small and medium-sized enterprises (SMEs). This chapter is divided into six sections. The first section gives a brief overview of SMEs, which are further defined in the second section. The third section reviews the characteristics of SMEs, followed by the fourth section outlining the implementation of BI in the context of SMEs. In the fifth section, the focus is directed to the situation of IT in the Thai SMEs context. The conclusion of this chapter is drawn in the final section.

4.1 Small and medium-sized enterprises' background

SMEs are widely recognised as being vital to developing and expanding economies (Robertson, Langston & Price 2014). The European Commission (2012) claimed that more than 99.8% of enterprises fall within the SME group and SMEs are the main driver of the world's economy. They contribute to economic growth in most countries because they employ the majority of workers (Ayyagari, Beck & Demirguc-Kunt 2007). For example, as of July 2006, the World Bank reported that nearly 140 million SMEs in 130 countries employed 65% of the overall labour force (World Bank 2006). In Canada, SMEs comprise 99.7% of enterprises, generate 65% of employment and 57% of economic output (Holt & Rupcic 2004). In Thailand, SMEs comprise 99.8% of enterprises, generate 78.2% of employment and 37.9% of economic output (The ASEAN Secretariat 2011). Besides the contribution to the economy, SMEs also play significant social and cultural roles (Schaper & Savery 2004). Zucchella and Siano (2014) state that due to the nature of SMEs, which frequently serve niche markets, they regularly reflect the more personal and distinctive social and cultural characteristics of the community than do larger enterprises.

As reviewed above, SMEs have a strong impact on the economy and the society of a country, and it can be noted that this segment should not be ignored. The importance of SMEs is evidenced by their support from the majority of governments. Coad et al. (2014) claim that most governments support the growth of SMEs as a priority via the creation of various programs, for example, technical support, training, regulatory provisions and policy interventions. However, there are limited numbers of studies related to IT, including issues such as BI in SMEs, so this study will investigate those issues. The following section will discuss the definition of SMEs, the characteristics of SMEs and the implementation of IT in SMEs. Some researchers argue that small-sized enterprises are different to medium-sized enterprises (Gutierrez, Orozco & Serrano 2009; Struker & Gille 2008; Laukkanen, Sarpola & Hallikainen 2005), but SMEs share common characteristics which are different from large enterprises. Consequently, small and medium-sized enterprises are often collected into one group.

4.2 Definitions of SMEs

The accepted definitions and classifications of SMEs are different not only from industry to industry but also from country to country (Ayyagari, Beck & Demirguc-Kunt 2007). Each country has differences in their political and economic objectives, and so they have different criteria to classify organisations (Simpson, Tuck & Bellamy 2004). However, the most widespread criteria that are applied to classify the term SME include the number of employees, invested capital, fixed assets and industry type (Ministry of Economic Development 2011). It can be noted that the definition of SMEs can be based on more than one criterion. For instance, the European Union (EU) defined SMEs as companies that have less than 250 employees and an annual turnover of less than 40 million euro (Rutkauskas & Ergashev 2012).

Although there are many criteria for classifying enterprises, some criteria such as turnover, are not extensively applied in research. Julian (2003) claims that SMEs are not willing to disclose sales information. In contrast, many researchers and practitioners choose the number of employees as the common criteria in their studies (Harrigan, Ramsey & Ibbotson 2008; Maguire, Koh & Magrys 2007; Deros, Yusof & Salleh 2006; Hashim & Wafa 2002). This criteria is also used by many countries such as in the OECD (Ministry of Economic Development 2011), Europe (Beaver 2002) and most countries in the APEC, including Japan, Singapore, Indonesia, and Thailand (Sinha 2003). However, the numbers of employees in the definition of SMEs are defined differently among countries. For example, in Indonesia an organisation with less than 100 employees is classified as an SME, whilst in Japan an SME is defined as a company with less than 200 employees, and in China SMEs employ less than 500 people (Sinha 2003). The dissimilarity in size of SMEs may imply that SMEs in different countries may possibly have different characteristics.

This study focuses specifically on the Thai context, and according to the Thailand Ministry of Industry, an SME is commonly defined as a company which has no more than 200 employees (Brimble, Oldfield & Monsakul 2002). In particular, small business is one with no more than 50 employees, whereas a medium-sized business is between 50 to 200 employees. Therefore, in order to be consistent with the existing studies conducted in Thailand, this study uses the Thailand Ministry of Industry definition of SMEs.

4.3 SMEs characteristics

As discussed, the definitions used for SMEs vary widely among countries, but SMEs worldwide share certain distinctive characteristics (MacGregor & Vrazalic 2005). These characteristics can contribute to the differences between SMEs and large enterprises, so Man, Lau and Chan (2002) point out that a small enterprise is not a little version of a large enterprise, but has dissimilarities in terms of structures, policy-making procedures, and utilisation of resources. Another study on SMEs by Deros, Yusof and Salleh (2006) classifies these dissimilarities in terms of structures, systems and procedures, cultures and behaviours, human resources, and markets and customers. In a more recent study, Malhotra and Temponi (2010) found that SMEs are more sensitive than larger companies to external market forces, competition, government regulations, the macroeconomic environment, and fiscal and tax policy. In accordance with these understandings, this study does not directly apply the concepts used to conduct research into large organistions to the study of SMEs.

Lack of resources is one of the key characteristics many researchers address when studying SMEs (Bhaird & Lucey 2010; Deros, Yusof & Salleh 2006; Knight, Madsen & Servais 2004; Levy & Powell 2003). These limited resources include finance, technology, knowledge and human resources. In particular, Bhaird and Lucey (2010) found that financial resources are personally funded by the owner in most SMEs. Due to their restricted financial budgets and low number of employees in SMEs, the majority of employees perform multiple tasks that are not specialised in any particular area (Kirchmer 2011; Hudson, Smart & Bourne 2001). Moreover, the unskilled workforce with a lack of technical specialisation results in SME managers being conservative when adopting IT innovations (Karkoviata 2001). This may be the reason why many SMEs are reluctant to invest in new technologies and are overly careful in assessing any investment strategies involving IT (Nguyen 2009). Furthermore, most SMEs do not have formal human resource planning and knowledge development programs and, as a result, they often face challenges in recruiting and improving human resources that lead to delayed future development (Atkinson & Curtis 2004).

The relatively small size of SMEs can be a source of many problems but can also provide unique advantages. Based on the SMEs' organisational structure and processes that are normally informal, SMEs can be more flexible and innovative compared to larger organisations (Snatkin et al. 2013). Zontanos and Anderson (2004) claim that the flexibility of SMEs usually results in a high degree of responsiveness in delivering customer service. In comparison with large organisations, SMEs are closer to customers and can provide what customers want (Zortea-Johnston, Darroch & Matear 2012; Singh, Garg & Deshmukh 2008). These close relations with customers can also drive SMEs to deliver value-added services that become competitive advantages when competing with large organisations (Clow & Cole 2004). However, despite these supporting characteristics of SMEs, they are under continual pressure to maintain competitiveness in national and international markets. Global competition, technological progress and changing customer requirements continually change the competitive paradigms that drive organisations to compete along various dimensions, such as product design and development, marketing, communications, manufacturing and distribution (Singh, Garg & Deshmukh 2008).

Besides resource limitations and flexibility, the owner/manager operation is another distinctive characteristic shared by SMEs (Bharati & Chaudhuri 2006). Many researchers claim that the owners of SMEs have important roles in the enterprise and normally engage with the process of organisational decision-making (Jansen et al. 2011; Levy & Powell 2008; Torres 2002). Although SME owners generally have a comprehensive understanding of their industries, they frequently lack knowledge of management and marketing (Gurau 2004). This lack of managerial knowledge often means that SMEs overlook the importance of strategic planning. As a result, SMEs' decisions are often made in direct response to problems or opportunities rather than considered, advance planning (Torres 2002). Moreover, SME managers normally rely on their intuition (Ghobadian & Oregan 2006; MacGregor & Vrazalic 2005). This argument is supported by other researchers who indicated that the decisions made by SMEs are often not well-informed (Zontanos & Anderson 2004). Consequently, when strategies are formed based on the limited essential skills of the manager and limited information, it is hardly surprising that many SMEs fail to meet and achieve their business objectives (Pansiri & Temtime 2008).

4.4 Information Technology and BI as competitive advantage for SMEs

Advances in computer technology has resulted in declining IT and BI systems cost and improved software and technological sophistication of the workforce. No longer are these adaptations reserved for the technologically leading and this results in innovation opportunities for SMEs (Cooper 1998). Prior studies have stated direct relationships between the investments in IT capabilities with financial performance in large organisation (Ravichandran & Lertwongsatien 2005). These relationships however are not restricted to large organisation but can also be found in the SME context (Chen & Fu 2001). Khazanchi (2005) claim that the flexibility of the managerial capabilities of SMEs dictate the extent of success of IT adoption and the resulting positive effects on financial performance. Given this context, SMEs should be better able to effectively utilize IT to exploit newer technologies than their larger, less agile competitors (Chen & Fu 2001).

Many research studies have shown that SMEs can benefit from using IT (Ongori & Migiro 2010; Saira, Zariyawati & Annuar 2010; Nguyen 2009; Kapurubandara & Lawson 2006). For example, a study on ICT, Ongori and Migiro (2010) found that benefits of ICTs adoption include better economical management of resources, access to robust information, improved knowledge management, and access to new markets and market growth. Nguyen (2009) found that IT assisted SMEs to lower production and labour costs, add value to products and services and increase a company's competitive advantage. Another IT study on SMEs by Saira, Zariyawati and Annuar (2010) found that Malaysian SMEs that use accounting systems would be able to collect more information to assist decision making. These examples demonstrate the capacity for SMEs to create competitive advantage from improvements in efficiency and the firms' profitability as a result of IT adoption. In regards to BI technology, the goal of BI is to provide organizations with intelligence that can be used to create competitive advantage. BI technology combines the capabilities of different systems, which previously operated independently (Turban et al. 2008). BI focuses on supporting a variety of business functions, using the process approach and advanced analytical techniques (Glancy & Yadav 2011). In utilizing BI, SMEs can gain competitive advantage by having a better understanding of the market and recognizing when customer demands change, while their competitors have only limited information and false estimations of customer requirements (Arrieta, Ricondo & Aranguren 2007). These benefits help SMEs make more suitable and better decision to respond quickly in a dynamic market (Kale, Banwait & Laroiya 2007). In a more recent study on SMEs in Poland, Olszak and Ziemba (2012) found that SMEs have noticed that BI had created competitive advantage through timely reaction to the changes in the organisation and in the environment of high operating costs and strong competition, and to make business decisions based on real, current, and complete information.

4.5 The implementation of BI in SMEs

Bharati and Chaudhury (2009) indicates that most small enterprises still underestimate the possible value of IT innovations by limiting themselves to administrative tasks only. Though BI systems have become an important part of enterprise decision support for more than two decades, SMEs still lag behind the BI explosion (Wirtschaft et al. 2010). A possible reason for this delay could be the complexity of BI which may lead to high maintenance and implementation costs (Sahay & Ranjan 2008). As a result, previously, many SMEs could not afford BI and its maintenance costs (Korczak, Dudycz & Dyczkowski 2012). On the other hand, BI applications are currently more diverse, more flexible, cheaper and less complex than they were in the past (LogicXML 2009). Even though current BI is less complex, the Extract-Transform-Load Tools in BI can detect data quality issues and restore data integrity in the warehouse which, in turn, assists SMEs in reducing data entry error and improving decision-making based on efficient data (Chaudhuri, Dayal & Narasayya 2011). Also, BI vendors offer more targeted products which are specially tailored for companies with financial and resource constraints (Pegasus Software 2008).

Even though, BI vendors try to make BI technology cheaper, the total cost of ownership (TCO) is still high for the majority of SMEs (Sheikh 2011). The costs to implement BI technology relate to purchasing hardware, software, also further management, required training and additional equipment. Therefore, many BI vendors have tried to offer other models to SMEs such as Cloud computing by using the concept of Software as a Service (SaaS) in order to overcome the issue of resource scarcity in SMEs (Hiziroglu & Cebeci 2013). Cloud computing is a model where resources like hardware, software, information are pooled and shared with the end-use via the internet whereas SaaS is the on-demand software delivery (Armbrust et al. 2010). This model is one being used most because it can lead to a considerable decrease of TCO. The other benefits of moving to cloud computing using SaaS are no complex setup tasks as required in traditional BI, no special skillset required like database knowledge and shorter learning cycle due to web browser based interface (Sheikh 2011). Therefore, SMEs that cannot afford the entire BI system infrastructure can turn to this model. Development of technologies like SaaS, web services and improvement of the web-based interface, as well as decreasing costs of Internet access, make it possible for such an approach to not only thrive, but replace the typical BI technology.

While the trend in developing BI tools for SMEs is continually increasing, Vetana's (2010) research argues that SMEs have been slow in spending money on BI. For the most part, SMEs still use desktop spreadsheets as a tool for generating analytics. In some cases, and particularly with smaller firms which have fewer requirements in managing complex data than midsize firms, Excel and other desktop spreadsheets are tools frequently used for ad hoc analyses and reporting (Vetana Research 2010). Even though these spreadsheets are simple to set up, easy to use, and proficient in producing fast results, they are basically prototyping tools that were designed specifically for individual productivity use rather than for use throughout the enterprise. According to Vetana Research (2010), most organisations have recognised that errors in data entry and formulas may be widespread across the enterprise when using Excel and other desktop spreadsheets. If ambiguous and inaccurate data are used repeatedly, the accumulated errors will be enormous. This poor quality of data can affect decision-making and lead to negative consequences for the business (Haug, Zachariassen & Van Liempd 2011).

4.6 The situation of IT in Thai SMEs

Thailand is a country where the majority of its enterprises are small to medium and they are important for national economic development. In Thailand, as of 2013, SMEs accounted for 98.5% of all companies (OSMEP 2014). According to the Business Monitor International (2011), the Thai IT market is the largest in the South East Asian region and is expected to grow by approximately 13% in 2011. This growth could be caused by the increasing interest in Thai SMEs as a result of multilateral agencies. For example, in 2000 the Thai government released the SME's Act for promoting and supporting SMEs by setting up the organisations such as the SMEs bank, the Office of Small and Medium Enterprises Promotion (OSMEP), and the Institute for Small and Medium Enterprises Development (ISMED). All of these organisations have the same objective, which is helping Thai SMEs to participate in the global market by providing investment promotion, financial assistance, and technical consultancy (Chooprayoon, Chun Che & Depickere 2007) .

In terms of IT, a small number of Thai SMEs use IT for increasing their productivity and efficiency (Mephokee & Ruengsrichaiya 2005). Thai SME sectors are still weak in respect to their ability to adjust themselves to advances in knowledge and innovation technology (Yokakul & Zawdie 2009). As a result, Thai SMEs are often not able to succeed or compete in the world market (Mephokee & Ruengsrichaiya 2005). However, government agencies do not ignore these issues. They have tried encouraging SMEs to implement IT. They have launched a new campaign to encourage SMEs to use Information and Communication Technology (ICT) and simultaneously they have encouraged local IT software companies to develop ERP software to support SMEs (Boonnoon 2011).

4.7 Chapter summary

SMEs play an important part in the world economy and more than 95% of enterprises can be categorised into this group (Roy & Sander 2004). The classification of SMEs varies from industry to industry and from country to country (Ayyagari, Beck & Demirguc-Kunt 2007) but there are some common criteria used, such as the number of employees and turnover. Due to the nature of SMEs, they are reluctant to reveal sales information, so many researchers select employee numbers as criteria to classify organisations in their studies (Julian 2003). As this research is conducted in Thailand, the Thailand Ministry of Industry's definition of

SMEs is used. Furthermore, although the definition of SMEs is different between countries, they share several similar characteristics (MacGregor & Vrazalic 2005). The main characteristics that distinguish SMEs from large organisations are the lack of resources, the owner/manager operation, and flexibility.

Despite current BI applications being more diverse, flexible and cheaper than they were in the past, the adoption of BI in SMEs is still not prevalent (LogicXML 2009). Many small enterprises overlook the potential value of IT innovations by focusing only on IT-related administrative tasks (Bharati & Chaudhury 2009), such as generating analytics using desktop-based spreadsheets. As this desktop spreadsheet is designed for individual use rather than being enterprise-wide, this can result in problems with ambiguous and inaccurate data, causing ineffective decision-making and affecting business performance (Vetana Research 2010).

CHAPTER 5: THEORETICAL FRAMEWORK

5.0 Introduction

Following the reviews of literature in Chapters 2, 3 and 4 relating to information technology (IT), business intelligence (BI) and small and medium-sized enterprises (SMEs), this chapter provides an overview of research on theories and concepts related to the research model used in this study. The first section reviews a definition of the term 'innovation', followed by the theoretical background of the diffusion of innovation theory. In order to build a comprehensive framework, four notable innovation adoption theories are clarified in the next section, followed by a discussion of the two prominent models selected for incorporation into the study framework. A discussion of these two models will help clarify the four characteristics affecting innovation adoption: technological innovation; environment; organisation; and owner-manager. Eleven potential determining factors in IT adoption are then extracted from prior research studies to broaden the framework. A summary of these driving factors found in prior research is presented in table form. The chapter concludes with an overview of the proposed theoretical model.

5.1 Definition of 'innovation'

Diffusion of innovation research and practice has been derived from diverse fields of study, including sociology, medicine, strategic management, marketing, economics and technology management. Here, an innovation is not only an outcome but also a process aimed at creating purposeful, focused change in an organisation's economic or social potential (Baars & Kemper 2008). However, although the adoption of an innovation may possibly be viewed as being 'new' by an organisation, it is not necessarily new in other contexts. For example, Rogers (1995) defined innovation as any new thought, behaviour or object perceived as new to the individual. Thong (1999) considered innovation in terms of a thought and practice that offered a renewal, regeneration or revitalisation. An innovation can also be seen as a new product, service, process or type of enterprise that can affect fundamental behaviours or business activities (Pollard 1999). The definition of innovation of Pollard (1999) is adopted in this study because it not represents only product but also processes that have an effect on business activities. When considering BI, as discussed in Chapter 3 (see Section 3.2), it can be considered an innovative approach that is likely to cause changes in: some work practices; knowledge of specific system applications; and computer-network based systems between users. For these reasons, BI can be seen as not only an innovation in terms of technology renewal, but also as a renewal in terms of thought and action. The next section discusses the theoretical background of the innovation theory that will be used as a foundation in developing the research framework for this study.

5.2 Theoretical background of the diffusion of innovation theory

There are a number of prominent theories involving the diffusion of innovation, each implying a unique model (Chuang, Nakatani & Zhou 2009). Damsgaard and Lyytinen (1997) assert that these theories can be categorised into two main models, including the macro perspective and micro perspective. Shaw et al. (2001) distinguished these two perspectives, explaining that the macro perspective relates to the concept of diffusion at industrial and national levels, whereas the micro perspective relates to the concept of diffusion at individual and organisational levels. In adopting these two perspectives, a study by Baskerville and Pries-Heje (2001) investigated the diffusion of innovation process in terms of 'ecological' and 'genealogical' views. Their ecological view included a macro perspective that used power dependency to analysis networks of cooperating agents to comprehend how extra-organisational power dependencies from the diffusion process. However, the micro perspective provides a genealogical view that relies on concepts of economic and innovation theories in order to facilitate an understanding of diffusion patterns amongst organisations that have the same character and populations (Baskerville & Pries-Heje 2001). Based on these discussions, it can be noted that the existing theories can be classified into two broad perspectives based on their focal points and aims as follows:

- From the macro point of view, theory is developed by focusing on organisational change. The study purpose is to investigate change as an overall operation that involves restructuring and reorganising the enterprise.

- From the micro point of view, theory is developed by focusing on the spread of technology adoption. Here, the study purpose is to investigate changes in the current operations that can be applied to other parts of the enterprise.

Based on these two perspectives of diffusion of innovation, the micro perspective appears to be more suitable for this study because the micro perspective focuses on diffusion of technology adoption which compatible with the study aims of examining the spread and adoption of BI systems among SMEs. This is in line with other studies on innovation diffusion that adopt genealogical views of the micro perspective (Wainwright & Waring 2007, 2006; Chung, Chen & Nunamaker 2005; Baskerville & Pries-Heje 2001; Damsgaard & Lyytinen 2001).

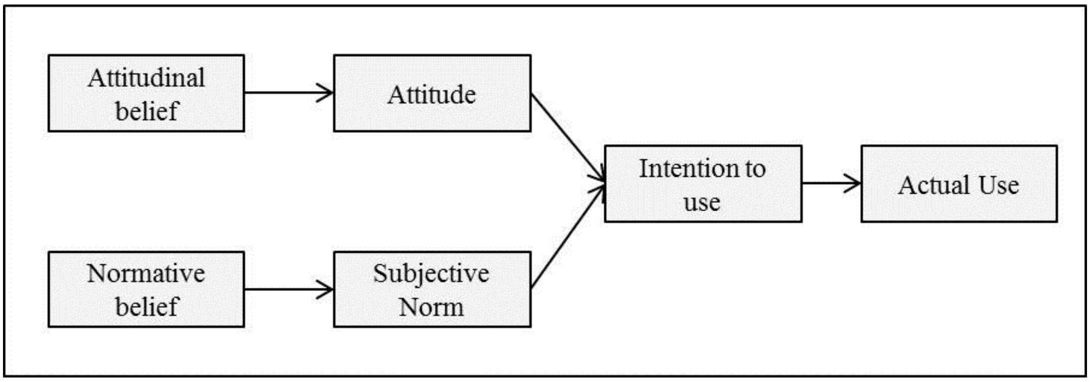
5.3 Adoption of innovation theory

Having confirmed that the micro perspective is suitable for application in this study, this section reviews the relevant theories used in IT studies to examine IT adoption and diffusion. As it is a characteristic of SMEs where owner-managers are the sole decision-makers having a direct effect on decision processes in their companies, they are the target respondents in this study. Therefore, when discussing relevant theories, this study focused on the theories that can reflect the owner-manager perspectives.

The theories that provide the driving factors that impact on individuals and societies participating in innovation adoption include: the theory of reasoned action (TRA) (Ajzen & Fishbein 1980); the diffusion of innovation theory (DOI) (Rogers 1983); the theory of planned behaviour (TPB) (Ajzen 1985); the technology acceptance model (TAM) (Davis 1986), the social cognitive theory (Brenner 1996); and the unified theory of acceptance and use of Technology (UTAUT) (Venkatesh et al. 2003). However, although Kishore (1999) showed that most empirical research studies in IT adoption have been based on either the TAM or DOI theory, a meta-analysis of the adoption of innovation theories by Legris, Ingham and Collerette (2003) revealed three major theories explaining the adoption of IT, namely TRA, TPB and TAM. Consequently, in the following section, TRA, TPB, TAM and DOI are discussed and evaluated for their strengths and suitability in studying technological innovation.

5.3.1 Theory of reasoned action (TRA)

TRA was formulated by Fishbein and Ajzen (1975), with the initial aim of studying individual behavioural intentions and intention to use technology. TRA, when applied to explain the use of behaviour, embraces four general concepts, namely subjective norms, behavioural attitudes, intention to use and actual use. The diagrammatic model of TRA is presented in Figure 5.1. TRA states that individuals assess the consequences of a specific behaviour, and generate intentions to act corresponding to their assessments. In other words, the individual's intention can be predicted from both attitude and subjective norm. Attitude can be predicted from an individual's beliefs about the consequences of the behaviour (attitudinal belief), while subjective norm can be predicted by perceiving how important other individuals perceive the behaviour is supposed or not supposed to be (normative belief). Hence the individual will use the innovation when they believe that the new process, product or idea can be applied successfully.

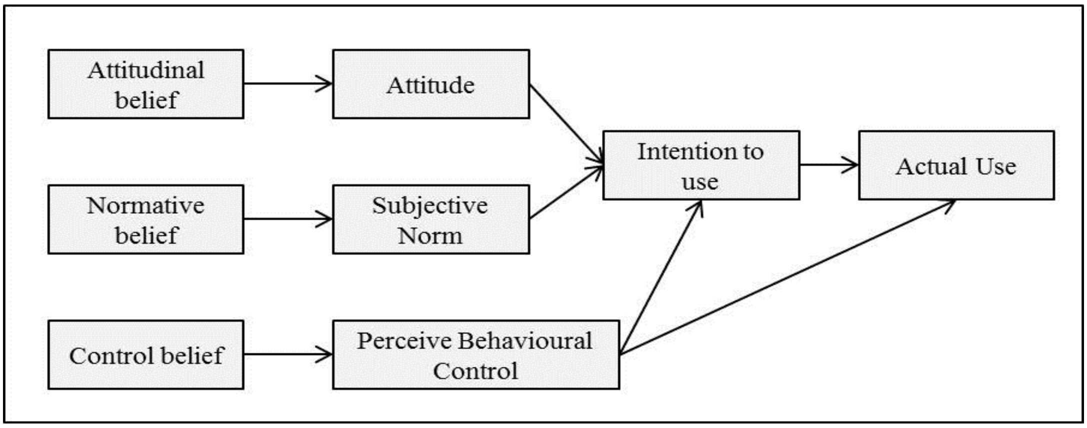


Source: Fishbein and Ajzen (1975)

Figure 5.1: Theory of reasoned action (TRA)

5.3.2 Theory of planned behaviour (TPB)

TPB developed by Ajzen (1991) was proposed as an extension to the TRA Theory. TPB attempts to account for the situation where individuals lack complete control over their behaviour by adding a control aspect, as shown in Figure 5.2. This theory proposes that besides attitude and subjective norms, individual intention and actual use can be predicted by perceived behavioural control. Consequently, although TPB is more functional in its application than TRA, the main concept still focuses on the idea that engagement and effective application of an innovation will necessarily take place just because the individual has a strong belief in the new process, product or idea. A number of researchers have chosen to adopt TPB to model the acceptance of diverse IT in business, such as Mathieson (1991) who studied users' intention to implement spreadsheets, and Quaddus and Hofmeyer (2007) who studied small businesses' intention to adopt B2B trading exchanges.

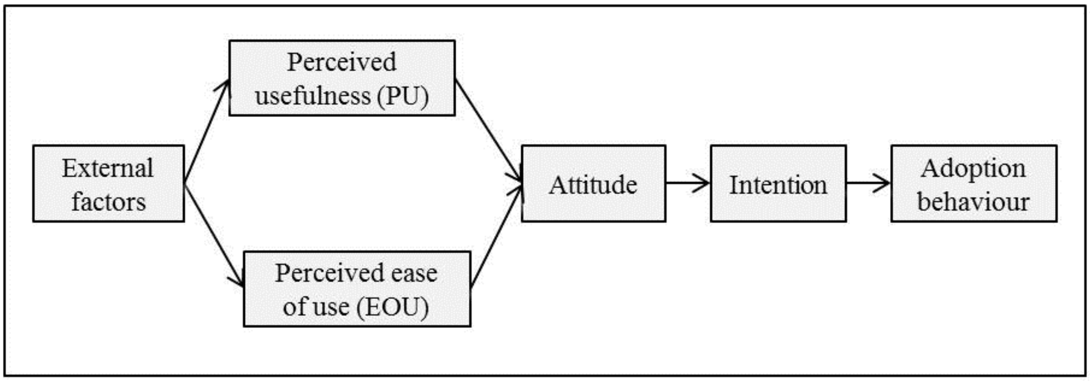


Source: Ajzen (1991)

Figure 5.2: Theory of planned behaviour (TPB)

5.3.3 Technology acceptance model (TAM)

TAM was developed from TRA to explain and predict user behaviours in accepting new technologies (see Figure 5.3) (Davis 1986). TAM demonstrates the relationships between external variables on internal beliefs, attitudes and intentions with perceived usefulness (PU) and perceived ease of use (PEOU). If technology is not difficult to use and is found to be useful, it will have a positive effect on the intended user's attitude. This can consequently increase the user intention towards adopting the technology, and thus build adoption behaviour (Vuori 2006). Davis (1989) recommends that the internal psychological factors or beliefs including PU and PEOU are significant factors in TAM for shaping attitudes towards the intention of accepting and using a technology.



Source: Davis (1989)

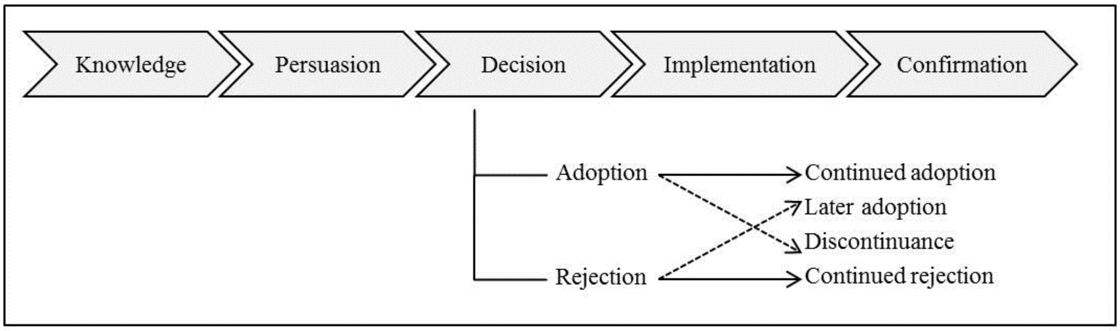
Figure 5.3: Technology acceptance model (TAM)

5.3.4 Diffusion of innovation (DOI) theory

DOI theory was developed by Rogers (1983) with the initial aim of describing the elements that impact on the process of innovation diffusion and adoption. In Roger's book *Diffusion of Innovations*, he defined innovation diffusion as 'the process by which innovation is communicated through certain channels over time among the members of the social system' (Rogers 1983, p. 233). Rogers (2005) claims that four main elements contribute to determining the decisions in adoption and diffusion of new technologies, including: 1) the innovation; 2) communication channels used to spread information about the innovation; 3) passage of time; and 4) the social system in which the innovation is provided to potential adopters. Furthermore, Rogers asserts that the diffusion of innovation is a meta-theory based on numerous theoretical perspectives related to the overall concept of diffusion. He explains that four major theories deal with his diffusion of innovation, including: 1) innovation decision process; 2) individual innovativeness; 3) rate of adoption; and 4) perceived attributes.

5.3.4.1 Innovation decision process

Innovation decision process (Rogers 2005) illustrates that there are five distinct stages in the process of diffusion occurring over time (see Figure 5.4). These five stages comprise knowledge, persuasion, decision, implementation and confirmation. In the Rogers' study, the process of diffusion starts with the knowledge that possible adopters have to learn about an innovation after being persuaded about the merits of that innovation. Next, the decision to adopt the innovation is taken based on the activities undertaken. Then, if the potential adopters see a positive outcome of the innovation, they will implement such innovation. The last stage in this process is to confirm, reaffirm or reject an adoption decision that has formerly been accepted.

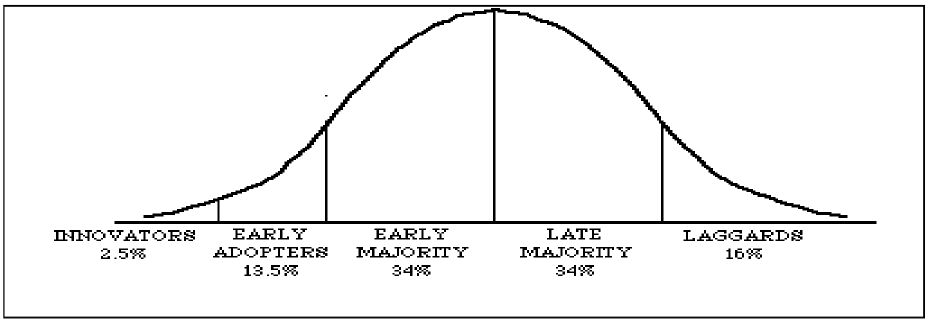


Source: Rogers (2005)

Figure 5.4: The stages in the innovation decision process

5.3.4.2 Individual innovativeness

Individual innovativeness (Rogers 2005) claims that some individuals are more likely to adopt innovations earlier than others. Figure 5.5 illustrates the bell-shaped curve representing adopter categorisations on the foundation of innovativeness, and the percentage of possible adopters falling into each category. The first group of adopters are the innovators who are risk takers and pioneers in accepting and implementing an innovation extremely early in the diffusion process. The second group are early adopters who quickly follow innovators in accepting the innovation. These two groups are followed by the early majority who necessitate persuasions on the importance of innovation directly from the innovators. The next group is the late majority who need time to make sure that the innovation which they will adopt is in their greatest interest. The last group are the laggards who refuse to embrace the adoption of innovation unless there is some pressure or excessive need to push them to accept it.

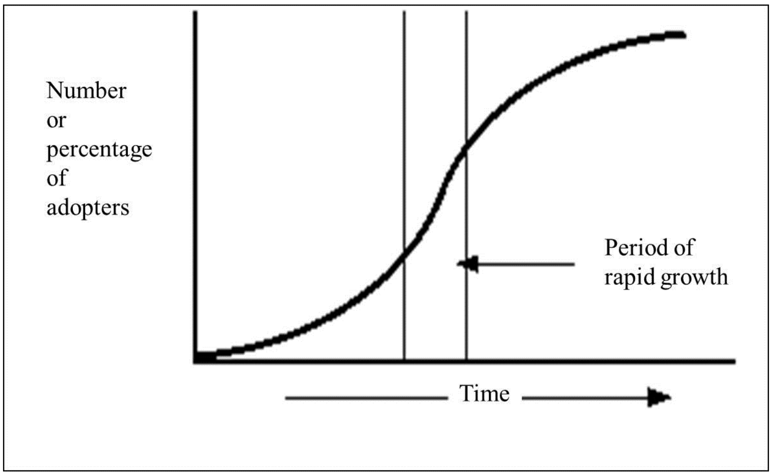


Source: Rogers (2005)

Figure 5.5: The bell-shaped curve represents adopter categorisations as the foundation of innovativeness

5.3.4.3 Rate of adoption

The rate of adoption (Rogers 2005) proposes that an S-curve is the best way to illustrate the process of adoption in innovation (see Figure 5.6). In the starting period of innovation diffusion, the initial rate of adoption increases gradually before entering into the stage of fast growth which then shrinks significantly and continues steadily. After that the rate of adoption slowly stabilises and ultimately declines. The rate of adoption is negatively correlated with the perceived complexity of the innovation, while it positively correlates with relative advantage, compatibility, trialability and observability.



Source: Rogers (2005)

Figure 5.6: The S-curve showing the adoption rate of innovation over time

5.3.4.4 The theory of perceived attributes

Perceived attributes (Rogers 2005) typically relate to the innovation decision process theory in the stage of decision. Rogers claims that potential adopters evaluate an innovation based on their perceptions, and will make a decision to accept innovation if they perceive that it has the following attributes: 1) it has relative advantage over other innovations (Relative Advantage); 2) it is easy to use or not excessively complex to understand (Complexity); 3) it is consistent with current practices' values, past experience, and the needs of potential adopters (Compatibility); 4) it can be trialled on a limited basis before adoption (Trialability); and 5) it offers observably obvious results (Observability). Rogers concludes that these five attributes are empirically interconnected with each other but simultaneously are conceptually different.

5.3.5 Evaluation of theories in the context of this thesis

As each of the above-mentioned four main theories focuses on different perspectives, this section discusses each one in turn to determine which is the most suitable for this study.

TRA is a well-accepted and widely studied intention model that has been successfully used to explain behaviours across a wide variety of settings (Venkatesh 1999). However, TRA is criticised for failing to identify the specific beliefs that are related to particular behaviours and situations. Furthermore, this theory is limited to focusing only on the behaviours in which individuals consider the implications of their actions before the actual action happens. However, these limitations have elevated suspicions about the applicability of TRA when studying actions of organisations with no regard for external factors that may impact on organisational decisions (Bagozzi, Davis & Warshaw 1992). In other words, TRA is seen as unsuitable for predicting and explaining organisational behaviours because it does not consider the external factors that may affect such behaviours.

The main purpose of TPB is to overcome the limitations of TRA by adding a third perception-perceived behavioural control. TPB is considered to be one of the most influential theories in predicting and explaining behaviour due to its applicability in various business domains, and its ability to provide a valuable framework for explaining the acceptance of new technologies (Huang 2006). However, TPB has been criticised for being concerned with behaviours where individuals consider the implications of their actions before deciding whether to act. This raises doubts about its applicability in the study of firms, where decision makers must consider numerous issues surrounding the firm they manage (Bagozzi, Davis & Warshaw 1992).

TAM has been widely applied in the information systems domain and has proven to be superior to TRA and TPB in enabling predictions of attitudes towards the use of innovative technologies (Gardner & Amoroso 2004; Venkatesh et al. 2003; Mathieson & Keil 1998). However, as TAM has several predictive limitations, some researchers recommend that it should be adapted by adding components that better predict the individual's technology acceptance (Wong 2005; Xu & Quaddus 2005; Wolcott et al. 2001). Furthermore, Mathieson (1991) and Taylor and Todd (1995) claim that TAM fails to capture the constraining influence and personal control factors that possibly affect adoption behaviour. These constraints can range from unconscious habits to limited ability, time and organisational limits (Manross & Rice 1986). Additionally, TAM has been criticised as ignoring the significance of social and organisational factors, such as mandatory use of technology and subjective norms – which refers to the perceived social pressure to perform or not perform a particular behaviour (Ajzen 1991). This is because TAM primarily concentrates on behaviours in which individuals consider the implications of their actions before choosing whether to act (Liautaud & Hammond 2000). These critiques are consistent with Lu et al. (2003) who claim that TAM theory primarily focuses on describing information system adoption behaviour at individual levels. Even though there are many extensions of TAM theory such as TAM2 and UTAUT (Unified Theory of Acceptance and Use of Technology) (Dadayan & Ferro 2005) in overcoming the initial limitations of TAM by explaining how social influences and cognitive instrumental processes affect percieved usefulness and usage intentions. These extensions of TAM theory have also been criticized though the models have concentrated on users without separating the individuals, usage environment and other socio-cultural variables and how do they effect to innovation diffusion (Fife & Pereira 2005).

Based on Roger's DOI theory, many innovation researchers have investigated how a multitude of factors interrelate, facilitate, or obstruct the adoption of technologies among particular members of particular adopter groups (Bunduchi, Weisshaar & Smart 2011; Beilock & Dimitrova 2003; McGowan & Madey 1998; Brancheau & Wetherbe 1990). As a consequence, many researchers found that DOI theory offers a powerful paradigm for conceptualising the development and acceptance of an innovation. However, DOI theory has been criticised as lacking explanations of adoption behaviour (Thong, Yap & Raman 1996) and the effects of adopters' demography on innovation adoption (Mathieson & Keil 1998; Hartwick & Barki 1994). Even so, DOI theory has remained the most often cited work dealing with innovation diffusion (Jeyaraj, Rottman & Lacity 2006), as can be observed in numerous studies on utilisation of spreadsheet software (Brancheau & Wetherbe 1990); telecommunications technologies (Grover & Goslar 1993); electronic data interchange (McGowan & Madey 1998); smart cards (Plouffe, Hulland & Vandenbosch 2001); internet (Beilock & Dimitrova 2003; Wolcott et al. 2001); knowledge management (Xu & Quaddus 2005); RFID (Bunduchi, Weisshaar & Smart 2011); and cloud computing (Lin & Chen 2012).

With regard to BI adoption among SMEs, BI technology has remained a fresh concept for innovation among SMEs even though it has been implemented in many large enterprises for a number of years. Moreover, the DOI theory can assist in explaining the adoption behaviour of a collection of individuals, groups, or organisations, rather than just individuals. In other words, DOI theory can investigate technological innovation adoption at the level of firms (Melville, Kraemer & Gurbaxani 2004), which is consistent with the aim of this research into BI systems' adoption among SMEs. In light of this discussion, DOI theory is chosen as a base theory for this study.

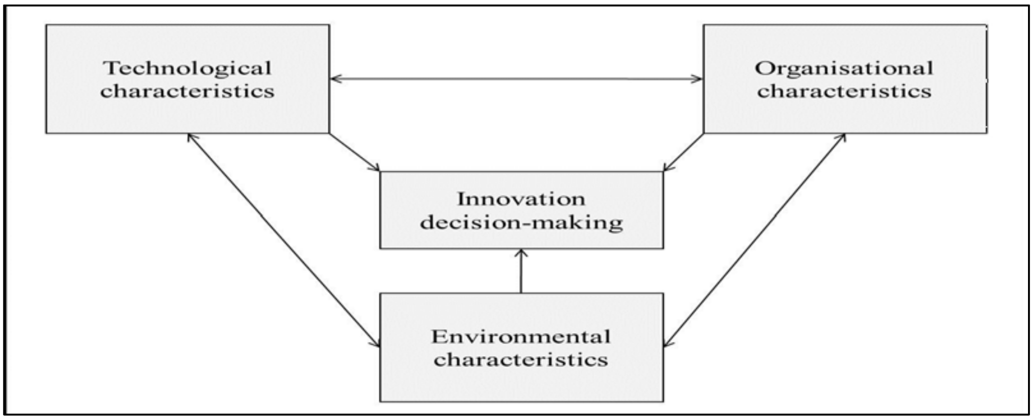
5.4 Multiple perspectives in diffusion of innovation

Technology, independently, is not sufficient to guarantee success in the diffusion of technological innovation, and thus the concept of multiple perspectives is applied in this study to clearly understand the enabling factors impacting on BI adoption. According to Clegg et al. (1997), technology alone cannot guarantee the improvement of organisational performance because it is not the only factor contributing to organisations meeting their objectives. A range of human and organisational components must be taken into account as well. Managers and end users affect the overall organisational performance because they interact with the technical changes occurring in the processes of IT adoption, development and implementation. Further to this, even when technological superiority is assured, it is not enough to guarantee the adoption of IT innovation by organisations (Surry & Ely 1999; Pool 1997). This is because other social, economic, technical, organisational and individual factors may impact on the selection and adoption of technologies (Segal 1994). As a result, several researchers have employed multiple perspectives in order to identify the groups of variables that may be important in the diffusion of innovations (Pease & Rowe 2007; Wejnert 2002; Chiasson & Lovato 2001).

5.4.1 Technology-organisation-environment (TOE) model

Based on the review of existing studies (Tan & Lin 2012; Ghobakhloo, Arias-Aranda & Benitez-Amado 2011; Oliveira & Martins 2010b; Chong et al. 2009; Soares-Aguiar & Palma-dos-Reis 2008; Zhu, Kraemer & Xu 2003; Kuan & Chau 2001), multiple perspective frameworks are popular in technology adoption research where many IT researchers adopt Rogers' innovation characteristics as a basis for combination with other relevant factors that support their descriptive models. In regard to technological innovation of an organisation, Tornatzky and Fleischer's (1990) study combines innovation characteristics with other elements to propose a TOE model. In Tornatzky and Fleischer's framework, Zhu et al. (2006) combined the TOE model with relative advantage, cost, security and compatibility to investigate the determinants of the post-adoption stage in electronic business diffusion. Chong et al. (2009) also studied the adoption of collaborative commerce through integrating the TOE model, by combining them with information sharing culture characteristics.

In agreement with other multi-perspective TOE models (Tan & Lin 2012; Ghobakhloo, Arias-Aranda & Benitez-Amado 2011; Oliveira & Martins 2010b; Chong et al. 2009; Soares-Aguiar & Palma-dos-Reis 2008; Zhu, Kraemer & Xu 2003; Kuan & Chau 2001), this study employs the seminal model of Tornatzky and Fleischer (1990) to facilitate the understanding of technological innovation adoption. The TOE framework was selected because it can be used to identify groups of variables that may be important in the diffusion of innovations, in addition to compensating for the aspects that the DOI model overlooks. The TOE model consists of three characteristics that affect the innovation decision-making process of technology adoption and implementation in a firm, including: 1) organisational; 2) technological; and 3) environmental contexts (see Figure 5.7). In considering Tornatzky and Fleischer's original TOE model, it can be noted that Roger's innovation diffusion theory is of key significance in forming a foundation for model building, because the technological context of the TOE model includes both internal and external technologies in relation to the adoption of technology applications in an organisation.

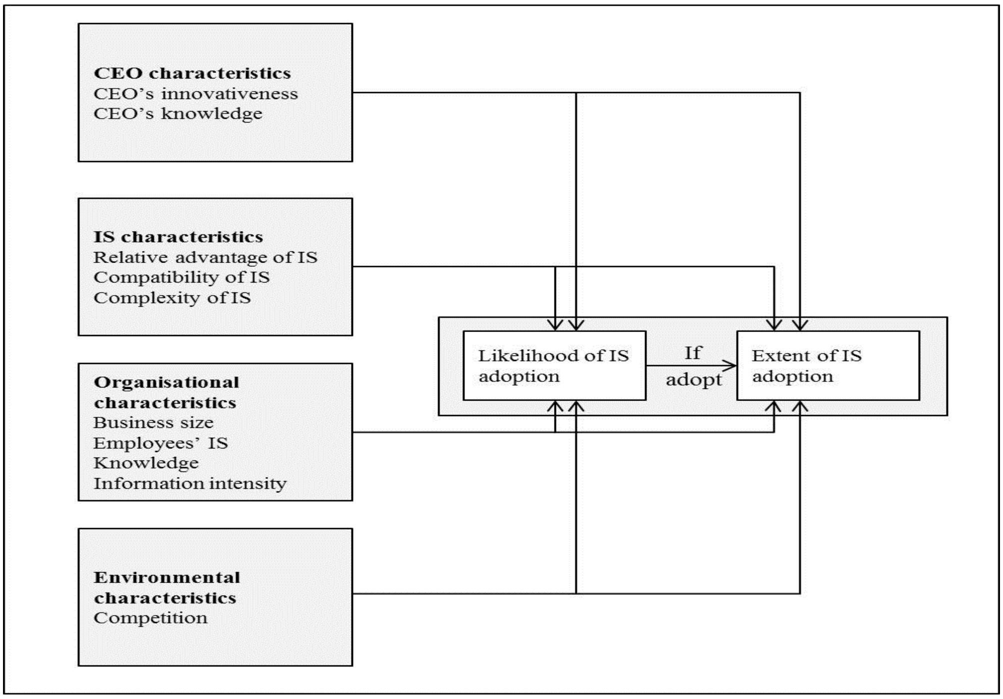


Source: Tornatzky and Fleischer (1990)

Figure 5.7: The context of technological innovation in a firm

5.4.2 Information systems adoption model for small business

Even though the majority of multi-perspective studies have been published on technology adoption in large companies, there is but a limited number focusing on SMEs. Thong (1999) developed an integrated perspective framework of IT adoption in SMEs to identify four contextual variables that are relevant to IT adoption: 1) Chief Executive Officers' (CEOs) characteristics; 2) Technological characteristics; 3) Organisational characteristics; and 4) Environmental characteristics (see Figure 5.8). Although this framework can be regarded as a further extension of the TOE model (in which CEOs' characteristics are viewed as organisational), Thong and Yap (1996) found that in the SME context, individual characteristics of CEOs are essential in determining IT adoption. Due to the simple and highly centralised organisational structure of SMEs, the CEO is usually the owner-manager (Ghobakhloo, Arias-Aranda & Benitez-Amado 2011). Therefore, in this study the term CEO is replaced by owner-manager. As the owner-manager has a significant impact on making IT adoption decisions, the information systems adoption model for small business was included in the conceptual framework of this study.



Source: Adopted from Thong (1999)

Figure 5.8: Information systems adoption model for small business

5.5 Potential factors affecting technological innovation adoption

Following on from the discussion in the previous section, DOI theory (Rogers 1995), the TOE model (Tornatzky & Fleischer 1990) and the information systems adoption model for small business (Thong 1999) are selected as the basic foundation for the development of a conceptual model. Four main characteristics of innovation technology adoption are discussed and presented as: 1) Characteristics of technological innovation; 2) Characteristics of environment; 3) Characteristics of organisation; and 4) Characteristics of owner-managers.

5.5.1 Characteristics of technological innovation

A review of IT adoption literature reveals that characteristics in the technological context of innovation are the main focus of many IT adoption studies (Oliveira & Martins 2011). Rogers (1995) claims that innovations with favourable characteristics are more likely to receive attention and more readily adopted for diffusion than those with unfavourable characteristics. For this reason, several researchers have attempted to explain the relationships between the characteristics of an innovation and its adoption (Ramdani, Chevers & Williams 2013; Oliveira & Martins 2010a; Kuan & Chau 2001; Thong 1999).

Rogers (1995) proposed the theory of perceived attributes to identify the attributes of innovation that may impact adoption. His theory comprises five attributes: 1) 'relative advantage' as being better than other innovations; 2) 'complexity' with respect to implementation and operation of an innovation; 3) 'compatibility' in terms of consistency with a firm's current practices; 4) 'trialability' as regarding the testing of innovation in a limited time before adoption; and 5) 'observability' as regarding the observation after implementation of the innovation. This theory advises the adopters to evaluate the technological innovation based on their perceptions involving the five characteristics of innovation (Surry & Farquhar 1997).

In addition to the five attributes of innovation identified by Rogers (1995), further attributes such as cost and risk were identified by Herbig and Day (1992), and perceived ease of use and perceived usefulness were identified by Tornatzky and Klein (1982). Researchers have suggested that some of these attributes overlap with the attributes in DOI theory (Carter & Bélanger 2005; Venkatesh et al. 2003). For example, the attribute 'perceived risk' is inversely related to ‘perceived relative advantage’ due to the perception of risk reducing the perceived relative advantages of a technology (Warkentin et al. 2002). ‘Perceived ease of use’ can be treated as similar (in reverse direction) to ‘complexity’. Likewise, ‘perceived usefulness’ has been referred to as ‘relative advantage’ and has been used interchangeably in many cases (Carter & Bélanger 2005).

A review of empirical studies showed that due to the existence of a wide variety of innovation attributes, researchers have employed different innovation attributes in their studies when examining the organisational adoption of innovation. They found that the same attributes may significantly impact on organisational adoption of different technological innovations (Ramdani, Chevers & Williams 2013; Sila 2013; Jang 2010; Wang, Wang & Yang 2010; Ramamurthy, Sen & Sinha 2008; Hwang et al. 2004). Conversely, different attributes could potentially have a significant influence on the same technological innovations. For example, two studies on RFID adoption separately conducted by Jang (2010) and Wang et al. (2010) used perceived benefits (relative advantage) as one of the factors when examining the relationships between technological characteristics and RFID adoption. Jang (2010) found that perceived benefits significantly impact on RFID adoption, while Wang et al. (2010) did not find any significant relationship at all. It can be noted here that although these results lack agreement, they show the possibility of inconsistent underlying factors.

Wolfe (1994) claimed that because of inconsistency in studies of organisational innovation adoption, it is not simple to establish a broadly accepted typology or checklist of innovation characteristics. However, according to the Tornatzky and Klein (1982) study based on a meta-analysis of 25 innovation attributes, a statistical method for merging the results of many individual analyses in the same area (Olkin 1992), only three innovation attributes, namely: relative advantage, complexity, and compatibility, are recommended as consistently correlated with the adoption of an innovation. The later conclusion agrees with Carter and Bélanger (2005) and Nahar et al. (2006) who both indicated that innovation, which has greater relative advantage, less complexity, and more compatibility, will usually be adopted over other technological innovations. Consequently, some studies have used only these three attributes as criteria for examining technological adoption in organisations (Wang, Wang & Yang 2010; Teo, Lim & Fedric 2007; Sia et al. 2004; Beatty, Shim & Jones 2001). Other characteristics, such as trialability and observability have been less considered by IT researchers (Premkumar, Ramamurthy & Crum 1997; Grover 1993).

Although only the three innovation attributes (relative advantage, complexity, and compatibility) mentioned above have been commonly examined in previous studies and indicated as significantly impacting on innovation adoption, this study intends to examine all five technological innovation characteristics based on the theory of perceived attributes. When the advantages of an innovation have observability and trialability, they will be more readily adopted as compatible with the current practices of the organisation (Rogers 1995). This reasoning is in line with the task-technology theory, which claims that technologies will be adopted when they: 1) have positive effects for adopters (relative advantages); 2) have a 'good fit' with the functions they support (compatibility); and 3) are utilised (trialability) (Goodhue & Thompson 1995). Therefore, the theory of perceived attributes is considered the most useful basis for determining the impact of technological factors in organisations.

Based on the above discussion, the characteristics of technological innovation contain five constructs: Relative advantage, Complexity, Compatibility, Trialability, and Observability.

5.5.2 Characteristics of environment

Environmental characteristics have long been accepted as a driver of innovation adoption as cited in many published studies on innovation (Ramdani, Chevers & Williams 2013; Sila 2013; Zhu, Kraemer & Xu 2003; Holsapple & Joshi 2000; Thong 1999; Premkumar, Ramamurthy & Crum 1997; Iacovou, Benbasat & Dexter 1995; Premkumar & Ramamurthy 1995; Grover 1993). Most IT implementations take place in external environmental contexts characterised by market volatility, uncertainty in competitive intensity, and industrial pressure. However, as organisations do not exist in a vacuum but conduct their businesses in external environments, their performances are highly affected by changes in the external environment (Zaltman, Duncan & Holbek 1973). For this reason, organisations will require more resources and capabilities to accomplish superior performances when they are in more turbulent and rapidly changing environments than they are in stable ones (Eisenhardt & Martin 2000). This indicates that the more turbulent and uncertain the market, the faster the innovation adoption (Mansfield et al. 1977). For example, Peltier, Zhao and Schibrowsky (2012) and Lee, Fiedler and Smith (2008) found that organisations see market uncertainty as the key driving factor encouraging their adoption of innovation in order to stay ahead of competitors. Also, to maintain leadership positions, organisations that are dominant in a particular market may well need to resort to rapid IT innovation or adoption when new competitors are introduced (Leonard-Barton 1991).

External competition tends to stimulate firms to look for new approaches to increase their efficiency and productivity to achieve competitive advantage (Themistocleous et al. 2004). For example, Waarts, Everdingen and Hillegersberg (2002) found that competitors are the key drivers in innovation technology adoption. This is especially so when competitive pressure significantly impacts on the IT adoption (Tan & Lin 2012; Alshawi, Missi & Irani 2011; Hwang et al. 2004; Premkumar, Ramamurthy & Crum 1997; Iacovou, Benbasat & Dexter 1995; Premkumar & Ramamurthy 1995). As seen in a study on data warehouse technology adoption in the Taiwanese banking industry, Hwang et al. (2004) found that competitive pressure was significant in forecasting data warehouse adoption. Another study on customer relationship management (CRM) adoption in SMEs by Alshawi, Missi and Irani (2011) found that environmental attributes, including the degree of competitive pressure and vendor selection, are key factors in CRM adoption. In a more recent study on cloud computing in Singapore, Tan and Lin (2012) found that competitive pressure has an important influence on organisations' adoption of cloud computing technology.

Apart from competitive pressure, coordination between firms and vendors is another criterion affecting IT adoption. Gatignon and Robertson (1989) pointed out that if firms can work well with their IT vendors, they will constantly favour the adoption of innovations. However, selection of implementation partners is a significant issue in IT adoption because partners can facilitate adoption implementation through the use of helping applications that quickly stabilise. This is important because even when innovative enterprise systems are advanced, they may not be able to meet the entire information processing needs of most organisations (Davenport 2000). According to the results of a study on enterprise resource planning (ERP) system adoption by Kumar, Maheshwari and Kumar (2002), implementation partners significantly impact on the adoption of IT in firms. This study confirms that the outsourcing of skills from consulting partners is now a common approach to ERP adoption. Hwang et al. (2004) found that vendor selection has also become a significant consideration due to organisations paying much attention to the selection of vendors when they outsource the implementation of BI technologies.

Overall, the environmental characteristics in IT adoption contain two constructs: Competitive pressure and Vendor selection.

5.5.3 Characteristics of organisations

The ability of organisations to adopt and implement technological innovation is a major issue affecting the adoption decision. A review of relevant literature indicates several organisational characteristics that may impact on technological innovation adoption (Lin 2013; Wang, Wang & Yang 2010; Scupola 2003; Kuan & Chau 2001; Mehrtens, Cragg & Mills 2001; Thong 1999). According to this review, absorptive capacity is a principal factor in examining the relationships between organisational characteristics and innovation adoption that is used as a predictor of whether an organisation can adopt innovation or not (Cohen & Levinthal 1990). Zahra and George (2002) define the absorptive capacity of an organisation as the ability of its members to advance and adapt to changes during the loop process of absorbing, transforming and generating knowledge. Cohen and Levinthal (1990) point out that this ability can assist organisations to increase recognition about the value of new and external information, and as a result, facilitate organisations in applying such information to increase economic benefits. Here, Fichman (1992) proposed that the firms' absorptive capacity in the adoption of new technologies is important. This finding is supported by other researchers, including Gray (2006), who highlighted absorptive capacity in SMEs as a prerequisite to the successful adoption of an innovation. Lal (2007) also studied IT adoption among SMEs and revealed that technological absorptive capacity can significantly impact on the intensity of information and communications technology (ICT) adoption among enterprises. In agreement, another study on the adoption of data warehouse systems by Ramamurthy, Sen and Sinha (2008) found that absorptive capacity in firms strongly influences the IT adoption of such systems.

Apart from absorptive capacity, organisational resource availability is another factor influencing the adoption of innovations. The term 'organisational resource availability' is often synonymous with organisational readiness. The majority of researchers have described both these terms in the same manner as the level of financial and technological resources of the firm (Duan, Deng & Corbitt 2012; Kim & Garrison 2010; Lee & Cheung 2004; Iacovou, Benbasat & Dexter 1995). Iacovou, Benbasat and Dexter (1995) refer to financial resources as the resources available to pay for the installation of a technological system, the costs related with the introduction and the ongoing expenses, whereas technological resources are referred to as the level of sophistication of IT usage and management within the organisation. Based on extensive literature reviews, a number of studies found that organisational resources availability strongly influences the adoption of innovation, and in the case of SMEs, the lack of financial and technological resources is a significant limitation (Alla, Rahman & Ismil 2012; Grandon & Pearson 2004; Stefansson 2002; Iacovou, Benbasat & Dexter 1995). For example, the study of Grandon and Pearson (2004) on electronic commerce adoption among SMEs in the USA found that firms with more organisational resources are more likely to adopt and reap greater benefits than firms with a low level of resources. A recent study by Alla, Rahman and Ismil (2012) on the adoption of accounting information systems (AIS) among Malaysian SMEs revealed that organisational resource availability strongly affects the intention of SMEs to implement AIS. Although many researchers' studies support organisational resource availability as one of the most important factors affecting innovation adoption, some researchers have found inconsistent results, implying that organisational resources may not be as important for adoption (Duan, Deng & Corbitt 2012; Dibrell, Davis & Craig 2008; Buonanno et al. 2005; Sarosa & Underwood 2005). Sarosa and Underwood (2005) conducted a study of IT adoption in SMEs and found that a lack of financial resources is not a barrier for IT adoption due to prices of basic IT hardware in Indonesia being relatively inexpensive. Also, the study by Buonanno et al. (2005) found organisational motivation to be the main obstacle in adopting ERP systems by SMEs, rather than financial constraints.

In this study, the organisational characteristics contain two constructs: Absorptive capacity and Organisational resource availability.

5.5.4 Characteristics of owner-managers

Characteristics of the owner-managers are another force that drives firms to adopt technological innovation. The literature reveals that the process of how potential adopters perceive innovation is one of the main determinants of adoption in many diffusion models (Ghobakhloo & Hong Tang 2013; Nguyen & Waring 2013; Chang & Tsia 2006; Wejnert 2002). According to Roger's DOI theory (1983), the innovation decision process is impacted by personal innovativeness. The common definition of innovativeness is the personal willingness of an adopter to trial and embrace an innovation in order to achieve a particular objective (Shih & Venkatesh 2004; Hirschman 1980). Parasuraman (2000) claims that personal innovativeness with the risk-taking tendency exists in certain individuals who take more risk in adopting an innovation than others. In the organisational context, innovativeness in decision-makers can be applied to explain why some companies act earlier in adapting innovation in their market than others.

Many empirical studies support the idea that owner-managers' innovativeness is important to IT decision adoption (Ghobakhloo & Hong Tang 2013; Al-Qirim 2007; Scupola 2003; Thong 1999; Agarwal & Prasad 1998). For example, in a study of small businesses' decisions in adopting new IT, Thong (1999) pointed out that the characteristics of a CEO (whether innovative or conservative and risk averse or risk seeking) are significantly associated with the decisions of a company to adopt or resist new IT. Another study by Agarwal and Prasad (1998) on user perceptions in IT adoption found that CEOs with higher personal innovativeness are more open to developing positive attitudes towards IT adoption than their less innovative contemporaries. Scupola (2003) found the more innovativeness of the owner-manager, the more possibility that electronic commerce will be adopted. A recent study by Nguyen and Waring (2013) and Ghobakhloo and Hong Tang (2013) also supports the idea that CEO characteristics in terms of innovativeness highly impact IT adoption.

In addition to the innovativeness, the IT knowledge of owner-managers has been examined in many research studies (Chao & Chandra 2012; Yu & Tao 2009; Lin & Lee 2005; Mirchandani & Motwani 2001; Thong 1999). Thong (1999) found that CEOs who are more IT knowledgeable are more inclined to adopt IT. Greater CEO knowledge in IT will decrease the degree of uncertainty and lead to lower risk in IT adoption. This view has been reinforced by many other researchers, including Mirchandani and Motwani (2001) who examined e-commerce adoption among small businesses. They identified a CEO's IT knowledge as a key factor highly associated with IT adoption in organisations. Another study conducted by Lin and Lee (2005) also claimed that CEOs will have more capability to deal with technology adoption when they gain knowledge of new technology. This implies that the more experienced top management is, the more open they are to investment in innovation activities. Another study by Wainwright, Green and Yarrow (2005) highlights that IT knowledge, IT skills, and IT practices in top management are key determinants of whether to adopt or reject by potential users. More recently, Chao and Chandra (2012) conducted a study in US small firms and found strong evidence supporting the positive impact of owners' IT knowledge capability on strategic alignment and IT adoption.

Based on the above-mentioned literature, two constructs under the characteristics of owner-managers are examined in this study: Owner-managers' innovativeness and IT knowledge.

In summary, it can be seen that a rich variety of factors have been identified as drivers impacting on organisations' adoption of technological innovations. Moreover, the majority of technological adoption research studies have been based on the diffusion of innovation as their theoretical foundation (Ghobakhloo & Hong Tang 2013; Nguyen & Waring 2013; Ifinedo 2011; Wang, Wang & Yang 2010). Therefore, in order to understand technological innovation adoption in organisations, the conceptual model of a comprehensive research framework has been developed from the models of Tornatzky and Fleischer (1990), Rogers (1995) and Thong (1999). The driving factors for technology adoption identified by previous researchers can be categorised into four main groups: Technological innovation, Environmental, Organisational, and Owner-managers, as summaried in Table 5.1.

Table 5.1: Selected papers on broad categories of factors of technological innovations' adoption by organisations

	Characteristics			
	Technological innovation	**Environment**	**Organisation**	**Owner-managers**
Fink (1998)	Yes	Yes	Yes	
Thong (1999)	Yes	Yes	Yes	Yes
Kuan and Chau (2001)	Yes	Yes	Yes	
Kumar, Maheshwari and Kumar (2002)		Yes	Yes	
Lertwongsatien and Wongpinunwatana (2003)	Yes	Yes	Yes	Yes
Scupola (2003)	Yes	Yes	Yes	Yes
Dholakia and Kshetri (2004)	Yes	Yes		
Hwang et al. (2004)		Yes	Yes	Yes
Kim and Galliers (2004)	Yes	Yes	Yes	
Al-Qirim (2007)	Yes	Yes	Yes	Yes
Pan and Jang (2008)	Yes		Yes	
Ramamurthy, Sen and Sinha (2008)	Yes		Yes	
Soares-Aguiar and Palma-dos-Reis (2008)	Yes	Yes	Yes	
Chang et al. (2010)	Yes	Yes	Yes	Yes
Jang (2010)	Yes	Yes	Yes	Yes
Wang, Wang and Yang (2010)	Yes	Yes	Yes	
Ghobakhloo, Arias-Aranda and Benitez-Amado (2011)	Yes	Yes	Yes	Yes
Ifinedo (2011)	Yes	Yes	Yes	Yes
Lin (2013)	Yes	Yes	Yes	Yes
Nguyen and Waring (2013)			Yes	Yes
Ramdani, Chevers and Williams (2013)	Yes	Yes	Yes	Yes
Sila (2013)	Yes	Yes	Yes	Yes

Table 5.2: Selected research findings on determinants of technological innovations' adoption by organisations (a more detailed view)

	Technological Innovation	**Characteristics of Technological Innovation**	**Characteristics of Environment**	**Characteristics of Organisation**	**Characteristics of Owner-managers**
Fink (1998)	IT	IT benefits	External environment, outside support, external resources	Organisational culture, in-house IT expertise and resources, IT implementation and selection	
Thong (1999)	IT	Relative advantage, compatibility, complexity	Competitiveness	Business size, employees' knowledge	CEO's IT knowledge and innovativeness
Kuan and Chau (2001)	Electronic data interchange	Perceived direct benefits	Perceived industry pressure, perceived government pressure	Perceived financial cost, perceived technical competence	
Kumar, Maheshwari and Kumar (2002)	ERP systems		IT skills from vendors	Firm size, sector time	
Lertwongsatien and Wongpinunwatana (2003)	Electronic commerce	Perceived benefits, perceived compatibility	Competitiveness	Firm size, existence of IT department	Top management support
Scupola (2003)	Electronic commerce	Electronic commerce barriers, electronic commerce benefits, related technologies	Competitive pressure, customer/supplier pressure, role of government	Employees' IS knowledge	Top management attitude
Dholakia and Kshetri (2004)	Internet systems	Prior experience with technology	Customer, perceived competitive pressure		
Hwang et al. (2004)	Data warehouse technology		Competitive pressure, selection of vendors	Firm size, IT champion, internal needs	Top management support
Kim and Galliers (2004)	Internet systems	Internal system factors	External technical factors, external market factors	Internal organisation factors	
Al-Qirim (2007)	Electronic commerce	Image	Pressure from suppliers/buyers		CEO's innovativeness
Pan and Jang (2008)	ERP systems	Technology readiness, production and operation improvement		Firm size, perceived barrier	

Table 5.2: Selected research findings on determinants of technological innovations' adoption by organisations (continued)

	Technological Innovation	**Characteristics of Technological Innovation**	**Characteristics of Environment**	**Characteristics of Organisation**	**Characteristics of Owner-managers**
Ramamurthy, Sen and Sinha (2008)	Data warehouse technology	Relative advantage, complexity		Commitment, firm size, absorptive capacity	
Soares-Aguiar and Palma-dos-Reis (2008)	Electronic-procurement systems (EPS)	Technology competence	The extent of adoption among competitors, the readiness of the trading partners to perform electronic transactions	Firm size, the perception companies have about the EPS success of their competitors	
Chang et al. (2010)	ERP	Complexity, compatibility, cost	Business competition	Employees' IT skills, firm size	CEO's innovativeness, CEO's IT knowledge
Jang (2010)	RFID	Perceived benefits, standardisation	Environmental uncertainty, competitive pressure, inter-organisational cooperation	IT knowledge capability	Top management support
Wang, Wang and Yang (2010)	RFID	Complexity, compatibility	Competitive pressure, trading partner pressure	Firm size	
Ghobakhloo, Arias-Aranda and Benitez-Amado (2011)	Electronic commerce	Perceived relative advantage, perceived compatibility	Buyer/supplier pressure, vendor selection, competition	Information intensity	CEO's innovativeness
Ifinedo (2011)	Electronic commerce	Relative advantage	External pressure	Organisational readiness	Management support
Lin (2013)	Electronic supply chain	Perceived benefits, perceived cost	Competitive pressure	Absorptive capacity	Top management support
Nguyen and Waring (2013)	CRM			Employee involvement, firm size, the perceived market position	Management's innovativeness
Ramdani, Chevers and Williams (2013)	Enterprise system	Relative advantage, compatibility, complexity, trialability, observability	Competitive pressure	Organisational readiness	Top management support
Sila (2013)	B2B e-commerce	Costs, network reliability, data security, scalability	Pressure from trading partners, pressure from competitors		Top management support

5.6 Chapter summary

The theoretical background of the diffusion of innovation theory and literature relating to the adoption of technological innovation was presented in this chapter. The multiple perspective frameworks based on three prominent adoption models, namely DOI theory, TOE model, and the information systems adoption model for small business were selected as the foundation for the development of the conceptual model used in this study. Studies related to the adoption of technological innovation in an organisation were reviewed.

Based on reviewing previous studies in this research domain, eleven enabling factors were extracted. Five factors under technological characteristics include relative advantage, complexity, compatibility, trialability and observability. Two factors under environmental characteristics include competitive pressure, selection of vendors. Two factors under organisational characteristics include absorptive capacity and organisational resource availability. Two factors under owner-manager characteristics include owner-managers' innovativeness and owner-managers' IT knowledge. These factors were then categorised into one of four meta-characteristics: specifically technological, environmental, organisational, and owner-managers.

Information from this chapter was used to develop the research model and hypotheses presented in the next chapter. The hypotheses were formulated to test the relationship between the eleven enabling factors and the adoption of BI technologies by Thai SMEs.

CHAPTER 6: FORMULATION OF HYPOTHESES

6.0 Introduction

Based on the discussion of theories pertaining to IT adoption in Chapter 5, this chapter presents the research model and formulates the hypotheses for this study. The first section presents the conceptual framework for the adoption of business intelligence (BI) in Thai SMEs. Next, as BI systems have not been widely adopted in SMEs, and factors affecting its adoption have not yet been fully investigated, the second section reviews prior studies related to BI adoption in enterprises of all sizes. Results from reviewing these studies are then set as a background from which to generate the hypotheses for this study. Based on this comprehensive framework, eleven potential driving factors affecting innovation adoption are covered under four key characteristics (Technological, Environmental, Organisational, and Owner-managers). Operational hypotheses are then formulated for each characteristic. Of the eleven potential driving factors, five hypotheses are under technological characteristics, two under environmental characteristics, two under organisational characteristics, and two under owner-manager characteristics. Lastly, a summary of the proposed hypotheses for this thesis is presented.

6.1 Research model for empirical investigation

Based on the previous review of research studies, this study categorises the driving factors of BI into four main characteristics (Technological, Environmental, Organisational, and Owner-managers) as disscused in Section 5.5. These characteristics are analysed and evaluated to determine whether or not they affect the adoption of BI.

6.1.1 Technological characteristics

Many studies used technological characteristics as a criteria for determining the level of IT adoption in a business (Ramdani, Chevers & Williams 2013; Chang et al. 2010; Hua, Rajesh & Theng 2009; Chen 2003). According to Rogers (1995), attributes affecting the adoption of technological innovation are: relative advantage, compatibility, complexity, trialability, and observability. Chen (2003) employed these attributes to examine E-businesses and discovered that these attributes have a strong influence on the adoption of E-business. In the conceptual framework of this study (refer Figure 6.1), technological characteristics include the possible factors affecting BI adoption as Relative advantage, Complexity, Compatibility, Trialability and Observability.

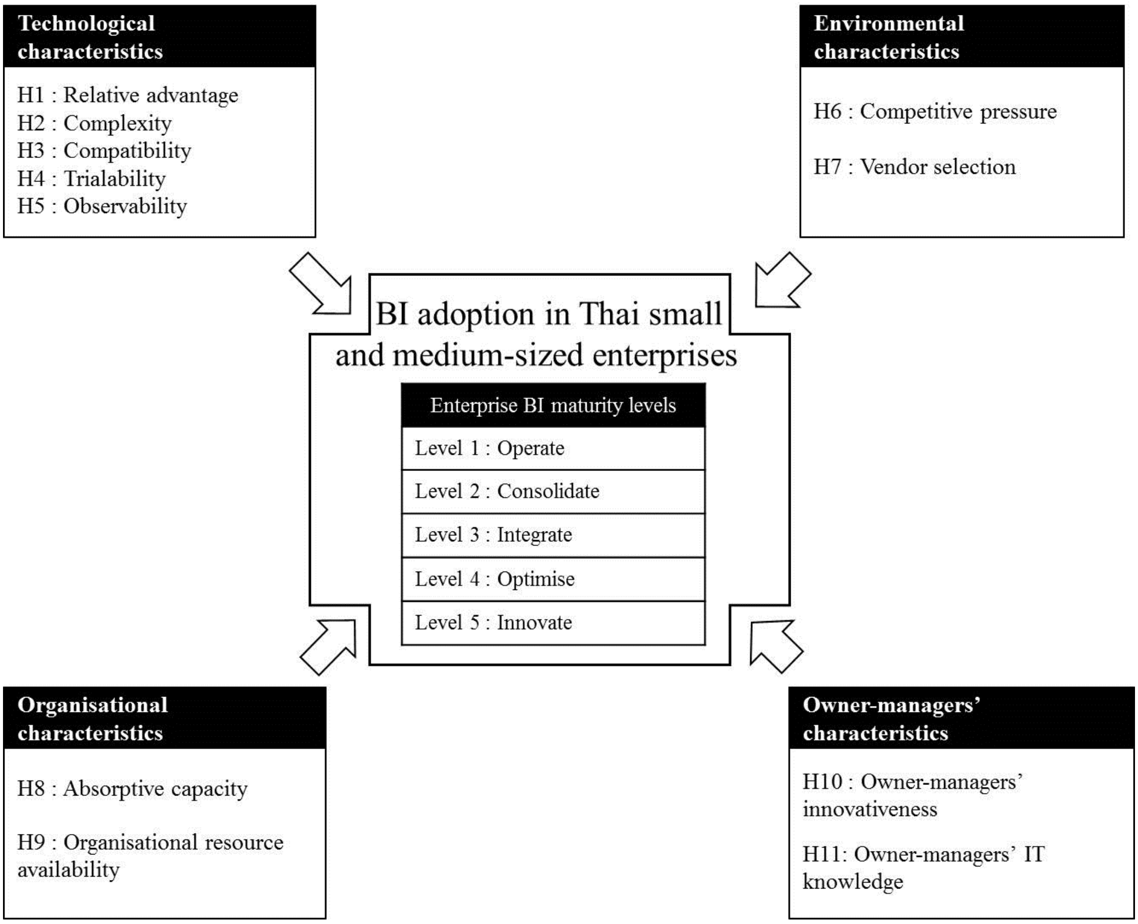


Figure 6.1: Conceptual framework of factors affecting the adoption of BI in Thai SMEs

6.1.1.1 BI's relative advantage

Relative advantage is one of the key drivers of innovation adoption and can be determined by the degree to which an innovation is perceived as being better than existing ideas or systems (Rogers 1995). Prior research studies indicate that BI technology can offer several advantages to firms (Khan, Amin & Lambrou 2010; O'Brien & Kok 2006). For example, retail companies can use data analysis tools in BI technology to find the profitable products and locations for their retail outlets. The banking industry can use BI to create better processes for checking credentials and generating the credit reports of customers. Also, by using complicated BI tools, banks are better able to detect money laundering where criminals attempt to hide and disguise the true origin and ownership of the proceeds of their criminal activities, and by this means avoid prosecution, conviction and confiscation of the criminal funds (Khan, Amin & Lambrou 2010). However, in spite of these benefits, *Information Week* (cited in Khan, Amin & Lambrou 2010) conducted a study of 388 technology professionals in the United States in 2007 and revealed that more than 30% of respondents claimed that BI vendors were unable to explain the benefits of BI to their stakeholders. They found that when BI vendors had no ability to explain the benefits of BI, customers did not adopt BI applications. Furthermore, a study by O'Brien and Kok (2006) found that the full benefits of BI are not entirely understood by firms due to lack of communication. In brief, the researcher posits:

Hypothesis 1: BI's relative advantage affects BI adoption in Thai SMEs.

6.1.1.2 BI's complexity

According to Rogers (1995), complexity is determined by the degree to which an innovation is perceived as difficult to understand and use. Other researchers have found that complexity is a barrier to innovation adoption (Chang et al. 2010; Alam et al. 2008; Sahay & Ranjan 2008; Bradford & Florin 2003). Ramamurthy, Sen and Sinha (2008) found that lower complexities in a technology resulted in higher positive effects on the adoption of data warehousing solutions. For instance, due to the high complexity of BI technology, employees resisted its adoption and continued to use traditional spreadsheet technologies (The Economist Intelligence Unit 2007). Voicu, Zirra and Ciocirlan (2009) confirmed that BI models are highly complicated because they integrate mathematical functions to predict trends in a firm's performance to provide solutions in a variety of situations. Therefore, users with a weak IT and computing knowledge require simple and stable solutions that will meet their needs in the shortest time. Hence, the researcher conjectures:

Hypothesis 2: BI's complexity affects BI adoption in Thai SMEs.

6.1.1.3 BI's compatibility

Compatibility is the degree to which an innovation is perceived to be consistent with existing values, past experiences, and needs of possible adopters (Rogers 1995). Several researchers have shown that BI systems are the expansion of ERP systems, with improved performances in consolidating, transforming and analysing data (Hawking & Sellitto 2010; Radding 2000). Moreover, Voicu, Zirra and Ciocirlan (2009) regarded ERP systems as the minimal prerequisite for implementing BI tools. Firms that have already implemented ERP systems need to decide whether to employ their ERP vendors to advise them on reducing compatibility-related problems, or use another BI vendor (Radding 2000). *Business Intelligence Guide* (2009) reported that 40% of the BI project costs were generated by the development of analytics and the transformation of data between systems. Furthermore, when the existing systems are not compatible with BI technologies, it can take a significant investment of time and resources to migrate and integrate data. The resultant high costs in money and time in these compatibility-related problems can clearly become a barrier to BI adoption. As a result, Khan, Amin and Lambrou (2010) found that BI project costs are the main concern in adopting BI. Thus, the researcher proposes:

Hypothesis 3: BI's compatibility affects BI adoption in Thai SMEs.

6.1.1.4 Trialability

Trialability is the extent to which potential adopters have the opportunity to experiment with an innovation (Rogers 1995). The higher the trialability, the more comfortable the potential adopters are with the technology and the more likely will be its adoption. Therefore, if BI providers give potential users opportunities to experience BI systems before adoption, doubts related to the unknown will be diminished. A number of empirical studies have confirmed that the perceived trialability of an innovation had an impact on potential user adoption of diverse IT such as information retrieval systems (Venkatesh & Morris 2000), B2B e-marketplaces (White et al. 2007), and e-learning (Zhang et al. 2010). Based on a study of B2B adoption in healthcare industries, White et al. (2007) found that trialability was important in decisions for adoption, in which hospital professionals test new procedures before rolling out B2B procedures more widely. Moreover, in a study of electronic data interchange (EDI) adoption, Jimenez-Martinez and Polo-Redondo (2004) found that trialability was a catalyst in the adoption speed because potential users can experiment with using the innovation, which enables them to improve their perceptions and benefits without any risks. In the context of SMEs, Kendall et al. (2001) found that trialability is another significant technological factor influencing the adoption of e-commerce. Based on a survey of 102 SMEs located in the Northwest of England, Ramdani, Chevers and Williams (2013) found that trialability has an impact on the adoption of enterprise systems, including ERP, CRM, SCM and e-procurement. However, the present study has not found any evidence to confirm that the trialability of BI systems will have any impact on their adoption. To remain consistent with the literature review and the diffusion of innovation (DOI) theory, this study has made the decision to maintain this factor. Thus, the researcher proposes:

Hypothesis 4: Trialability affects BI adoption in Thai SMEs.

6.1.1.5 Observability

Apart from trialability, a number of studies have found that observability has an impact on the adoption of various innovations, such as spatial decision support systems (SDSS), a computer-based system designed to assist planners to analyse spatial data (information tied to geographic location) for making land use decisions (Peterson 1998), e-commerce (Ling 2001), communication technology (Ilie et al. 2005) and mobile phone adoption (Wei & Zhang 2008). Here, observability means the degree that potential adopters of an innovation can perceive the results of using that innovation from users who have already adopted it (Rogers 1995). Lundblad (2003) claims that the visible results of an innovation affect the perceptions of its value by both individuals and communities. Moreover, the visibility of results stimulates them to communicate about the innovation, as peers were found to frequently request information related to the evaluation of an innovation. Therefore, readily observable innovation effects normally lead to rapid adoption. In a study on e-commerce adoption by Alam et al. (2008), a survey was conducted among 194 electronic manufacturing firms in Malaysia in which 75% were SMEs, to show that observability is a significant factor in e-commerce adoption. This finding was supported by Hua, Rajesh and Theng (2009) who found that the determinants of e-commerce adoption among SMEs in Malaysia are impacted upon by observability. In the BI systems and other technologies related to BI, some researchers have also found that observability is significant to technologies' adoption. For example, Chiasson and Lovato (2001) found that the observability of decision support system (DSS) benefits appears to be a significant factor in DSS adoption. A study of BI adoption in telecommunications companies in Malaysia by Ahmad (2011) found that the perceived observability of BI has a positive effect on the success of BI deployment in companies. Thus, the researcher posits:

Hypothesis 5: Observability affects BI adoption in Thai SMEs.

6.1.2 Environmental characteristics

Based on an analysis of innovation literature, environmental factors are commonly used as a key determinant of innovation adoption (Damanpour & Schneider 2006). It is necessary to examine the influence of environmental factors before adopting a technology because business competitiveness and the selection of vendors influence the success of an innovation adoption (Ngai, Law & Wat 2008).

6.1.2.1 Competitive pressure

Due to recent dynamic changes in business environments, many firms now need to reduce uncertainties from surrounding situations and create competitive advantage by acquiring innovative technologies (Hwang et al. 2004). As the environment itself affects decisions for the utilisation of new technologies, many firms are forced to adjust their strategies, business processes, and technological implementation to conduct their business in a way that can increase competition (Curko, Bach & Radonic 2007). Many studies have found a strong relationship between the degree of competitive pressure and technology adoption (Alshawi, Missi & Irani 2011; Hwang et al. 2004; Lu & Mazouz 2000). For instance, Lu and Mazouz (2000) conducted a study on data warehousing technology in medical device manufacturers and found that IT adoption is directly related to the degree of competitive pressure. Another study on data warehouse technology adoption by Hwang et al. (2004) found that environmental attributes, including the degree of competitive pressure and vendor selection, were key factors in data warehouse adoption in the Taiwan banking industry. Hence, the researcher conjectures:

Hypothesis 6: Competitive pressure affects BI adoption in Thai SMEs.

6.1.2.2 Vendor selection

Besides competitive pressure, selecting a vendor is another environmental factor affecting the adoption of technology. Normally vendors are responsible for providing software, hardware, user training, and technical support to customers in order to maintain their smooth performance (Senn & Gibson 1981). A study by Hwang et al. (2004) found a relationship between BI vendor selection and technology adoption. As BI is different from other enterprise information technologies, it requires a tailored solution to suit each particular firm and industry, and not just a total package (Hill & Scott 2004). Kimball (1996) suggested that firms need to be careful to select a suitable BI vendor when deciding to outsource. In summary, the researcher posits:

Hypothesis 7: Vendor selection affects BI adoption in Thai SMEs.

6.1.3 Organisational characteristics

According to Tornatzky & Fleischer (1990), an organisation's structure and processes can constrain and facilitate an innovation adoption. In the context of technology adoption, a firm's characteristics play a significant role in the adoption decision. In the organisational characteristics, the possible factors affecting BI adoption are: absorptive capacity and organisational resource availability.

6.1.3.1 Absorptive capacity

Griffith, Sawyer and Neale (2003) define the absorptive capacity of an organisation as the ability of its members to utilise existing or pre-existing IT knowledge. This ability helps organisations to increase their recognition of the value of new and external technological information, and as a result, increase the economic benefits of the company. Moreover, absorptive capacity can be used as a predictor of whether the organisation has the ability to adopt innovation or not (Cohen & Levinthal 1990). In other words, BI technologies require the awareness and understanding of its users in recognising the potential for the development of IT within the firms' context (O'Brien & Kok 2006). O'Brien and Kok (2006) conducted a study on telecommunication firms in South Africa and found that many organisations were not utilising BI to its full potential due to staff lack of knowledge, shortage of technical skills, and lack of training. Therefore, the researcher posits:

Hypothesis 8: Absorptive capacity affects BI adoption in Thai SMEs.

6.1.3.2 Organisational resource availability

Organisational resource availability is another factor that many studies have identified to influence innovation adoption (Adler-Milstein & Bates 2010; Oliveira & Martins 2010b; Soares-Aguiar & Palma-dos-Reis 2008). Managers will support the adoption of new technology when capital, equipment, human resources and organisational time to implement technological innovation are available (Chong et al. 2009). For example, Scupola (2003) found that resource unavailability prevented Taiwan's SMEs from investing in ERP. Therefore, in the BI context, BI implementation normally requires financial resources and skilled workers due to its complexity and high cost (Sahay & Ranjan 2008). Hence, the researcher conjectures:

Hypothesis 9: Organisational resource availability affects BI adoption in Thai SMEs.

6.1.4 Owner-manager characteristics

The characteristics of owner-managers or chief executive officers (CEOs) play an important role in IT adoption decisions in SMEs. Ghobakhloo, Arias-Aranda and Benitez-Amado (2011) claim that SMEs generally have simple and highly centralised structures, with authority mainly being given to the CEO, and when the owner and the CEO are the same person. Thus the owner-manager is the sole decision-maker having a direct effect on decision processes ranging from daily functions to future investments (Nguyen 2009; Bruque & Moyano 2007; Jarvenpaa & Ives 1991). Many studies on SMEs suggest that the role of owner-managers is crucial to the organisation because their decisions influence all activities, both present and future (Smith 2007; Fuller-Love 2006; Thong 1999). This principle could be applied to the case of IT adoption decisions starting from the stage of system planning to its implementation, and future maintenance and upgrading (Nguyen 2009; Bruque & Moyano 2007; Fuller & Lewis 2002; Riemenschneider & McKinney 2001). These decisions are primarily based on the owner managers' experiential knowledge, which originally comes from an integration of existing competencies of knowledge, judgment, communication skills and personal experience (Carson & Gilmore 2000). Numerous studies have found that the greater understanding of IT that management has, the greater possibility that IT will be adopted and successfully implemented (Bassellier, Benbasat & Reich 2003; DeLone 1988). A study by Thong (1999) proposed that owner-managers who have innovativeness and IT backgrounds have more potential for success in IT adoption.

6.1.4.1 Owner-managers' innovativeness

Innovativeness is an influencing factor of owner-manager characteristics (Ghobakhloo & Hong Tang 2013). According to Agarwal and Prasad (1998), a tendency exists in certain individuals for intrinsic enthusiasm towards innovativeness when trying out new IT in order to achieve particular goals. In support of this argument, Nov and Ye (2008) found that personal innovativeness can be a reliable predictor of a user's attitude to the utilisation of new technologies. This claim is also in line with a study by Thong (1999), which found that owner-managers with personal innovativeness are more likely to adopt IT because they are less averse. As they have no one else to account to, they are free to apply distinctive and risky approaches, such as making IT structural changes that may have the potential to cause more problems. Numerous studies have identified that owner-managers' innovativeness is usually significant, which has a positive influence on IT adoption (Fogarty & Armstrong 2009; Jiang 2009; Mirchandani & Motwani 2001; Thong 1999; Thong & Yap 1995). For example, a study by Chang et al. (2010) found that a CEO's innovativeness is a significant determinant in ERP adoption for SMEs. Similarly, a survey of 325 manufacturing SMEs located in the central industrial sector of Iran found that the innovativeness of an owner-manager significantly impacts on their e-commerce adoption (Ghobakhloo & Hong Tang 2013). Based on this literature, although it can be seen that owner-managers' innovativeness strongly affects the adoption decision of various technologies, a limited number of studies have been conducted that investigate the relationship between owner-managers' innovativeness and the adoption of BI systems. Hence, the researcher conjectures:

Hypothesis 10: Owner-managers' innovativeness affects BI adoption in Thai SMEs.

6.1.4.2 Owner-managers' IT knowledge

The IT knowledge and experience of owner-managers is another trait impacting on the adoption of IT in SMEs (Ghobakhloo, Arias-Aranda & Benitez-Amado 2011; Drew 2003; Fink 1998). Thong and Yap (1995) claimed that owner-managers who have more IT knowledge will be more likely to adopt an innovation. Moreover, higher levels of IT knowledge in owner-managers can decrease the degree of uncertainty involved in their IT investment. This in turn will increase their confidence in adopting new technologies and lower the risk of IT implementation (Thong 1999). Similarly, a study by Palvia and Palvia (1999) found that the owner-managers will be more satisfied with the implementation of IT when they have high levels of computer skills, whereas the satisfaction of IT implementation will be reduced when the owner-managers have lower computer skills. A number of more recent studies have also found strong correlations between owner-managers' IT knowledge and IT adoption (Chao & Chandra 2012; Chan & Ngai 2007; Jeon, Han & Lee 2006). For example, Chao and Chandra (2012) conducted a survey with 217 small manufacturers and financial services organisations in the USA and found that the level of owner's IT knowledge is a key predictor of both IT adoption and IT strategic alignment. Interestingly, Chao and Chandra (2012) found that although owner-managers' IT knowledge can increase the possibility of IT adoption in organisations, advanced IT applications, including CRM and BI, have received quite low rates of adoption among smaller firms due to having critical constraints of resources. They suggest that these smaller firms can overcome this problem by considering the on-demand applications which are available in CRM and BI. In summary, the researcher posits:

Hypothesis 11: Owner-managers' IT knowledge affects BI adoption in Thai SMEs.

6.2 Summary of hypotheses

The above hypotheses have been developed by relating theoretical foundations and prior studies. In particular, there are five hypotheses (H1–H5) within the technological characteristics, two hypotheses (H6–H7) within environmental characteristics, two hypotheses (H8–H9) within organisational characteristics, and two hypotheses (H10–H11) within owner-managers' characteristics. Collectively, eleven hypotheses have been proposed and will be tested. All eleven hypotheses are summarised in the following table.

Table 6.1: Summary of proposed hypotheses

Characteristics	Enabling factors	Hypotheses
Technological innovation	Relative advantage	H1: BI's relative advantage affects BI adoption in Thai SMEs
	Complexity	H2: BI's complexity affects BI adoption in Thai SMEs
	Compatibility	H3: BI's compatibility affects BI adoption in Thai SMEs
	Trialability	H4: Trialability affects BI adoption in Thai SMEs
	Observability	H5: Observability affects BI adoption in Thai SMEs
Environment	Competitive pressure	H6: Competitive pressure affects BI adoption in Thai SMEs
	Vendor selection	H7: Vendor selection affects BI adoption in Thai SMEs
Organisation	Absorptive capacity	H8: Absorptive capacity affects BI adoption in Thai SMEs
	Organisational resource availability	H9: Organisational resource availability affects BI adoption in Thai SMEs
Owner-managers	Owner-managers' innovativeness	H10: Owner-managers' innovativeness affects BI adoption in Thai SMEs
	Owner-managers' IT knowledge	H11: Owner-managers' IT knowledge affects BI adoption in Thai SMEs

6.3 Chapter summary

In this chapter, the development of the hypotheses to be tested in this study was discussed. Based on the research framework, eleven enabling factors under four characteristics were transformed to eleven hypotheses that related to the impact of factors to BI adoption in Thai SMEs. Five hypotheses were categorised under the technological characteristics, two under the environmental characteristics, two under the organisational characteristics, and two under owner-manager characteristics. A summary of the hypotheses was also provided.

In the next chapter, the research methodology used to test the hypotheses developed from the conceptual framework outlined in this chapter will be presented. Sampling procedures applied for producing a suitable list of sample organisations and ethical considerations pertaining to the data collection will also be provided.

CHAPTER 7: RESEARCH METHODOLOGY

7.1 Introduction

Chapter 6 detailed the conceptual framework and hypotheses of this study. This chapter describes the research methodology undertaken in order to empirically test the hypotheses derived from the conceptual framework. The first section justifies the research paradigm, while the next section explains the rationale for the quantitative research methodology and questionnaire approach used in this study. Next, the sampling procedures including the methods of selection of the target population, sample frame, sample size and sample techniques are described. Then, for preparing the self-administered questionnaire of this study, previous related studies are reviewed to construct a questionnaire. Pre-testing and pilot testing are also applied to determine the validity and reliability of the questionnaire instrument. Then, ethical considerations pertaining to the data collection and procedures are examined. Finally, the chapter is summarised before proceeding to Chapter 8.

7.2 Justification of the research paradigm

A paradigm is 'a basic belief system or worldview that guides the investigator' (Guba & Lincoln 1994, p. 105) to reflect a philosophic view of world reality, the philosophy of knowledge, and the knowledge of methods and techniques needed to reach that knowledge (Neuman 2006). When comparing paradigms, including positivism, post-positivism, critical theory and constructivism, the oldest and most popular philosophical approach in the physical and social sciences is the ***positivism paradigm*** (Easterby-Smith et al. 2008). In accordance with a number of studies into marketing and information systems (Guba & Lincoln 2000), the positivism paradigm is used as the fundamental basis of this study. In this study, a quantitative approach of the questionnaire survey reflects the positivism paradigm.

Positivists assume that there is a single apprehensible reality which is controllably measurable, inherently understandable, objectively quantifiable, and outcome oriented (Kuhn 1996). In this paradigm, they concentrate on facts to investigate direct causes and effects, while remaining external to the events being examined. The positivism paradigm equates with formulating hypotheses for problem-solving (Buttery & Buttery 1991). Positivists use theories based on past empirical research to formulate and test hypotheses and theories that are used to set up causality (Zikmund 2003). In order to confirm or refute the proposed causality, empirical testing using a quantitative approach offering objective, value-free and unambiguous interpretations of reality is used (Guba & Lincoln 1994). According to Orlikowski and Baroudi (1991), research in the area of information systems is positivist when there is evidence of formal propositions; quantifiability; and measures of variance necessitating hypothesis testing and the drawing of inference about a phenomenon from a population sample.

As the aim of this study is to identify the relationships between IT adoption and enabling factors through testing hypotheses drawn from existing theory and empirical research, the fundamental paradigm of this study is best classified as positivist. Therefore, in order to reflect a positivism paradigm, this study has adopted a quantitative approach to obtain data.

7.3 Quantitative research methodology

Research methods are generally classified into two types, namely: quantitative and qualitative, with both offering different approaches for collecting and interpreting information or research data depending on the research being undertaken (Cherry 2000). The methods chosen should be suited to the subject under investigation and able to supply the information best matching the aims of the research (Collis & Hussey 2009). Although the qualitative approaches of interviews and observation are often used in conjunction with the quantitative approach (often described as ‘mixed methods’ studies), in this study a quantitative research methodology of questionnaires alone was considered the most suitable due to the large population under investigation.

The aim of quantitative research is to develop and employ mathematical models, theories and hypotheses pertaining to natural phenomena (Cavana, Delahaye & Sekaran 2001). Quantitative approaches offer a primary connection between empirical observation and the mathematical expression of quantitative relationships. Quantitative research has been utilised in a number of studies to measure and test hypotheses based on an empirical examination of dependent and independent variables employing statistical techniques (Neuman 2006).

According to Cavana, Delahaye and Sekaran (2001, p. 186), ‘measurement of the variables in the theoretical framework is an essential part of research and an important aspect of quantitative research design’. As a result, many researchers consider quantitative methods as the appropriate approach when examining relationships between several variable or factors (Bernard 2012; Cavana, Delahaye & Sekaran 2001). As this study investigates relationships between BI adoption and a range of enabling factors in Thai SMEs, a quantitative method has been regarded as the best appropriate approach.

This study attempts to examine the relationships between BI adoption and the enabling factors of technology, environment, organisation, and owner-manager in the context of Thai SMEs by testing the proposed hypotheses based on existing theory. This aligns with a number of quantitative researchers who have found that driving factors can impact on organisational decision-making in the adoption of technological innovation (Chang et al. 2010; Chaveesuk 2010; Shiau, Hsu & Wang 2009; Ramamurthy, Sen & Sinha 2008; Hwang et al. 2004; Duan & Kinman 2000). In this study, a quantitative technique utilising a postal questionnaire survey method was adopted to measure and collect data. This method allows the development of concrete numerical descriptions of respondents’ perceptions on a number of constructs. Also, it permits the relationships between constructs to be tested by adopting various statistical techniques as presented in section 7.6.

7.4 Questionnaire survey

In research into IT and decision support technologies in organisations, the most commonly used methodology is the questionnaire survey (Shiau, Hsu & Wang 2009; Ramamurthy, Sen & Sinha 2008; Hwang et al. 2004; Duan & Kinman 2000). Yin (1994) suggested two main reasons for using survey technique, which other techniques cnanot provide. For instance, a number of the research questions are related to ‘who’, ‘what’, ‘when’, ‘where’, ‘how many or how much’, and ‘to what extent’. These are appropriate for surveys, while the question type using ‘how’ and ‘why’ are suitable for a case study. The nature of questions in this research being investigated, for example ‘What is the most advanced analytical application your organisation has implemented?’ or ‘To what extent is your organisation open to change?’ are suitable for the use of a survey-based research approach.

The degree of focus upon contemporary events is another support to use a survey-based research approach. The survey method is selected in examining contemporary events as opposed to historical events (Yin 1994). This study emphasizes the ongoing contemporary issues of diffusion of IT (e.g. BI) and orwner-manager attitues (e.g. factors in adoption new IT). Furthermore, the survey-based research approach is preferred as it allows researchers to gain data from large populations in which responses can be simply coded and easily analysed (Sekaran 2006).

Although questionnaires can be either self-administered or by mail, in this study mail questionnaires were preferred due to their advantage of covering a large number of individuals and geographic areas at low expense of time and money. Further to this, mail questionnaires allow participants to complete the required information at their convenience, offering a better likelihood that they will take the time to think about their replies (Sekaran 2006; Zikmund 2003). Even so, mail survey questionnaires have some drawbacks. For example, the qualitative aspects of further explanation and enquiry are limited (Sekaran 2006). With this concern, pre-test and pilot tests of the questionnaire were conducted to ensure that participants could understand all the questions asked. Moreover, problems relating to the issue of confidentiality might prevent people from participating when using mail survey questionnaires (Sekaran 2006). To deal with this issue, the survey questionnaire in this study contained a covering letter stating that all data collected would be dealt with according to Victoria University requirements for anonymity and confidentiality. Furthermore, as the return rate of mail questionnaires is generally low, it can be difficult to achieve representativeness in the sample (Sekaran 2006). To assist with this concern, the researcher utilised much effort with the aim of getting a better response rate by providing an envelope addressed to a particular participant to make certain of successful delivery.

7.5 Sampling procedure

Although in some cases it is possible to collect and analyse data from every possible member of an interested population if the research focuses on a small group, most quantitative research employs sampling procedures because the group of interest is too large. Therefore, this study has used a questionnaire survey based on a sample of the population of interest to fulfil its research aims. In this process, a comprehensive research framework was developed to empirically examine the adoption of BI in SMEs through primary data collected from 2,000 owner-managers of SMEs. As the whole population of SMEs is a large group of interest, the sampling consideration has been crucial in achieving accurate conclusions reflecting SMEs' structures and characteristics. Several procedures were applied to produce a suitable list of sample organisations. The first procedure was to identify the target population that was most appropriate to the study aims. Following this, a sample frame suited to gaining access to the SME target population was identified and used to determine the sample size. Finally, appropriate sampling techniques were adopted to select the sample for data collection.

7.5.1 Targeted population

In this study the target population refers to the group of interest in the investigation, namely the sample population of SMEs. However, as this was extremely large, it would lead to unmanageable complexity and be unacceptably costly (Neuman 2006). Therefore, in order to avoid these obstacles, the target population for this study was limited to Thai enterprises that: 1) had no more than 200 employees and 2) were registered in the Office of Small and Medium Enterprises Promotion (OSMEP) database.

7.5.2 Sample frame

A sampling frame comprising the target group of SMEs for this study was designed to generate a relevant sample for the research. In this research, all SMEs listed in the OSMEP database were included in the sample frame. This database was deemed to be the most reliable as it lists the majority of Thai SMEs and there is no other more readily accepted and updated database (Chooprayoon, Chun Che & Depickere 2007). Also, this database is publicly available to people who are interested. They can send their requests to access the SME list, as was done by the researcher.

7.5.3 Sample size

In academic research, samples are used to make generalisations about populations (Saunders, Lewis & Thornhill 2009). Such samples are usually selected to represent a population of particular interest, with sample sizes generally being decided after considering matters of statistical precision, available resources of cost and time, and other practical issues

(Tabachnick, Fidell & Osterlind 2001). Whilst various approaches can be used to determine appropriate sample size, statistical formulas have now become increasing popular as they assist in creating a more precise degree of representativeness and allow researchers to have more confidence in generalising the findings (Saunders, Lewis & Thornhill 2009). In this study, the researcher chose the proportional stratified statistical formula of Yamane (1973) to calculate sample size, as this method uses a minimum sample size at a confidence level of 95%.

$$\text{Yamane's formula} \quad n = \frac{N}{1+N(e)^2}$$

n = the sample size

N = the number of population

e = the error rate of sample (the level of precision)

In applying this formula to the present study, N refers to the whole population of Thai SMEs, which is about 2.8 million. In determining a tolerable error rate for the sample, the commonly accepted five per cent has been adopted. Therefore, using the above formula, the researcher finds that:

$$n = \frac{2800000}{1+2800000(0.05)^2}$$

$$\text{or} \quad n = 399.942$$

Using this calculation, the minimum sample size is 400 organisations. However, as it is unlikely that this study can achieve a 100% response rate, the highest potential number of responses should be taken into consideration. Although the precise response rate is unknown, based upon previous research studies using email surveys, response rates are normally around eight to ten per cent (Dillman 2007; Hager et al. 2003). Therefore, as the response rate will be approximately twenty per cent, a new sample size has been calculated to achieve the new target number of respondents. This is calculated by the following formula known as the actual sample size (Saunders, Lewis & Thornhill 2009):

$$n^a = \frac{n \times 100}{re\%}$$

n^a = the actual sample size

n = the minimum sample size

re = the approximated response rate expressed as a percentage

Applying the formula to this study, the minimum sample size obtained is 400 and the approximated response rate is twenty per cent.

$$n^a = \frac{400 \times 100}{20\%}$$

$$n^a = 2{,}000$$

By this calculation, the actual sample size is 2,000. Therefore, the survey questionnaire was distributed to 2,000 respondents who are owner-managers or managers, with the expectation of receiving at least 400 responses.

7.5.4 Sampling techniques

After achieving the sample size presented in section 7.5.3, sampling techniques were applied to select the sample for data collection in two stages. In the first stage, the stratified sampling technique was employed to calculate the number of samples in each sector of Thai SMEs. In the second stage, a systematic sampling technique was used to draw samples from each industry.

7.5.4.1 First stage: stratified sampling technique

A stratified sampling technique is useful when the population is heterogeneous in the variables or characteristics under study. This sampling technique separates the population into two or more significant and relevant strata (Burns 2000). Consequently, the representative sample in this technique can be improved, at least in terms of the stratification variables, because the likelihood that the member in each strata can be included in the sample is increased (Babbie 2012). Based on the Thailand Ministry of Industry, SMEs can be defined into four industries, including manufacturing, service, wholesale and retail. This classification suggested that this study included four strata. However, as the numbers of SMEs in these four industries are unequal, in order to understand SMEs the proportion in each industry sample should be different. Based on this reasoning, stratified sampling was adopted in order to represent the population and allow generalisability of the results.

According to a 2011 annual report from OSMEP, the number of enterprises in Thailand was 2,924,912. Large companies accounted for only 0.4%, which is 11,745 enterprises, whereas SMEs accounted for 99.6% which is 2,913,167 enterprises (OSMEP 2011). Therefore, the sampling frame in this study contains a list of 2,913,167 SMEs. The list was divided into four categories by industry type. The number and percentage of SMEs in each industry are shown in Table 7.1.

Table 7.1: Number of SMEs in each industry

Industries	Number of enterprises	Percentage
Retail	1,136,160	39.00%
Manufacturing	545,098	18.71%
Service	983,610	33.76%
Wholesale	248,299	8.53%
All sectors	**2,913,167**	**100%**

In order to distribute the survey to the target 2,000 respondents, each industry has been allocated questionnaires based on proportion. Sample distribution for the SME categorised industry is shown in Table 7.2, with survey questionnaires distributed to 780 SME retailers, 374 SME manufacturers, 675 SME service providers, and 171 SME wholesalers.

Table 7.2: Sample size per SMEs categorised industry

Industries	Percentage of enterprises	Sample distribution
Retail	39.00%	780
Manufacturing	18.71%	374
Service	33.76%	675
Wholesale	8.53%	171
All sectors	**100%**	**2,000**

7.5.4.2 Second stage: Systematic sampling

After calculating the sample size based on each industry type, systematic sampling was used to calculate the sampling interval to select the sample population. This technique was used to enhance the probability of obtaining a representative sample and to avoid bias in the selection process, as this technique can spread the sample across the population members. Here, the formula used to calculate the sampling interval was N/n, when N is population size and n is sample size (Saunders, Lewis & Thornhill 2009). Application of this formula to the study is shown as:

Population size (N) = 2,239,280

Sample size (n) = 2,000

Sampling interval (N/n) = 2,239,280/2,000 = 1,119.64

Here, the sampling interval is 1,120 (rounded up from 1,119.64). In this study, the first randomly selected sample in the first sampling interval of 1 to 1,120 is the nineteenth SME in the alphabetically sorted list. The next sample would be SMEs number 1,139 (calculated 19 + 1,139). The sample population was selected at increasing intervals of 1,120 until a total sample population of 2,000 was reached. The same selection approach was used in all four sectors in order to ensure a representative percentage of each sector.

7.6 Development of the survey questionnaire

There were three stages in preparing the self-administered questionnaire of this study. Firstly, previous studies related to the areas of IT, BI, decision support systems and SMEs were adapted to initially construct a questionnaire suited to self-administration. Secondly, pre-testing of the questionnaire was conducted by five BI specialists in order to verify its content and identify any problems in the design. In the last stage, the modified pilot survey questionnaire was trialled to determine validity and reliability of the instrument (refer section 7.6.3). Following all these three steps, the statistical analyses were taken into consideration for a final revision of the survey questionnaire prior to distribution (see Appendix A). The subsequent sections present the development of the survey questionnaire in detail.

7.6.1 Questionnaire construction

The survey questionnaire in this study consisted of three main parts including: 1) general questions for collecting basic information of respondents and enterprises' profile; 2) questions related to the use of information in enterprises in order to classify their BI level; and 3) questions involving the driving factors for BI adoption.

7.6.1.1 Characteristics of respondents and enterprises

The first part of the survey questionnaire was designed to elicit basic information including demographics and enterprise profiles from respondents. This part used a combination of two scales: nominal and ordinal. The construction of questions in this part is summarised in Table 7.3

Table 7.3: Characteristics of respondents and enterprises

Construct	Item description	Measurement
Gender	Gender of respondent	Nominal scale 1) Male 2) Female
Age	Age group of respondent	Ordinal scale 1) 18 to 20 2) 21 to 30 3) 31 to 40 4) 41 to 50 5) More than 50 years old
Education	Education level of respondent	Ordinal scale 1) High school or equivalent 2) Vocational or diploma 3) Bachelor degree 4) Master degree or higher
Position	Position level of respondent	Ordinal scale 1) Owner-manager 2) Manager 3) Other
Industry sector	Industry sector of organisation	Ordinal scale 1) Manufacturing 2) Service 3) Wholesale 4) Retail

Construct	Item description	Measurement
Business experience	Time period that organisation has operated	Ordinal scale 1) Less than 1 year 2) 1–5 years 3) 6–10 years 4) More than 10 years
Size	Number of employees in the organisation	Ordinal scale 1) Sole proprietor 2) 2–9 3) 10–50 4) 51–100 5) 101–200
Location	Location	Nominal scale Bangkok and Vicinity Central Regions and Eastern Regions Northern Region Northeast Region Southern Region
Business activities	Business activities supported by computer software	Nominal scale Financial accounting Stock control Production planning Customer management Marketing mix Market research Profit forecasting Strategic analysis Cash flow forecasting Sales planning Staff planning Other

7.6.1.2 Classification of BI levels

The purpose of part two of the questionnaire was to classify the BI level of SMEs. Questions were created from the information evolution model (IEM) checklist provided by SAS (Davis, Miller & Russell 2006). As this enhanced model classifies organisations into five levels of BI's using five dimensions, five constructs representing each dimension and five values in the measurement representing each level of BI were adopted, with respondents being asked to choose the answers that best describe their organisations. The total sum of frequencies in values given by respondents was used to classify their organisations into five levels of BI adoption, ranging from the lowest to highest as *operate, consolidate, integrate, optimise, and innovate* (see Table 3.3 in Chapter 3 showing the five levels of BI across five dimensions). Organisations were categorised as an 'operate organisation' when the respondents frequently choose the first answer in each question. On the other hand, organisations were categorised as an 'innovative organisation' when the respondents frequently choose the last answer in each question. However, as BI defined in this study covers a broad category of processes, applications, and technologies, the term BI here includes application, irrespective if SMEs use software package, stand alone application or systems which have the BI function. Table 7.4 provides all constructs in this part.

Table 7.4: Classification of BI levels

Construct	Item description	Measurement (Ordinal scale)
Infrastructure	Where is your organisation data stored?	Organisational information resides in: 1) personal desktop computers 2) functional desktop computer or a functional server 3) databases that can be easily shared between functional areas 4) an enterprise system that supports multiple databases 5) flexible systems that can keep structured and unstructured data
Knowledge process	What is the knowledge process within your organisation?	Knowledge process in the organisation can be described as: 1) individual employees develop their own processes to manage data 2) employees in the same functional area share the same processes in managing data 3) all functional areas in the enterprise use the same processes to manage data 4) the processes for managing data are standardised and in line with outside enterprises 5) not only standardised processes, but also enterprise plans aim to establish new processes to support forthcoming new innovations

Table 7.4: Classification of BI levels (continued)

Construct	Item description	Measurement (Ordinal scale)
Human resources	How do your employees use the decision-making software?	The majority of staff members: 1) lack computer skills and often make decisions based on their experience 2) rely on some other staff with computer skills to manage and analyse data 3) have the ability to use computer software in managing and analysing data 4) have the ability to use advanced decision-making software 5) have expertise in using the advanced decision-making software
Culture	To what extent is your organisation open to change?	Organisational culture can be viewed as: 1) change is feared among employees 2) employees will accept change if it leads to benefits for them or their group 3) employees are used to change and accept change when it is clearly understood 4) employees view change as an opportunity rather than a threat 5) previous changes to business process that have failed, but that lead to learning, are accepted without rebuke or punishment
Application	What is the most advanced analytical application your organisation has implemented?	The organisation has implemented: 1) basic software programs to generate reports 2) software programs that can keep data in a standardised format and allow queries with a limited user view 3) software programs that can keep the whole organisational data in a standardised format and allow queries with a multidimensional view of data 4) software programs that can identify useful information, detect relationships in the data and provide predictive results 5) software programs that allow users to keep track of what is currently happening and can generate an automated exception reporting when something unusual occurs

7.6.1.3 Conceptual measurement

The questions in this part were developed based on the conceptual framework which is discussed in Chapter 5. The constructs are divided into four groups in line with the four contexts presented in the conceptual framework, namely: *technology, environment, organisation, and owner-manager*. All constructs were measured by implementing a Likert rating scale because this scale is suitable for measuring beliefs, feelings or attitudes (Singleton Jr & Straits 1999).

5-point Likert scales ranging from 'strongly disagree' to 'strongly agree' were selected for use in this section. However, the optimal number of scale points has been debated among researchers. For example, Churchill Jr and Peter (1984) claim that the more scale points used in the questionnaire, the more reliable the scale with fewer points resulting in lower reliability. Similarly, Dawes (2008) argued that more than seven points on a scale is too much for respondents as most people are not able to make clear judgments on scales larger than seven. The reasons for selecting the five points are supported by previous studies. Many researchers acknowledge that the five to seven-point scale is the best number range to capture the respondents' opinion (Malhotra 2008). However, a number of researchers point out that the five-point scale is just as good as any other (Sekaran 2006; Parasuraman, Zeithaml & Berry 2004). Moreover, some researchers claim that an increase in scale does not increase the reliability of the rating (Elmore & Beggs 1975); conversely this may cause respondents' confusion (Hair, Bush & David 2003).

Based on the review of literature related to the driving factors of BI adoption in large organisations and innovation adoption in SMEs, the constructs and items in this study were validated for adoption in order to measure the conceptual model (Chaveesuk 2010; Hung et al. 2010; Ramamurthy, Sen & Sinha 2008; Park & Chen 2007; Grandon & Pearson 2004; Hwang et al. 2004; Thong 1999; Iacovou, Benbasat & Dexter 1995; Moore & Benbasat 1991). However, as the term BI might well be new to SME owner-managers, the item description for each construct was adjusted to avoid the difficulty by focusing upon the functions and activities that might be supported rather than requiring a common understanding of the term BI. Therefore, this study uses the word 'technology' to refer to BI, as previously defined in Chapter 3. The adjustment of item descriptions also made the questions more consistent. However, the measurements that were used in each item were designed to specifically focus on BI such as 'This technology provides competitive information and improves decision-support' and 'this technology monitors problems and provides solutions in real-time'. These relative advantages in providing competitive information, improving decision making and providing solution in real-time are from the implementation of BI technology. However, some measurements are generic and can be used to measure other technologies and can similarly be used to measure BI as well. For example, 'The process of introducing this technology was complicated'. This is due to the fact that BI is an instance of innovation technology. Table 7.5 presents the questions used to measure the four aspects presented in the conceptual framework of this study, focusing on BI adoption in SMEs.

Table 7.5: Conceptual measurement items adopted in all contexts of this study's framework

Construct	Item description
Technological context	
Relative advantage (based on Chaveesuk 2010; Moore & Benbasat 1991)	1. This technology enables your company to reduce the cost of operations. 2. This technology provides competitive information and improves decision-support. 3. This technology accomplishes tasks that allow us to enhance business strategies. 4. This technology monitors problems and provides solutions in real-time.
Complexity (based on Chaveesuk 2010; Moore & Benbasat 1991)	1. The process of introducing this technology was complicated. 2. The operation of this technology was considerably complicated to implement and use within your firm. 3. This technology was difficult to learn. 4. Considerable resistance existed within the firm towards the use of this technology.
Compatibility (based on Chaveesuk 2010; Moore & Benbasat 1991)	1. Using this technology fits well with how the company functions. 2. Using this technology is consistent with our firm's values and beliefs. 3. This technology is compatible with the organisation's IT infrastructure. 4. The changes introduced by this technology are compatible with existing operating practices.
Trialability (based on Park & Chen 2007; Moore & Benbasat 1991)	1. Company employees were able to trial this technology before the adoption decision was made. 2. Company employees were able to **adequately** trial this technology before the adoption decision was made. 3. I was able to try out this technology before the adoption decision was made. 4. I was able to try out this technology **adequately** before the adoption decision was made.
Observability (based on Moore & Benbasat 1991)	1. I have seen this technology used in other firms. 2. I was aware of the existence of this technology in the market. 3. I would have no difficulty telling others (employees, business partners) about the results of using this technology after seeing it in operation. 4. The results of using this technology were apparent to me before it was adopted.

Table 7.5: Conceptual measurement items adopted in all contexts of this study's framework (continued)

Construct	**Item description**
Environmental context	
Competitive pressure (based on Grandon & Pearson 2004; Hwang et al. 2004)	1. The degree of competition in our industry placed pressure on the firm's decision to adopt this technology. 2. I knew that my competing rivals were already using this technology. 3. The firm needed to utilise this technology to maintain its competitiveness in the market. 4. It was a strategic necessity to use this technology.
Vendor selection (based on Chaveesuk 2010; Hwang et al. 2004)	1. The vendors' reputation was important in selecting this technology. 2. The relationship between technology vendor and customers was important. 3. The capability of the technology vendor to plan and complete the project was important. 4. The technological competency of the vendor was significant.
Organisational context	
Absorptive capacity (based on Chaveesuk 2010)	1. Key users of this technology understood what this technology could do for the company. 2. Key users needed extensive training to develop skills and to understand the use of this technology. 3. There were hardly any major knowledge barriers in using this technology. 4. Key users were technically knowledgeable in exploiting these technology capabilities.
Organisational resource availability (based on Iacovou, Benbasat & Dexter 1995)	1. The firm had the technological resources to adopt this technology. 2. The firm provided financial resources to adopt this technology. 3. Other organisational resources (e.g. training, IS support) contributed to build higher levels of this technology adoption. 4. There were no difficulties in finding all of the necessary resources (e.g. funding, people, time) to implement this technology.
Owner-manager context	
Owner-managers' innovativeness (based on Hung et al. 2010; Thong & Yap 1995)	1. I always introduce new and original ideas. 2. I always look for something new rather than improving something existing. 3. I would sooner create something new than improve something existing. 4. I often have a fresh perspective on old problems.
Owner-managers' IT knowledge (based onThong 1999; Thong & Yap 1995)	1. I use a computer at home. 2. I use a computer at work. 3. I attended computer classes in the past. 4. I have a sound level of understanding of IT when compared to the other owners of the business.

7.6.2 Pre-testing questionnaire

Before the final administration of the survey questionnaire, a pre-test was adopted to verify content by evaluating how each question was understood and to provide the validity of instrument. Zikmund (2003, p. 223) defined pre-testing as 'a trial run with a group of respondents used to screen out problems in the instructions or design of a questionnaire'. The advantages of pre-test in survey questionnaires have long been recognised by researchers (Churchill & Iacobucci 2005; Zikmund 2003; Hunt, Sparkman & Wilcox 1982) to ensure that respondents can comprehend all questions with no ambiguity and no troubles related to wording or measurement.

For this study, the survey questionnaire was distributed to five BI market specialists identified in previous contacts with the researcher. These specialists were asked to comment on the meaning, understanding and formatting of the questionnaire, especially the questions that related to the five dimension in IEM model in order to suit with the Thai SMEs market. Their responses indicated a need for minor adjustments, recommending that the questionnaire provide more definitions of technical terms in order to assist respondents in understanding the context. Also, they recommended that the sequence of questions be reorganised to make it more logical. As a result, some wording and layout were adjusted to ensure a full understanding by respondents. After all suggestions and recommendations by the specialists were implemented in the survey questionnaire which provide the validity of instrument, the next stage of pilot testing for reliability of the questionnaire was conducted.

7.6.3 Pilot survey questionnaire

According to Veal and Ticehurst (2005), the aim of a pilot survey is to: 1) assess the questionnaire wording; 2) assess questionnaire layout; 3) assess question sequencing; 4) gain familiarity with respondents; 5) estimate completion time; 6) estimate response rate; and 7) assess analysis procedures. Therefore, to identify weaknesses in the questionnaire design and instrumentation and present proxy data for selection, a pilot study was conducted between April and May 2013. Moreover, in accordance with Cooper and Schindler (2006), who recommended that the group size of a pilot study ranges from 25 to 100 subjects, this study utilised a small sample of 50 SMEs covering four main industry types randomly drawn from the database of the OSMEP in Thailand.

Thirty-two questionnaires were returned within two weeks, representing a 64% response rate. As five of these were unusable due to incomplete answering, only 27 questionnaires were useful for analysis. Comments from respondents regarding questionnaire design were mainly related to poor formatting and inappropriate wording in some questions. Therefore, to increase comprehension of the survey questionnaire, the suggested adjustments were made. Next, an internal consistent reliability method based on Cronbach's alpha was employed to measure items in the questionnaire. It was clear that the pilot study not only tested the question wording but also all other aspects of the survey.

Based on a rule of thumb, values of Cronbach's alpha are considered as good and acceptable at above 0.70 (Nunnally, Bernstein & Berge 1978) and this may decrease to 0.6 in exploratory research (Hair et al. 2006; Sekaran 2006). In this study, the values of each item ranged from 0.791 to 0.955, which is satisfactory.

Table 7.6: Reliability analysis of the pilot survey

Measurement items	Items	Cronbach's alpha	Reliability results
Technological			
Relative advantage	4	0.862	Good
Complexity	4	0.861	Good
Compatibility	4	0.869	Good
Trialability	4	0.793	Acceptable
Observability	4	0.791	Acceptable
Environmental			
Competitive pressure	4	0.934	Good
Vendor selection	4	0.853	Good
Organisational			
Absorptive capacity	4	0.838	Good
Organisational resource availability	4	0.891	Good
Owner-manager			
Owner-managers' innovativeness	4	0.955	Good
Owner-managers' IT knowledge	4	0.893	Good

As shown in Table 7.6 above, all items yielded high reliability scores with the majority of items considered as good (more than 8.0), and only two items acceptable (more than 7.0). As a result, there are no items excluded due to the reliability score. Here, the questionnaire was ready for the actual survey. The final version of the questionnaire was distributed to a large sample of 2,000 SMEs. The full questionnaire and cover pages can be found in Appendixes A and B.

7.7 Ethical consideration

In considering the correct conduct for this study, prior to distributing the survey questionnaire, the research proposal and survey questionnaire were submitted to the Human Research Ethics Committee of Victoria University. Subsequently the committee approved this project to conduct a postal mail survey subject to executing the responsibilities required to protect the interests of survey respondents.

With respect to the survey respondents, there was no requirement to respond to this survey. Respondents were invited to take part on their own free will. They had the right to deny or end their participation if they so desired. Fundamentally, as participants were to be free from any deception or stress that might occur during participation in the research, the identities of the researchers, and the voluntary nature of participation was made explicit in writing. The introductory page of the postal survey questionnaire was clearly stated, together with the objectives of the study and the nature of how participants were selected. Respondents were assured that their information would be protected through the anonymity of subjects. All information of respondents which could possibly expose their identities was kept in strict confidence. Lastly, following data analysis all completed questionnaires were stored at Victoria University, with only the researcher and supervisor having access.

7.8 Chapter summary

This chapter describes the research methodology and methods used in this study, together with the sample selection procedure, sample techniques, development of the questionnaire, and the measurement process. The survey research strategy has been chosen and conducted using postal self-administered questionnaires to collect quantitative data. A sample size of 2,000 Thai SMEs was drawn using a probability sampling of the systematic sampling technique. Before final administration of the survey questionnaire, a pre-test was conducted to ensure that respondents understood and could complete all the questions in the questionnaire. Prior to administering the questionnaire a pilot study revealed that the questionnaire was reliable and valid. Ethical issues were taken into account and the research approved by the Victoria University Human Research Ethics Committee. Results from the data collection are analysed and discussed in the next chapter.

CHAPTER 8: DATA ANALYSIS AND RESULTS

8.1 Introduction

Following the description of the methodology used in data collection for this research, this chapter reports the results of the data analysis. The first section provides an explanation of the process used to administer the questionnaire, followed by an evaluation of the non-response bias. Then, a data preparation is described which includes the processes involved in data coding, data cleaning and data screening. Convergent and discriminant validity are then verified using factor analysis. The reliability of the measurement constructs is confirmed by using internal consistency reliability. To present the results of this study, statistical techniques including descriptive statistics and inferential statistics, including multinomial logistic regression and Kruskal-Wallis (K-W) test used in this study, are presented in several tables and figures. The final section concludes with a summary of the research results.

8.2 Data collection and response rate

The previous chapter described the approach used to select the sample of SMEs from a population of two million. This randomly selected sample of 2,000 SMEs from the database of the Office of Small and Medium Enterprises Promotion (OSMEP) has provided a reliable updated database of SMEs in Thailand (Chooprayoon, Chun Che & Depickere 2007). This chapter will describe the data collection process and the response rate achieved in this study. The data collection commenced on the first of May and finished at the end of June 2013. The collection was undertaken via postal mail in two rounds, with survey packages in the first mailing round including a questionnaire, cover letter, consent form, questionnaire (see Appendixes A, B and C), and registered reply paid envelope. These were distributed to 2,000 SMEs to invite the owner-managers or managers to complete and return the questionnaires within a month. Although 84 survey packages were returned undelivered as the enterprise had either closed down or changed location, the response rate of the first mailing round was 287 questionnaires (14.35%) returned on time.

In order to enhance the response rate and level of representation, a second mailing round was distributed to the 1,713 remaining enterprises that had not returned the questionnaire after the first mailing round conducted. The new survey packages contained a reminder letter, a consent form, a questionnaire, and a registered reply paid envelope. To encourage responses to the questionnaire, the importance of participation in this study was emphasised in the reminder letter (see Appendix D). The respondents were requested to complete the questionnaire and return it within a month. Subsequently, an additional 198 questionnaires were returned, with only 31 survey packages being returned as undelivered mail. The response rate for both mailing rounds increased the overall response rate of this study to 24.25%.

Even though 485 questionnaires were returned, 58 were excluded for two reasons. First, 26 questionnaires fell outside the qualification concerning the definition of SMEs in this study (an enterprise with more than 200 employees). Second, 32 questionnaires were considered as unusable due to uncompleted questionnaires. This left 427 responses remaining for data analysis. This quantity of returned questionnaires was regarded as sufficient for data analysis. Summaries of the data collection and usable response rate are shown in Table 8.1.

Table 8.1: Data collection and response rate

	Sent out	Returned questionnaire	Non-delivered questionnaire	Response rate (from 2,000)
Initial	2,000	287	84	14.35 %
Reminder letter	1,713	198	31	9.9%
Total returned questionnaire		**485**		**24.25 %**
Incomplete questionnaire		32		
Not meeting SME's criteria		26		
Usable response for analysis		**427**		**21.35 %**

8.3 Evaluation of non-response bias

As ignoring the non-respondents in this study could have impacted upon the external validity of collected data, which in turn could affect the survey results (Kervin 1999), analysis of the non-respondents was performed to identify any shared or differentiated characteristics between respondents and non-respondents. These characteristics could lead to the discovery of any biases existing within the dataset. Although it would be ideal to directly seek the reason why non-respondents declined to participate in the survey, they would be unlikely to reply because of their initial lack of participation. Therefore, non-response bias was tested by comparing the early and late respondents using the ***extrapolation*** method suggested by Armstrong and Overton (1977). The assumption underlying this approach is that the late respondents to a survey can be viewed as a sample from the non-response group. Using this method, if no differences are found between early and late respondents, an assumption can be made that a non-response error is unlikely to affect the sample results.

As calculation of the response rate for this study was only 21.35%, this low figure may be attributed to the difference between respondents and non-respondents causing a non-response bias. Therefore, a Pearson Chi-square test was calculated to determine whether any differences exist between these two groups by comparing them against responses to the eight demographic variables (gender, age group, education level, position, industry sector, employee number, year in business, and location). In applying the extrapolation method in this study, early responses refer to those who completed and returned the questionnaires on time (the first mailing round was returned within four weeks after the initial mailing), whereas late responses are those who had returned questionnaires later (the second mailing round was returned within four weeks after the reminder mailing).

Table 8.2: Results of non-response biases analysis

	Early responses (n=257)	Late responses (n = 170)	χ^2	d.f.	*p*
Gender			**2.185**	**1**	**0.139**
Male	162	120			
Female	95	50			
Age group			**7.408**	**4**	**0.116**
18-20	13	6			
21-30	55	35			
31-40	79	63			
41-50	66	51			
More than 50	44	15			
Education level			**2.079**	**3**	**0.556**
High school	34	20			
Vocational	67	44			
Bachelor	90	70			
Master degree or higher	66	36			
Position			**2.942**	**2**	**0.230**
Owner-manager	169	103			
Manager	81	65			
Other	7	2			
Industry sector			**6.933**	**3**	**0.074**
Manufacturing	44	44			
Service	67	33			
Wholesale	52	27			
Retail	94	66			
Employee number			**6.422**	**4**	**0.169**
Sole proprietor	6	6			
2-9	79	40			
10-50	86	56			
51-100	51	49			
101-200	35	170			
Year in business			**2.664**	**3**	**0.446**
Less than 1 year	22	17			
1-5 years	75	39			
6-10 years	70	51			
More than 10 years	90	63			
Location			**5.826**	**4**	**0.213**
Bangkok and vicinity	72	52			
Central and eastern regions	71	57			
Northern region	47	27			
Northeast region	50	20			
Southern region	17	14			

As shown in Table 8.2, results from the Pearson Chi-square test revealed that there were no significant differences between early and late respondents with respect to gender ($\chi2$ = 2.185, p = 0.139), age group ($\chi2$ = 7.593, p = 0.108), education level ($\chi2$ = 2.079, p=0.556), position ($\chi2$ = 2.942, p = 0.230), industry sector ($\chi2$ = 6.933, p = 0.074), employee number ($\chi2$ =

6.422, p = 0.169), year in business ($\chi 2$ = 2.120, p = 0.548), and location ($\chi 2$ = 5.826, p = 0.213). Based on these results, the non-response bias or error is considered to be negligible in the present study. Even though there is a non-response bias in this study, the industry sector variable has a p-value close to 0.05. It should be noted that the respondent pool contained more SMEs from the service, wholesale and retail sections than the non-respondent group.

8.4 Data preparation

Before analysing the data, raw data collected from the field research needs to be converted into information so that the researcher can extract the relevant data relating to the research question. Preparatory procedures were conducted by translating the data collected into a form that was suitable for analysis (Aaker, Kumar & George 2004). These procedures were undertaken to ensure that the data obtained was of a good standard, being complete, consistent, legible and accurate, as well as able to handle the missing responses and non-response errors. The preparatory procedures involved steps such as data coding, data cleaning and data screening (Aaker, Kumar & George 2004; Cavana, Delahaye & Sekaran 2001; Quee 1999) as detailed.

8.4.1 Data coding

According to Malhotra (2008), coding and editing questionnaire responses is the first step in data preparation. This involves assigning a particular code number for each possible answer in a questionnaire, with the appropriate number then being transferred to a computer file for further analysis. In this study, the questionnaire consisted solely of structured questions that allow the researcher to employ a pre-coding method with the questionnaire being coded at the time of design, and a unique variable name being assigned to each item. However, as this questionnaire had negatively worded items under the constructs of complexity (see Table 7.5), a reverse coding was required. Here, reverse coding involved a process in which the value assigned for a response was opposite to the others (Zikmund 2003). As a five-point Likert-type scale was used for these negatively worded items, a value of 5 (strongly agree) was transformed to a value of 1 (strongly disagree), and a value of 4 (agree) was transformed to a value of 2 (disagree). All coded data for the 427 completed questionnaires was then keyed into SPSS software for further analysis. The sheet summarising coding instructions together with important information about variables in the survey data set is presented in Appendix L.

8.4.2 Data cleaning and screening

As the data was manually keyed into the computer software program, the data codes were verified via a data cleaning process by checking all variables for incorrect codes. This process ensured that any coding errors and errors related to inconsistencies in the questionnaire, such as missing data or excessive variations in values, could be detected before the analysis stage (Hair et al. 2010). The following subsections will assess the missing data and outliers.

8.4.2.1 Assessment of missing data

The problem of missing data is common in research studies, especially in those that employ a survey questionnaire with a large number of questions, some of which remain unanswered by respondents. Missing data can also occur due to researcher error, such as when answers from respondents are not correctly recorded by the researcher (Tabachnick, Fidell & Osterlind 2001). To ensure that there were no errors or missing values, a pre-analytical computer test of descriptive statistics using SPSS was conducted.

As mentioned earlier in section 8.1, 32 respondents returned incomplete questionnaires. These respondents had failed to answer the questions in section two of the questionnaire which were designed to classify the BI adoption levels of the organisation. As this section asks respondents to rate the extent of their agreement or disagreement regarding the enabling factors of BI adoption, a deflection method was chosen and applied to deal with missing data. This method was adopted because it would have less effect on the sample size, which in turn lightly affects the generalisability of the research findings. As a result of this action, responses from 32 questionnaires were excluded from this study.

8.4.2.2 Assessment of outliers

According to Hair et al. (2006, p. 64), outliers are defined as cases ‘with a unique combination of characteristics identifiable as distinctly different from other observations’. In other words, cases with scores that are very different from the rest are regarded as outliers (Kline 2011). Identifying the presence of outliers in the data screening process is vital because they can cause sampling errors, wherein cases are not representative of the intended population.

Outliers can be identified by univariate detection. Detecting univariate outliers was achieved through observations of each variable. Distinct observations that fell at the outer ranges of the distribution were regarded as outliers. This process was executed by converting the data values to standard z-scores of each variable. Hair et al. (2010) suggest that for a large sample size which has more than 80 samples, a standard z-score value can range from +/–3 to +/–4. In this study, z-scores of +/–3.29 recommended by Tabachnick, Fidell and Osterlind (2001), were selected as a benchmark to identify outliers. Based on this benchmark, three responses were found to contain only one outlier. After further investigation, it was found that these cases were extreme strongly in agreement with the interval scaled statements. In a study investigating BI adopter's perceptions towards BI technology, it is possible that adopters may have a strong feeling either towards or against a particular variable. As a result, the existence of outliers could probably occur, and if these extreme cases are excluded, they may affect generalisability towards the intended population of study. Moreover, the non-parametric techniques that will be employed to analyse data are not sensitive to outliers, particularly with a large sample size such as this. Hence, from the outlier analysis, the nine responses were retained in the final sample of 427 responses used in this study.

8.5 Measurement model evaluation

In order to analyse the measurement model, this study was conducted in three steps. The first step involved testing the correlation of the dependent variable using Spearman correlation. The second step involved the convergent and discriminant validation of all items listed in the determinant factors (independent variables) of four characteristics using factor analysis. The third step involved testing of the reliability of internal consistency through calculating the coefficient scores using Cronbach's alpha. Base on a rule of thumb, Cronbach's alpha is acceptable in most research when the value is greater than 0.6 (Malhotra 2008; Hair et al. 2006; Sekaran 2000).

8.5.1 Correlation of dependent variable

As this study categorises SMEs into different levels of BI adoption based on five dimensions adopted from the IEM model, Spearman correlation is used to test accuracy and reliability. Using the IEM model, an organisation will be classified into one level if the organisation possesses properties mostly similar to the description of that level in each dimension. It can be assumed that if respondents' organisations are ranked high in one dimension, they will also be ranked high in other dimensions. For example, organisations that have their infrastructure in the integrate level (lowest level) should have their knowledge process in the integrate level rather than the optimise level (highest level). Spearman correlation is used to identify the correlation between each dimension as shown in Table 8.3.

Table 8.3: Correlation coefficients tests for all dimensions

		Infrastructure	Knowledge process	Human capital	Culture	Application
Infrastructure	Correlation coefficient	1.000	.813**	.603**	.351**	.635**
	Sig. (2-tailed)	.	.000	.000	.000	.000
	N	427	427	427	427	427
Knowledge process	Correlation coefficient	.813**	1.000	.576**	.308**	.667**
	Sig. (2-tailed)	.000	.	.000	.000	.000
	N	427	427	427	427	427
Human capital	Correlation coefficient	.603**	.576**	1.000	.311**	.664**
	Sig. (2-tailed)	.000	.000	.	.000	.000
	N	427	427	427	427	427
Culture	Correlation coefficient	.351**	.308**	.311**	1.000	.359**
	Sig. (2-tailed)	.000	.000	.000	.	.000
	N	427	427	427	427	427
Application	Correlation coefficient	.635**	.667**	.664**	.359**	1.000
	Sig. (2-tailed)	.000	.000	.000	.000	.
	N	427	427	427	427	427

** Correlation is significant at the 0.01 level (2-tailed)

As shown in Table 8.3, the p-values of all dimensions are 0.00, which are lower than significance level = 0.05. Although this reveals a significant association between each dimension, the values of correlation coefficient between pair dimensions are different. Based on a suggestion from Hinkle, Wiersma and Jurs (2003), the strength of correlation can be interpreted by using the following set of descriptors:

Coefficient range	Strength of correlation
+/–.90 to +/–1.00	Very high
+/–.70 to +/–.90	High
+/–.50 to +/–.70	Moderate
+/–.30 to +/–.50	Low
+/–.00 to +/–.30	Little

The results in Table 8.3 show that all dimensions have a positive correlation between pair dimensions, which means that the ranks of both dimensions are moving in the same direction. However, the majority of coefficient values are greater than 0.50, which is considered to be moderate correlation. Interestingly, one pair, Infrastructure and Knowledge process, has a value greater than 0.70, revealing a strong positive association between the Infrastructure and Knowledge process of organisations. However, all pairs between Culture and other dimensions have values of less than 0.50 but greater than 0.30, which is considered a low correlation. In sum, even though the strength of correlation between dimensions varies from low to high, all dimensions in the IEM model have relationships with each other. Hence, it can be concluded that the IEM model has a degree of accuracy and reliability in categorisation of organisations into the BI adoption levels.

8.5.2 Convergent and discriminant validity of independent variables

Convergent validity refers to the degree to which measurement items of the same construct demonstrate a converged relationship (Hair et al. 2010) which can be confirmed when items load strongly on their associated factors using a standardised loading of above 0.50. On the other hand, discriminant validity is the degree to which measurement items of one construct lack correlation with measurement items in other constructs (Hair et al. 2010). This is demonstrated when each item loads stronger on its related factor than on other factors. In this thesis, items that did not load strongly on intended factors were deleted and not considered for further analysis. Thus the two validities allow greater confidence in subsequent interpretations of findings (Farrell & Rudd 2009).

The observation of convergent and discriminant validity in this study was conducted using the principal components of factor analysis to extract the maximum variance from all items (Harris 2004). A varimax rotation criterion was then used to rotate the outcome to obtain factors that were simple and interpretable. The validity of these measurement scales was assessed in the four characteristics of the conceptual framework, including technological (5 constructs), environmental (2 constructs), organisational (2 constructs) and owner-managers (2 constructs).

8.5.2.1 Technological characteristics

Factor analysis of the technological characteristics presented in Table 8.4 shows that the convergent and discriminant validity of scales measuring Relative advantage, Complexity, Trialability and Observability were confirmed. Although five factors were extracted, two items including one in Compatibility and another in Observability did not load well in their particular constructs. As a result, they were dropped from further analysis, and analysis of validity was recalculated to allow the model to collectively explain its 73.35% of total variance. As can be seen, all items have loading values of above 0.50 on their associated factors and load more strongly on other associated factors.

Table 8.4: Construct validity analysis for technological characteristics

	Component				
	1	2	3	4	5
Relative advantage 1	**.765**	–.182	–.046	.160	.197
Relative advantage 2	**.708**	–.218	.062	.049	.230
Relative advantage 3	**.770**	–.144	.092	.234	.117
Relative advantage 4	**.750**	–.138	–.080	.133	.127
Complexity 1	–.479	**.709**	–.067	–.063	–.145
Complexity 2	–.522	**.701**	–.066	–.067	–.134
Complexity 3	–.319	**.797**	–.048	–.042	–0.62
Complexity 4	–.033	**.689**	.128	–.065	–.228
Compatibility 2	–.109	–.172	**.747**	–.054	–.023
Compatibility 3	.273	.173	**.710**	.117	.067
Compatibility 4	–.043	–.076	**.794**	.084	.190
Trialability 1	.167	.012	.155	**.596**	–.208
Trialability 2	.197	–.103	.114	**.658**	–.052
Trialability 3	.084	–.049	–.029	**.812**	.125
Trialability 4	.038	–.041	–.046	**.820**	.108
Observability 2	.220	–.084	–.057	.003	**.586**
Observability 3	.202	–.025	.209	–.018	**.654**
Observability 4	.087	–.163	.067	–.043	**.737**

8.5.2.2 Environmental characteristics

Factor analysis of environmental characteristics presented in Table 8.5 shows that the convergent and discriminant validity of scales measuring Competitive pressure and Vendor selection were confirmed. Two factors were extracted which allowed the model to collectively explain its 72.71%. As can be seen, all items loaded into their expected constructs with the loading value being more than 0.50 and loading more strongly on other associated factors.

Table 8.5: Construct validity analysis for environmental characteristics

	Component	
	1	2
Competitive pressure 1	**.754**	.383
Competitive pressure 2	**.805**	.178
Competitive pressure 3	**.712**	.189
Competitive pressure 4	**.750**	.145
Vendor selection 1	–.015	**.610**
Vendor selection 2	.416	**.751**
Vendor selection 3	.370	**.754**
Vendor selection 4	.302	**.757**

8.5.2.3 Organisational characteristics

Factor analysis of the organisational characteristics presented in Table 8.6 shows that the convergent and discriminant validity of scales measuring Absorptive capacity and Organisational resource availability were established. Although two factors were extracted, one item of absorptive capacity did not load on the intended factor. Subsequently, this item was dropped and the analysis of validity was recalculated. In this way, the model was able to collectively explain its 70.03% of total variance. As can be seen, all items have loading values exceeding 0.50 on their associated factors and load more strongly on other associated factors.

Table 8.6: Construct validity analysis for Organisational characteristics

	Component	
	1	2
Absorptive capacity 1	**.671**	.181
Absorptive capacity 3	**.749**	–.141
Absorptive capacity 4	**.735**	.183
Organisational resource availability 1	.097	**.802**
Organisational resource availability 2	.110	**.855**
Organisational resource availability 3	.119	**.704**
Organisational resource availability 4	.035	**.760**

8.5.2.4 Owner-manager characteristics

Factor analysis of the owner-manager characteristics presented in Table 8.7 shows that the convergent and discriminant validity of scales measuring owner-managers’ innovativeness and owner-managers’ IT knowledge were established. Two factors were extracted which allowed the model to collectively explain its 62.28%. All items have loading values exceeding 0.50 on their associated factors and load more strongly on other associated factors.

Table 8.7: Construct validity analysis for owner-manager characteristics

	Component	
	1	2
Owner-managers' innovativeness 1	**.688**	.263
Owner-managers' innovativeness 2	**.727**	.083
Owner-managers' innovativeness 3	**.711**	–.069
Owner-managers' innovativeness 4	**.659**	.112
Owner-managers' IT knowledge 1	–.247	**.663**
Owner-managers' IT knowledge 2	.425	**.524**
Owner-managers' IT knowledge 3	.170	**.797**
Owner-managers' IT knowledge 4	.226	**.691**

8.5.3 Reliability analysis of independent variables

After testing the convergent and discriminant validity, the coefficient scores for Cronbach's alpha were calculated for assessing the reliability of constructs. As can be seen in Table 8.8, the values of alpha are ranging from 0.611 to 0.844. These value ranges are considered as acceptable with above the recommended value of 0.60 (Hair et al. 2006; Sekaran 2000). Therefore, reliability and validity of the measurement model was demonstrated, providing a strong indication for further analysis. In this table, the means and number of items are also presented to give the general descriptive statistics for each construct.

Table 8.8: Reliability analysis

Measurement items	Cronbach's alpha	Mean	Item
Technological characteristics			
Relative advantage	0.841	2.857	4
Complexity	0.844	2.910	4
Compatibility	0.665	3.323	3
Trialability	0.730	3.166	4
Observability	0.671	3.372	3
Environmental characteristics			
Competitive pressure	0.794	3.200	4
Vendor selection	0.772	3.186	4
Organisational characteristics			
Absorptive capacity	0.611	3.121	3
Organisational resource availability	0.807	2.772	4
Owner-manager characteristics			
Owner-managers' innovativeness	0.689	3.185	4
Owner-managers' IT knowledge	0.624	3.511	4

8.6 Descriptive statistics

In this study, descriptive statistics are used to explain fundamental features of the data. In this context, the descriptive statistics include a demographic profile of respondents, characteristics of responding organisations, and proportion of BI adoption. The following subsections present the detail of responses used in assessing the data.

8.6.1 Demographic profile of respondents

The demographic profiles of the 427 respondents who contributed to this survey are shown in Table 8.9. In terms of owners' backgrounds, the majority of respondents were male at 60.2%, with females comprising 39.8%. Respondents' ages ranged from 18 to over 50 years, with the highest percentage being 31 to 40 years (33.3%), and the smallest 18 to 20 years (4.4%). In terms of education, SME respondents who had completed a bachelor degree contributed to 37.5% of the total, while only 12.6% had graduated from high school or equivalent. In regard to position in the organisation, about two-thirds (63.7%) of respondents held owner-manager positions, while one-third (34.2%) were managers and only 2.1% other positions, including a family business successor and senior employee.

In terms of organisational backgrounds, the overall industry type was well suited and comparable with the sampling frame retrieved from the OSMEP database. The majority of organisations were from the retail sector at 37.5%, followed by services, manufacturing and wholesale at 23.4%, 20.6%, and 18.5 %, respectively. As this study focuses on SMEs, organisations that did not meet the SME criteria given earlier were excluded. With this study limiting the number of employees working in organisations to 200, around two-thirds (64%) of the sample were categorised as small businesses with 50 employees or less, and the remainder were categorised as medium businesses with between 51 to 200 employees. In relation to length of time in business, around one-third (32.6%) of responding organisations indicated that they had been operating between one to five years. Only a small proportion of responding organisations (14%) were start-up enterprises which had been operational for less than one year. In terms of location, despite the random selection of the sample, results show that participating organisations from Central and Eastern Regions came first with 30%, followed closely by Bangkok and its Vicinity with 29%. The third and fourth places were held by the Northern and Northeast regions, with 17.3% and 16.4%, respectively. Lastly, the Southern Region represented only 7.3% of responding organisations.

Table 8.9: Descriptive statistics of 'respondents' profile

	TOTAL RESPONDENTS	
Gender	**No.**	**Per cent**
Male	257	60.2
Female	170	39.8
Age	**No.**	**Per cent**
18–20	19	4.2
21–30	90	21.1
31–40	142	33.3
41–50	117	27.4
More than 50 years old	59	13.8
Education level	**No.**	**Per cent**
High School or Equivalent	54	12.6
Vocational or Diploma	111	26.0
Bachelor Degree	160	37.5
Master Degree or higher	102	23.9
Position	**No.**	**Per cent**
Owner-manager	272	63.7
Manager	146	34.2
Other	9	2.1
Industry type	**No.**	**Per cent**
Manufacturing	88	20.6
Service	100	23.4
Wholesale	79	18.5
Retail	160	37.5
Number of employees	**No.**	**Per cent**
Sole proprietor	12	2.8
2–9 persons	119	27.9
10–50 persons	142	33.3
51–100 persons	100	23.4
101–200 persons	54	12.6
Number of years in business	**No.**	**Per cent**
Less than 1 year	59	13.8
1–5 years	139	32.6
6–10 years	109	25.5
More than 10 years	120	28.1

Table 8.9: Descriptive statistics of 'respondents' profile (continued)

	TOTAL RESPONDENTS	
Location	**No.**	**Per cent**
Bangkok and Vicinity	124	29.0
Central region and Eastern region	128	30.0
Northern region	74	17.3
Northeast region	70	16.4
Southern region	31	7.3
Business activities supported by computer software	**No.**	**Per cent**
Financial accounting	269	63.0
Stock control	227	53.2
Production planning	65	15.2
Customer management	178	41.7
Marketing mix	131	30.7
Market research	67	15.7
Profit forecasting	19	4.4
Strategic analysis	32	7.5
Cash flow forecasting	45	10.5
Sales planning	62	14.5
Staff planning	38	8.9
Other	25	5.9
Count of organisations by number of business activities supported by computer software categories	**No.**	**Per cent**
1–3 business activities	324	75.88
4–6 business activities	95	22.25
7–9 business activities	7	1.64
10–12 business activities	1	0.2

8.6.2 Characteristics of responding organisations

The characteristics of organisations described by the 427 respondents are summarised in Table 8.10. These results are from section two of the questionnaire which comprises five questions representing each dimension of the BI maturity model, with five choices for each BI level. Here, the respondents were asked to indicate the characteristics and analytical applications that they used in their organisation. Their responses implied the implementation of the way BI was interpreted in their organisations and, in turn, used to categorise the BI levels of those organisations.

Table 8.10: Characteristics of organisations

BI Level \ Dimension	Infrastructure		Knowledge process		Human capital		Culture		Application	
	No.	%	No.	%	No.	%	No.	%	No.	%
Operate	193	45.3	192	45.0	211	49.4	199	46.6	199	46.6
Consolidate	130	30.4	124	29.0	136	31.9	138	32.3	131	30.7
Integrate	92	21.5	98	23.0	67	15.7	54	12.6	85	19.9
Optimise	11	2.6	9	2.1	7	1.6	19	4.4	11	2.6
Innovate	1	0.2	4	0.9	6	1.4	17	4.0	1	0.2

As can be seen in Table 8.10, there is an obvious pattern in responses among the five dimensions, with the proportions of observed responses seeming to decrease with the increasing of the BI adoption level. For example, in the Infrastructure dimension, nearly half of the respondents indicated that the infrastructure of their organisations was at the Operate level. Almost one-third indicated that their organisational infrastructure was at the Consolidate level, followed by 21.5% at the Integrate level. Only 2.6% of respondents indicated that their organisation's infrastructure was at the Optimise level, with only a few respondents (0.2%) selecting the Innovate level. In other dimensions, the overall trend of responses followed the same pattern, with almost 50% being represented at the Operate level, 30% at the Consolidate level and around 20% at the Integrate level. Roughly two per cent of respondents were represented at the Optimise level, and less than one per cent of respondents selected the Innovate level except in the Culture dimension which was almost five per cent at the Innovate level.

8.6.3 Proportion of BI adoption at each level

Due to the highly individual nature of organisations, the characteristics of each dimension in the BI model varied. For this reason, a formulation was used to calculate and interpret the results from each respondent in order to classify their organisation into an appropriate BI level (see Appendix M). In applying this formula to the present study, organisations were classified into the BI levels shown in Table 8.11. Here, the majority of organisations were categorised as Operate level at 48.2%, approximately 31.9 % at Consolidate level, and almost 20% at Integrate level. Roughly 3% were at Optimise level, with no organisations being categorised at Innovate level.

Table 8.11: The number of response organisations classified at each level of BI

Level of BI	No.	Per cent
Operate	206	48.2
Consolidate	136	31.9
Integrate	73	17.1
Optimise	12	2.8
Innovate	0	0
Total	**427**	**100**

As shown in Table 8.11, the number of cases at Optimise level is very low (only twelve), and with no cases at the Innovate level. Clearly, the gap between these two levels and the other levels is very wide, making it unsuitable for interpretation in this study. This is consistent with a suggestion by Aaker, Kumar and George (2004) that when samples are categorised into a sub-group, a minimum sample size of 20 for each group is essential. Therefore, the two levels of BI, including Optimise (12 cases) and Innovate (0 case), were incorporated into the Integrate level to yield the number of organisations at Integrate as 85, which brings it to around 20%. As a result of this action, the label of this level was changed from Integrate to Integrate+ to represent the upper level of BI. As a consequence, only the three BI levels of Operate level, Consolidate level and Integrate+ level are presented in this study. The revised proportion of organisations at each level of BI is shown in Table 8.12.

Table 8.12: Revised number of organisations classified at each level of BI

Level of BI	No.	Per cent
Operate	206	48.2
Consolidate	136	31.9
Integrate+	85	19.9
Total	**427**	**100**

8.6.4 Proportion of the three organisational groups based on the BI adoption levels

After categorising the levels of BI in participating organisations into three groups (Operate, Consolidate and Integrate+), each was profiled based on descriptive statistics in terms of frequencies and percentages. This allowed a more detailed description of characteristics in the BI adoption of each group (see Table 8.13). As the findings in this study reflect the current situation of BI adoption by classifying SMEs into the levels of BI, the analysis does not go into deep details of each industry type of SMEs. The comparison is only made between different levels of BI adoption. Mean scores of the enabling factors impacting on BI adoption were classified in groups as presented in Table 8.14. For further details of all the items listed under enabling factors, please refer to Appendix N.

Table 8.13: Descriptive statistics across the three level groups of BI adoption

	Operate		Consolidate		Integrate+	
Gender	**n = 206**	**%**	**n = 136**	**%**	**n = 85**	**%**
Male	97	47.1	96	70.6	64	75.3
Female	109	52.9	40	29.4	21	24.7
Age	**No.**	**%**	**No.**	**%**	**No.**	**%**
18–20	16	7.8	2	1.5	0	0
21–30	65	31.6	22	16.2	4	4.7
31–40	50	24.3	57	41.9	33	38.8
41–50	40	19.4	44	32.4	35	41.2
More than 50 years old	35	17.0	11	8.1	13	15.3
Education level	**No.**	**%**	**No.**	**%**	**No.**	**%**
High School or Equivalent	44	21.4	8	5.9	2	2.4
Vocational or Diploma	89	43.2	17	12.5	5	5.9
Bachelor Degree	58	28.2	68	50.0	34	40.0
Master Degree or higher	15	7.3	43	31.6	44	51.8
Position	**No.**	**%**	**No.**	**%**	**No.**	**%**
Owner-manager	162	78.6	72	52.9	38	44.7
Manager	40	19.4	62	45.6	44	51.8
Other	4	1.9	2	1.5	3	3.5

Table 8.13: Descriptive statistics across the three level groups of BI adoption (continued)

	Operate		Consolidate		Integrate+	
Industry type	**No.**	**%**	**No.**	**%**	**No.**	**%**
Manufacturing	20	9.7	34	25.0	34	40.0
Service	61	29.6	25	18.4	14	16.5
Wholesale	18	8.7	33	24.3	28	32.9
Retail	107	51.9	44	32.4	9	10.6
Number of employees	**No.**	**%**	**No.**	**%**	**No.**	**%**
Sole proprietor	10	4.9	2	1.5	0	0
2–9 persons	105	51.0	14	10.3	0	0
10–50 persons	53	25.7	64	47.1	25	29.4
51–100 persons	32	15.5	42	30.9	26	30.6
101–200 persons	6	2.9	14	10.3	34	40.0
Number of years in business	**No.**	**%**	**No.**	**%**	**No.**	**%**
Less than 1 year	53	25.7	4	2.9	2	2.4
1–5 years	82	39.8	41	30.1	16	18.8
6–10 years	37	18.0	51	37.5	21	24.7
More than 10 years	34	16.5	40	29.4	46	54.1
Location	**No.**	**%**	**No.**	**%**	**No.**	**%**
Bangkok and Vicinity	67	32.5	34	25.0	23	27.1
Central region and Eastern region	65	31.6	35	25.7	28	32.9
Northern region	29	14.1	33	24.3	12	14.1
Northeast region	32	15.5	22	16.2	16	18.8
Southern region	13	6.3	12	8.8	6	7.1
Business activities supported by computer software	**No.**	**%**	**No.**	**%**	**No.**	**%**
Financial accounting	125	60.7	72	52.9	75	88.2
Stock control	78	37.9	84	61.8	67	78.8
Production planning	12	5.8	21	15.4	32	37.6
Customer management	75	36.4	53	39.0	50	58.5
Marketing mix	37	18	60	44.1	34	40.0
Market research	23	11.2	16	11.8	28	32.9
Profit forecasting	6	2.9	2	1.5	11	12.9
Strategic analysis	11	5.3	6	4.4	15	17.6
Cash flow forecasting	19	9.2	12	8.8	14	16.5
Sales planning	10	4.9	14	10.3	38	44.7
Staff planning	6	2.9	22	16.2	10	11.8
Other	5	2.4	13	9.6	7	8.2
Count of organisations by number of business activities supported by computer software categories	**No.**	**%**	**No.**	**%**	**No.**	**%**
1–3 business activities	188	91.26	107	78.68	29	34.12
4–6 business activities	18	8.74	29	21.32	48	56.47
7–9 business activities	0	0	0	0	7	8.23
10–12 business activities	0	0	0	0	1	1.18

Source: Data drawn from survey questionnaire responses

Table 8.14: Descriptive statistics of enabling factors across the three level groups of BI adoption

Variables (Factors)	Operate n = 206	Consolidate n = 136	Integrate+ n = 85
Technological characteristics			
Relative advantage	2.3289	3.2739	3.4676
Complexity	3.4207	2.3775	1.6902
Compatibility	3.3188	3.2819	3.4000
Trialability	3.0789	3.2261	3.2824
Observability	3.0663	3.5466	3.8314
Environmental characteristics			
Competitive pressure	2.7209	3.5588	3.7853
Vendor selection	2.6432	3.6489	3.7618
Organisational characteristics			
Absorptive capacity	3.1149	3.0882	3.1882
Organisational resource availability	2.4672	2.7482	3.5500
Owner-manager characteristics			
Owner-managers' innovativeness	3.0231	3.2629	3.4529
Owner-managers' IT knowledge	3.5182	3.4357	3.6147

Source: Data drawn from survey questionnaire responses

Operate organisations

A total of 206 out of 427 organisations were classified at the Operate level, with slightly more female respondents (52.9%) than males (47.1%). Although the age range of respondents was diverse, the majority ranged from 21–30 years (31.6%). Most of these had educational levels lower than bachelor degree, with 43.2% having a vocational training or diploma, and 21.4% having a high school certificate or equivalent. The majority of respondents were owner-managers (78.6%), and in terms of industry type, most firms were from the retail (51.9%) and service sectors (29.6%). Organisations at this level covered all possible sizes of SMEs, with about half being classified as small due to having between two to nine employees. Most of the respondent organisations were start-up or new enterprises, with 25.7% being operational for less than one year, and 39.8% operating between one to five years. Therefore, the implementation of computer software for supporting business activities in Operate level was limited. More than 90% of respondents indicated that they used computer software in only one to three business activities, while a small remainder used computer software for four to six business activities. The business activities that many organisations in this level used computer software for included financial accounting, stock control and customer management.

Consolidate organisations

The 135 out of 427 participating organisations represented in this study were classified at the Consolidate level. The majority in this level were males (70.6%), with ages ranging from 18 to more than 50 years, with a majority in the range of 31–40 years (41.9%). About half had at least a bachelor's degree and held the owner-manager position in their organisation. The industry sectors of these organisations were diverse, with 32.4% from retail, 25% from manufacturing, 24.3% from wholesale, and 18.4% from services. In addition, the organisations in this level were either small or medium-sized in terms of the number of employees. Nearly 50% had between 10–50 employees, while around 30% had between 51–100 employees. The length of time in business of organisations in this level was variable, ranging from less than one year to more than ten years, with most being in operation for six to ten years. When considering the business activities supported by computer software, the number of business activities in this level was not much different from the Operate level. This is due to around 60% of organisations using computer software for only a few business activities (one to three activities), with their main business activities utilising software similar to that used at Operate level, including financial accounting, stock control and customer management. Almost half of the organisations in this level also used computer software to support their marketing functions.

Integrate+ Organisations

At the Integrate level, 85 out of 427 participating organisations were found. More than 75% of these respondents were male, with ages ranging from 21 to over 50 years. Here, the majority were older than the Consolidate organisations, with most being over 40 years of age (56.5%). All were well educated, with 40% having bachelor degrees and 51.8% holding master degrees or higher. More than half held the manager's position (51.8%) in their particular organisation. In terms of industry type, most organisations were from either manufacturing (40%) or the wholesale (32.9%) sector. In terms of organisational size, organisations in Integrate+ level had more employees than other lower levels. The number of employees ranged from more than ten to 200, with most firms (70%) having 51 to 200 employees being categorised as medium-sized organisations. Of these, around 30% had 51 to 100 employees, while 40% had 101 to 200 employees. In relation to length of time in business, over half of the organisations had been operating for more than ten years (54.1%). Overall, implementation of computer software to support business activities in the Integrated organisations was widespread, with the majority of organisations indicating that they had used computer software to support four to six of their business activities (64.6%). In addition to not only using computer software for financial accounting, stock control and customer management, similar to organisations in the lower levels, integrate+ level also used computer software to support other business areas, including production planning, marketing and sales planning.

8.7 Inferential statistics

Inferential statistics are a group of methods used to make predictions and generalisations about the nature of an entire group (population) based on data that the researcher has collected from a small portion of that group (sample). In this study, the inferential statistics are based on two main approaches, including logistic regression and non-parametric tests. First, logistic regression is employed to test the hypotheses in this study in order to identify the enabling factors which impact on the BI adoption of Thai SMEs. Second, after finding which enabling factors drive SMEs to adopt BI, the analysis is conducted using the more robust non-parametric Kruskal-Wallis (K-W) test. This non-parametric test is used in addition to logistic regression in order to gain better understanding of the association between levels of BI adoption and enabling factors and to improve the reliability of the data analysis.

The data analysis technique that has predominated in recent studies on IT adoption (for example, Nasri and Charfeddine (2012)) is the Structural Equation Modelling (SEM). This is due to the fact that most studies have used the structure proposed initially by theory of reasoned action (TRA) theory, this is, beliefs – attitudes – intention – behavior. However, SEM has certain disadvantages, such as the need for larger samples and the complexity associated with incorporating not latent and ordinal variables such as the level of BI adoption. Since the proposed model has done away with the attitude construct, it can be approproately tested through the use of logistic regression.

The reason that logistic regression and a non-parametric test are used in this study is that both analysis types are suitable for the situation in which the dependent variable is not continuous or quantitative. In other words, they are suitable for both categorical and nominal situations (Hosmer, Lemeshow & Sturdivant 2013; Pett 1997; Stevens 1946). Due to the discrete nature of the dependent variable in which the adoption of BI has five possible categorical levels

(Operate, Consolidate, Integrate, Optimise and Innovate), logistic regression and the non-parametric test are deemed the most appropriate analysis tool.

As the type of dependent variable in this study is categorical and both logistic regression and non-parametric tests assume neither normal distribution nor homogeneity of variances (Israel 2009), the testing of assumptions is not taken into account. Therefore, no testing for normal distribution and homogeneity of variance has been undertaken.

8.7.1 Logistic regression

When a dependent variable (response variable) has more than two categories, the choice of logistic regression relies on the type of categories in the dependent variable, which can be ordered or unordered. If categories in the dependent variable have natural ordering, ordinal logistic regression models should be employed for modelling the response variable. On the other hand, if categories in the dependent variable cannot be ranked in order, or when the assumptions of ordinal logistic regression do not hold, the multinomial logistic regression has to be used to analyse data (Hosmer, Lemeshow & Sturdivant 2013). As the dependent variable in this study are the levels of BI adoption that can be ranked from low to high, ordinal logistic regression analysis seems to be suitable for this study. Nevertheless, a strict assumption has to be met before the ordinal logistic regression model can be used, that is, the parallel lines assumption. The parallel lines assumption implies that the relationship between each pair of outcome groups is the same. In other words, the coefficients that describe the relationships between the lowest versus all higher categories of the response variable are the same as those that describe the relationship between the next lowest category and all higher categories (Hosmer, Lemeshow & Sturdivant 2013). The parallel lines assumption is satisfied when the significant value in the test of parallel lines is more than 0.05. The output of parallel analysis in this study is shown in Table 8.15.

Table 8.15: Test of parallel line

Model	–2 Log likelihood	Chi-square	df	Sig.
Null hypothesis	386.040			
General	356.044	29.996	11	.002

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

a. Link function: Logit.

From Table 8.15, result shows that the value of significance in the test of parallelism is 0.002, which is less than 0.05. This result indicates that the general model, without considering the rank ordered of dependent categories, gives a significantly better fit to the data than the ordinal model. Therefore, as the assumption of parallel lines is violated, an ordinal logistic regression cannot be considered for this study. As a result, a multinomial logistic regression has been found to be the most appropriate regression model. Unlike other models, this one suits the category of dependent variable and lenient assumptions that the logistic regression of this study imposes.

Multinomial logistic regression requires the minimum ratio of valid cases to predictor variables to be at least 20 to 1 (Leech, Barrett & Morgan 2011). As 427 responses for the survey were collected and 11 predictor variables were included in the regression model, at 39:1, the ratio of valid cases in this study is more than the required minimum, thus satisfying the requirement of this study. Furthermore, multinomial logistic regression will be accurate when three significant criteria have been met: (1) the overall relationship is statistically significant; (2) there is no evidence of numerical problems; and (3) the classification accuracy rate is considerably higher than if obtained by chance alone (Hair et al. 2010). However, before assessing the accuracy of a multinomial logistic model and explaining the main regression measures, it will be helpful to interpret the regression equation in the next section.

8.7.2 Multinomial logistic regression equation

Multinomial logistic regression involves nominal response variables with more than two categories. Therefore, a multinomial logistic regression model is a multi-equation model. However, the number of equations depends on the number of categories of outcomes minus one. If the response variable has any '*k*' categories, a '*k-1*' number of non-redundant logits can be generated. The simplest type of logit for this situation is called a baseline category logit which compares each category to a baseline (reference category). For the baseline category, the coefficients are all zero (Aldrich & Nelson 1990).

If the baseline category is 'k' for the 'i^{th}' category, the model is:

$$\text{Logit}(P_i) = \ln\left[\frac{P(category_i)}{P(category_k)}\right] = \alpha_{i0} + \beta_{i1} X_1 + \beta_{i2} X_2 + \beta_{i3} X_3 \ldots + \beta_{in} X_n + \varepsilon_i$$

Where: $i = 1,2\ldots k-1$

P = probability

k = referenced category

α = a constant, equalling the value of Y when the value of X = 0

β = Beta, the coefficient of independent variables which represents the slopes of the regression line. Every Beta value explains how much Y change for each one unit change in X.

ε = the error term, the error in predicting the value of Y, giving the value of X

X = independent variable (enabling factors of BI adoption)

The above-mentioned multinomial logistic regression procedure is used to identify the impact of independent variables (enabling factors) on the dependent variable (levels of BI adoption) in the study model. As there are three categories of the dependent variable (BI adoption levels) and this study uses operate (the lowest level of BI adoption) as the reference category, there will be two non-redundant logits, Consolidate/Operate and Integrate+/Operate. In this case, the logistic regression equation will be developed in the study model as follows:

$\text{Logit}(P_{\text{Operate}}) = 0$ (reference category)

$$\text{Logit}(P_{\text{Consolidate}}) = \ln\left[\frac{P(Considerate)}{P(Operate)}\right] = \alpha_{Consolidate} + \beta_1 RAD + \beta_2 COM + \beta_3 COP + \beta_4 TRI + \beta_5 OBS + \beta_6 CPP + \beta_7 VEN + \beta_8 ABS + \beta_9 ORE + \beta_{10} OIN + \beta_{11} OIT + \varepsilon_{Consolidate}$$

$$\text{Logit}(P_{\text{Integrate+}}) = \ln\left[\frac{P(Integrate+)}{P(Operate)}\right] = \alpha_{Integrate+} + \beta_1 RAD + \beta_2 COM + \beta_3 COP + \beta_4 TRI + \beta_5 OBS + \beta_6 CPP + \beta_7 VEN + \beta_8 ABS + \beta_9 ORE + \beta_{10} OIN + \beta_{11} OIT + \varepsilon_{Integrate+}$$

Where:

β (1-11) = Coefficient of independent variables

RAD = Relative advantage

COM = Complexity

COP = Compatibility

TRI = Trialability

OBS = Observability

CPP = Competitive pressure

VEN = Vendor selection

ABS = Absorptive capacity

ORE = Organisational resource availability

OIN = Owner-managers' innovativeness

OIT = Owner-managers' IT knowledge

Since this study is interested in understanding relationships between the dependent variable and the independent variables, direct entry of all independent variables from the above model will be used. Following this, the next section will identify the accuracy of multinomial logistic regression before explaining the main regression measures.

8.7.3 Assessment of accuracy of the multinomial logistic model

Even though the multinomial logistic regression is an analysis type appropriate for this study, and has less assumptions than other techniques, the results from multinomial logistic regression will be accurate when the three criteria (significance of overall model, numerical problems detected and the classification accuracy of the model) have been met. Using these three criteria, the following will analyse the data from multinomial logistic regression.

8.7.3.1 Evaluation of significance of the overall model

Besides analysing and assessing the reliability and correlation of all variables, it has been necessary to assess the extent to which the study model and its related components are valid for predicting the levels of BI. The first step in analysing any model construct is to find the best way to support and properly explain the relationships between the predictor and dependent variables (Hosmer, Taber & Lemeshow 1991). Table 8.16 describes all parameters for which the fit of this study model has been calculated. 'Intercept only' describes a model measure that has no independent variables, whereas 'Final' describes the model measure computed after all independent variables have been included in the model. The presence of a relationship between the dependent variables and a combination of independent variables has been based on the statistical significance of the final model shown in Table 8.16. The idea behind interpreting this model is that the independent variables provide significant statistical proof that they affect the dependent variable (three levels of BI adoption).

Table 8.16: Model fitting information

Model	–2 Log likelihood	Chi-square	df	Sig.
Intercept only	885.916			
Final	257.835	628.081	22	.000

The first row of the Table 8.16 shows the initial log likelihood value as 885.916, while the final log likelihood is 257.835. The difference between these two measures is presented through the Chi-square value of 628.081 (885.916-257.835 = 628.081), with a significance of 0.000. Thus, according to the model fitting information, the significance of the test is less than 0.05 in verifying relationships between the combination of independent variables and dependent variables.

Table 8.17: Goodness-of-fit

	Chi-square	df	Sig.
Pearson	6848.589	830	.000
Deviance	257.835	830	1.000

Moreover, as seen in Table 8.17, the overall goodness-of-fit statistics in the model are consistent with the data used. The Pearson and Deviance statistics have a chi-square distribution of 6848.589 and 257.835, respectively, with the displayed degree of freedom being 830. Also, the *p* value of Pearson Chi-square is 0.000, which is less than 0.005, indicating that the model fits the data adequately.

Table 8.18: Pseudo R-square

McFadden	.709
Cox and Snell	.770
Nagelkerke	.881

As shown in Table 8.18, the Pseudo R-square results provide further evidence of good fit for the model in regard to explaining variations in the data. This is due to the proportion of variations in the dependent variable being accounted for by the independent variables. Furthermore, as a larger Pseudo R-square up to a maximum of 1 offers a better fit for the model (Tabachnick, Fidell & Osterlind 2001), the three matrix calculations of Pseudo R-square for this study model are: McFadden 0.709; Cox and Snell 0.770; and Nagelkerke 0.881. Thus the overall relationships between the dependent variable and independent variables (predictor variables) are strong in supporting the model as good for the prediction of BI adoption.

8.7.3.2 Detection of numerical problems

When using logistic regression, the identification of numerical problems in multicollinearity between the independent variables can be detected. However, according to Hair et al. (2010), when such problems are found, the analysis should be ignored and not interpreted. In Table 8.19, the column of standard error (Std Error) for B coefficients reveals whether independent variables possess any numerical problems, with a standard error larger than 2.0 indicating a problem.

Table 8.19: Parameter estimates table – Standard error

Level of BI	**Consolidate**		**Integrate+**	
	B	**Std Error**	**B**	**Std Error**
Intercept	–12.605	4.342	–14.329	5.168
MRAD	2.891	.685	2.507	.759
MRCOM	–2.545	.552	–4.936	.713
MCOP	–.746	.557	–.935	.659
MTRI	–.731	.450	–.848	.570
MOBS	–1.168	.576	2.458	.692
MBUC	2.737	.646	2.571	.759
MVEN	2.037	.628	1.854	.710
MABS	–.712	.616	–1.467	.756
MORE	–.285	.470	1.906	.608
MOIN	1.381	.518	1.452	.622
MOIT	–1.037	.481	–1.032	.582

*The reference category is: operate.

As shown in Table 8.19, the standard errors for B coefficients in both levels of BI adoption (consolidate and integrate+) have no error values higher than the error limit of 2.0. Therefore, no numerical problems or multicollinearity issues have been found in the independent variables of this study.

8.7.3.3 Evaluating of classification accuracy of the model

Measurements of classification accuracy can be used to assess the usefulness of a multinomial logistic regression model. Here, a model will be accepted as useful when the classification accuracy rate is higher than the proportional by chance accuracy. This is the case when independent variables are capable of differentiating survey respondents from a classified dependent variable. Although by chance accuracy is found when the independent variables have no relationship with classifications of the dependent variable values, its results can provide some correct predictions of the group membership (Hair et al. 2010). A proportional by chance accuracy can be calculated by squaring and summing the percentage of cases in each category of the dependent variable. Here, a generally accepted benchmark criterion for the acceptance of a logistic regression model is a 25% improvement over the proportional by chance accuracy (e.g.Wedagama & Dissanayake 2010; Islam, Zhou & Li 2009; Wedagama 2009).

Table 8.20: Case processing summary

		N	Marginal Percentage
Level of BI	**Operate**	206	48.2%
	Consolidate	136	31.9%
	Integrate+	85	19.9%

a. The dependent variable has only one value observed in 427 (100.0%) subpopulations.

As shown in Table 8.20, although the dependent variable 'levels of BI adoption' in this study are characterised into five different categories, there are only three in which the participants can be included: namely Operate, Consolidate and Integrate+. By applying the squared percentages of each category in the Marginal Percentage and adding them up, the proportional by chance accuracy is 0.37 ($0.482^2 + 0.319^2 + 0.199^2$). However, by applying the benchmark criterion of 25% improvement mentioned above, the proportional by chance accuracy criteria becomes 46.3% (1.25* 37% = 46.3%).

Table 8.21: Classification accuracy table

Observed	Predicted			
	Operate	Consolidate	Integrate+	Per cent correct
Operate	200	6	0	97.1%
Consolidate	4	114	18	83.8%
Integrate+	1	16	68	80.0%
Overall percentage	48.0%	31.9%	20.1%	89.5%

Based on the multinomial logistic regression model, the classification accuracy rate presented in Table 8.21 is 89.5%. As this is greater than the proportional by chance accuracy criteria of 46.3%, the criterion for classifying accuracy is fulfilled, and the multinomial logistic regression model of this study can clearly be accepted as useful.

As the results of all three above-mentioned tests have proven the predictive model to be statistically valid, the results from multinomial logistic regression will be accepted and used for making predictions presented in the following sections.

8.7.4 Multinomial logistic regression

The significance of the individual independent variables is tested using two approaches: the Likelihood ratio test, and Parameter Estimates, via a Wald test. First, the overall relationship between the dependent variable and each independent variable is assessed by the likelihood ratio test. Also, the results of this test are used to test the hypotheses in this study. Second, the statistical significance of each independent variable in distinguishing between the two groups of the dependent variable is tested using the parameter estimates via a Wald test. However, if the independent variable is found to have an overall relationship with the dependent variable, this independent variable will not always have the statistical significance to differentiate between the two groups of the dependent variable. Therefore, in order to check the significance of the independent variable's role in differentiating each group of the dependent variable, its overall relationship with the dependent variable is verified first.

The likelihood ratio test requires the null hypothesis to state that no effect of the parameter values on the dependent variable has been found. The null hypothesis is verified by comparing the significance levels of the independent variables in response to the defined confidence intervals (Hair et al. 2010). Table 8.22 shows the output of the likelihood ratio test using a multinomial logistic regression.

Table 8.22: Likelihood ratio tests

Enabling factors	Model fitting criteria	Likelihood ratio tests		
	–2 log likelihood of reduced model	Chi-square	df	Sig.
Intercept	267.606	9.772	2	.008
Relative advantage	284.482	26.647	2	.000
Complexity	330.650	72.816	2	.000
Compatibility	260.111	2.277	2	.320
Trialability	260.767	2.932	2	.231
Observability	273.989	16.154	2	.000
Competitive pressure	279.829	21.995	2	.000
Vendor selection	272.097	14.263	2	.001
Absorptive capacity	262.026	4.192	2	.123
Organisational resource availability	296.429	38.595	2	.000
Owner-managers' innovativeness	265.907	8.072	2	.018
Owner-managers' IT knowledge	262.815	4.981	2	.083

The Chi-square statistic is the difference in –2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

As shown in Table 8.22, some independent variables find an overall relationship between the dependent and independent variable, whereas others support the null hypothesis. Here, the regression is applied with a 95% confidence interval in which the p-value is less than the established cutoff of 0.05 for an independent variable. As a result, the independent variable contributes significantly to the full model, indicating that it has a significant relationship with the dependent variable. Therefore, of the eleven enabling factors used in the model, seven have a significant relationship with BI adoption. These include relative advantage, complexity, observability, competitive pressure, vendor selection, owner-managers' innovativeness and organisational resource availability. The remaining four factors, including compatibility, trialability, absorptive capacity, and owner-managers' IT knowledge, do not have a significant relationship with BI adoption.

Additionally, the likelihood ratio tests can be used to find out which enabling factors are important in predicting group membership by considering the value of –2 log likelihood (–2LL). As seen in Table 8.23, out of seven significant factors, Complexity emerged as the most predicting factor of BI adoption due to having the highest –2LL (330.650). The second most significant was Organisational resource availability with –2LL 296.429, and the third was Relative advantage with –2LL 284.482. Competitive pressure, Observability and Vendor selection followed with –2LL 279.829, 273.989 and 272.097, respectively. Owner-managers' innovativeness ranked last in the series of driving factors with –2LL 265.907. A summary of this ranking of enabling factors in BI adoption from most important to least is provided in Table 8.23.

Table 8.23: Ranking of importance of enabling factors in BI adoption

Enabling factors	Model fitting criteria	Likelihood ratio tests		
	–2 log likelihood of reduced model	Chi-square	df	Sig.
Complexity	330.650	72.816	2	.000
Organisational resource availability	296.429	38.595	2	.000
Relative advantage	284.482	26.647	2	.000
Competitive pressure	279.829	21.995	2	.000
Observability	273.989	16.154	2	.000
Vendor selection	272.097	14.263	2	.001

Following the likelihood of ratio tests presented in Table 8.23, the parameter estimates are analysed to find the effects of the significant independent variables on differentiating the levels of BI adoption in detail. The output of parameter estimates table can be seen in Table 8.24.

Table 8.24: Parameter estimates

Levels of BI adoption[a]		B	Std Error	Wald	df	Sig.	Exp (B)	95% Confidence interval for exp (B)	
								Lower bound	Upper bound
Consolidate	Intercept	–12.605	4.342	8.426	1	.004			
	Relative advantage	2.891	.685	17.796	1	.000	18.010	4.701	69.000
	Complexity	–2.545	.552	21.277	1	.000	.078	.027	.231
	Compatibility	–.746	.557	1.795	1	.180	.474	.159	1.413
	Trialability	–.731	.450	2.644	1	.104	.481	.199	1.162
	Observability	1.168	.576	4.106	1	.043	3.215	1.039	9.951
	Competitive pressure	2.737	.646	17.962	1	.000	15.446	4.355	54.775
	Vendor selection	2.037	.628	10.518	1	.001	7.669	2.239	26.265
	Absorptive capacity	–.712	.616	1.335	1	.248	.491	.147	1.641
	Organisational resource availability	–.285	.470	.367	1	.545	.752	.300	1.889
	Owner-managers' innovativeness	1.381	.518	7.099	1	.008	3.980	1.441	10.995
	Owner-managers' IT knowledge	–1.037	.481	4.648	1	.031	.354	.138	.910
Integrate+	Intercept	–14.329	5.168	7.689	1	.006			
	Relative advantage	2.507	.759	10.913	1	.001	12.265	2.772	54.276
	Complexity	–4.936	.713	47.885	1	.000	.007	.002	.029
	Compatibility	–.935	.659	2.012	1	.156	.393	.108	1.429
	Trialability	–.848	.570	2.214	1	.137	.428	.140	1.309
	Observability	2.458	.692	12.631	1	.000	11.686	3.012	45.335
	Competitive pressure	2.571	.759	11.465	1	.001	13.084	2.953	57.962
	Vendor selection	1.854	.710	6.826	1	.009	6.388	1.589	25.677
	Absorptive capacity	–1.467	.756	3.763	1	.052	.231	.052	1.015
	Organisational resource availability	1.906	.608	9.836	1	.002	6.729	2.044	22.147
	Owner-managers' innovativeness	1.452	.622	5.459	1	.019	4.273	1.264	14.448
	Owner-managers' IT knowledge	–1.032	.582	3.144	1	.076	.356	.114	1.115

a. The reference category is: Operate.

Regarding the independent variables that are found significant in the likelihood ratio test, the role of these independent variables in differentiating between groups of the dependent variable is analysed from the parameter estimates table. As mentioned earlier in section 8.6.2, there are two logistic regression equations in this study; these two equations in the table are labelled by the group they contrast to the reference group, which is illustrated in the footnote embedded in the table. The first equation is labelled 'Consolidate' and the second equation is labelled 'Integrate+'. The coefficients for each logistic regression equation are found in the column labelled B and the p-value for each independent factor is found in the column labelled 'Sig.' indicating that this independent factor has a relationship in distinguishing the groups of dependent when p-value is less than 0.05. From Table 8.24, the values of the coefficient can be transferred into the two logistic regression equations for predicting the dependent variable from the independent variables. The first equation was demonstrated by the enabling factors that have a statistical significant relationship to distinguishing the Operate level from the Consolidate level, including Relative advantage, Complexity, Observability, Competitive pressure, Vendor selection and Owner-manager's innovativeness. After applying the coefficients of significant independent variables, the first logistic regression equation was:

$$\text{Logit}\ (P_{\text{Consolidate}}) = \ln\left[\frac{P(Considerate)}{P(Operate)}\right] = -12.605 + 2.891RAD - 2.545COM + 1.168OBS + 2.737CPP + 2.037VEN + 1.381OIN$$

The second equation was demonstrated by the enabling factors that have a statistical significant relationship to distinguishing the Operate level from the Integrate level, including Relative advantage, Complexity, Observability, Competitive pressure, Vendor selection, Organisational resource availability and Owner-manager's innovativeness. After applying the coefficients of significant independent variables, the second logistic regression equation was:

$$\text{Logit}\ (P_{\text{Integrate}}) = \ln\left[\frac{P(Integrate)}{P(Operate)}\right] = -14.329 + 2.507RAD - 4.936COM + 2.458OBS + 2.571CPP + 1.854VEN + 1.906ORE + 1.452OIN$$

Where:
Negative regression coefficient means that the influence factor decreases the probability of the outcome.
Positive regression coefficient means that the influence factor increases the probability of the outcome.
A large regression coefficient means that the influence factor is strongly influencing the probability of the outcome.
A small or near zero regression coefficient means that the influence factor is weakly influencing the probability of the outcome.

8.7.5 Kruskal-Wallis (K-W)

A Kruskal-Wallis test was used to further analyse data in this study in order to gain a better understanding of the association between the dependent variable and independent variables. This test was employed to compare the three groups of SMEs based on BI adoption levels (Operate, Consolidate, and Integrate+). The main assumption of this test is that dependent variables can be meaningfully ranked into a logical order. In this study, the dependent variables are consistent with the Kruskal-Wallis assumption and are classified and ranked from low to high based on BI adoption levels. The null hypothesis of the Kruskal-Wallis test is that there are significant differences of the critical factors across the three groups of BI adoption levels. However, the null hypothesis is rejected due to the *p* value of the Kruskal-Wallis statistic being less than 0.05. Results of the Kruskal-Wallis test for all independent variables are provided in accordance with the four characteristics presented in the research framework.

Technological characteristics – The ranks and test statistics for the Kruskal-Wallis test for all factors under the technological characteristics are provided in Table 8.25.

Table 8.25: Kruskal-Wallis test for technological characteristics

Ranks

	Level of BI	N	Mean rank
Relative advantage	Operate	206	126.95
	Consolidate	136	289.79
	Integrate+	85	303.69
	Total	427	
Complexity	Operate	206	311.10
	Consolidate	136	155.68
	Integrate+	85	71.98
	Total	427	
Compatibility	Operate	206	211.22
	Consolidate	136	205.54
	Integrate+	85	234.28
	Total	427	
Trialability	Operate	206	206.82
	Consolidate	136	210.00
	Integrate+	85	237.81
	Total	427	
Observability	Operate	206	156.02
	Consolidate	136	248.70
	Integrate+	85	298.99
	Total	427	

Test statistics[a,b]

	Relative advantage	Complexity	Compatibility	Trialability	Observability
Chi-square	200.737	274.851	3.191	4.142	98.972
df	2	2	2	2	2
Asymp. Sig.	.000	.000	.203	.126	.000

a. Kruskal-Wallis test
b. Grouping variable: Level of BI

The first part of the Kruskal-Wallis test (Table 8.25) presents the mean rank of all five factors under the technological characteristics in each group of BI adoption. The operated organisations had the lowest mean rank score from four out of five factors, including relative advantage, compatibility, trialability and observability. Regarding all these four factors, the following mean rank score was from the consolidated organisations. The integrated organisations had the highest score of all these four factors. However, complexity was one of the five factors which had an inverse trend with the integrated organisations having the lowest score of complexity followed by the consolidated organisations, and the operated organisations having the highest score. In regard to test statistics, the results of significant testing among five factors under technological characteristics are dissimilar. Three out of five factors were found to have significant differences across the three groups of BI adoption, including relative advantage (Chi-square = 200.737 with p-value = 0.000), complexity (Chi-square = 274.851 with a p-value = 0.000) and observability (Chi-square 98.972 with a p-value = 0.000). However, two out of five were found to have no significant differences across the three groups of BI adoption, including compatibility (Chi-square = 3.191 with a p-value = 0.203) and trialability (Chi-square = 4.142 with a p-value = 0.126).

Environmental characteristics – The ranks and test statistics for the Kruskal-Wallis test for all factors under the environmental characteristics are provided in Table 8.26.

Table 8.26: Kruskal-Wallis test for environmental characteristics

Ranks

Factor	Level of BI	N	Mean rank
Competitive pressure	Operate	206	120.45
	Consolidate	136	287.64
	Integrate+	85	322.90
	Total	427	
Vendor selection	Operate	206	122.85
	Consolidate	136	290.03
	Integrate+	85	313.26
	Total	427	

Test statistics[a,b]

	Competitive pressure	**Vendor selection**
Chi-square	236.310	221.422
df	2	2
Asymp. Sig.	.000	.000

a. Kruskal-Wallis test
b. Grouping variable: Level of BI

The first part of the Kruskal-Wallis test (Table 8.26) presents the mean rank of two factors under the environmental characteristics in each group of BI adoption. The operated organisations had the lowest score of both factors, including competitive pressure and vendor selection, followed by the consolidated organisations. The integrated organisations had the highest level of both factors. The test statistics show that the Chi-square of competitive pressure is 236.310 with a p-value of 0.000 whereas the Chi-square of vendor selection is 221.422 with a p-value of 0.000. Thus it can be concluded that both factors under the environmental characteristics, including the competitive pressure and vendor selection, have significant differences across the three groups of BI adoption.

Organisational characteristics – The ranks and test statistics for the Kruskal-Wallis test for all factors under the organisational characteristics are provided in Table 8.27.

Table 8.27: Kruskal-Wallis test for organisational characteristics

Ranks

Factor	Level of BI	N	Mean rank
Absorptive capacity	Operate	206	210.12
	Consolidate	136	211.93
	Integrate+	85	226.72
	Total	427	
Organisational resource availability	Operate	206	158.61
	Consolidate	136	218.12
	Integrate+	85	341.64
	Total	427	

Test statistics[a,b]

	Absorptive capacity	Organisational resource availability
Chi-square	1.225	134.057
df	2	2
Asymp. Sig.	.542	.000

a. Kruskal-Wallis test
b. Grouping variable: Level of BI

The first part of the Kruskal-Wallis test (Table 8.27) presents the mean rank of two factors under the organisational characteristics in each group of BI adoption. Again, the operated organisations had the lowest score of both factors, including absorptive capacity and organisational resource availability, followed by the consolidated organisations. The integrated organisations had the highest score of both absorptive capacity and organisational resource availability. However, the results of test statistics are dissimilar between the two factors under the organisational characteristics. Due to the Chi-square of absorptive capacity being 1.225 with p-value of 0.542, the absorptive capacity was found to have no significant differences across the three groups of BI adoption. However, as the Chi-square of organisational resource availability was 134.057 with p-value of 0.000, it can be concluded that there are significant differences in organisational resource availability across the three groups of BI adoption.

Owner-manager characteristics – The ranks and test statistics for the Kruskal-Wallis test for all factors under the owner-manager characteristics are provided in Table 8.28.

Table 8.28: Kruskal-Wallis test for owner-manager characteristics

Ranks

Factor	Level of BI	N	Mean rank
Owner-managers' innovativeness	Operate	206	184.03
	Consolidate	136	228.94
	Integrate+	85	262.71
	Total	427	
Owner-managers' IT knowledge	Operate	206	214.47
	Consolidate	136	198.82
	Integrate+	85	237.14
	Total	427	

Test statistics[a,b]

	Owner-managers' innovativeness	**Owner-managers' IT knowledge**
Chi-square	27.772	5.115
df	2	2
Asymp. Sig.	.000	.077

a. Kruskal-Wallis test
b. Grouping variable: Level of BI

The first part of the Kruskal-Wallis test (Table 8.28) presents the mean rank of two factors under the owner-manager characteristics in each group of BI. The operated organisations had the lowest score of owner-managers' innovativeness, followed by the consolidated organisations. Conversely, the lowest score of owner-managers' IT knowledge was from the consolidated organisations, followed by the operated organisations. The integrated organisations had the highest score of both factors including owner-managers' innovativeness and IT knowledge. However, the results of test statistics are dissimilar between the two factors under the owner-manager characteristics. The test statistics show that the Chi-square of owner-managers' innovativeness is 27.772 with a p-value of 0.000, whereas the Chi-square of owner-managers' IT knowledge is 5.115 with a p-value of 0.077. Thus, it can be concluded that the owner-managers' innovativeness shows significant differences across the three groups of BI adoption, whereas owner-managers' IT knowledge shows no significant differences across the three groups of BI adoption. Nevertheless, when considering the p-value of owner-manager's IT knowledge, this value is close to the cutoff point 0.05. Therefore, it should be noted that when the Kruskal-Wallis test is applied with a 90% confidence interval, it can be concluded that the owner-managers' IT knowledge has significant differences across the three groups of BI adoption.

8.8 Hypotheses testing

The significance of the enabling factors affecting BI adoption is analysed according to the results obtained from the likelihood ratio tests and the parameter estimates outputs of the multinomial logistic regression (section 8.7.4), and the Kruskal-Wallis test (section 8.7.5). Eleven hypotheses are discussed in accordance with the four characteristics presented in the research framework.

Technological characteristics

H1: *BI's relative advantage affects BI adoption in Thai SMEs.*

With a significance level of 0.000, relative advantage is found to be significant in the likelihood ratio test. This implies that the relationship between relative advantage and the adoption of BI is significant. Consequently, as BI's relative advantage affects BI adoption in Thai SMEs, Hypothesis 1 is supported.

As relative advantage has an impact on the BI adoption decision, the potential of relative advantage in distinguishing the reference organisational group (Operate) from others can be interpreted by the parameter estimates table shown in Appendix O. Also, the Exp (B) values in this table are used to examine the dependent group favoured by each factor. An Exp (B) of less than 1 indicates that the probability of being in the reference dependent group increases for each unit increase in the related independent variable. Conversely, when the Exp (B) value is more than 1, the probability of being in another dependent group increases for each unit increase in the related independent variable (Field 2009). From the parameter estimates table, relative advantage is found to be significant in distinguishing between both the Operated with Consolidated organisations and the Operated with Integrated organisations, due to both having a significance level of 0.05. In addition, the corresponding Exp (B) values are displayed as 18.010 and 12.265, respectively, as both are more than 1. Thus it can be concluded that it would be more probable that respondents rating a high relative advantage would be in the Consolidated or Integrated organisations rather than Operated organisations (reference group).

In addition to significant effects in BI adoption, relative advantage is found to be significantly different across the three groups of organisations. The lowest mean rank of relative advantage is found in the Operated organisations, followed by Consolidated and then Integrated organisations. The Kruskal-Wallis test shows the p-value of relative advantage as 0.00, so it can be concluded that there are different perceptions of relative advantage across the three groups of organisations.

H2: *BI's complexity affects BI adoption in Thai SMEs.*

The likelihood ratio test verifies the significance of the factor complexity which has a significance level of 0.000. This test implies that the adoption of BI is affected by complexity, which consequently substantiates Hypothesis 2.

Having shown that complexity has an impact on BI adoption decisions, the potential of complexity in distinguishing the reference organisations with others is analysed more deeply. From the parameter estimates table, complexity has an acceptable significance level in distinguishing between both the Operated with the Consolidated organisations and the Operated with the Integrated organisations. Also, as both corresponding Exp (B) values are less than 1, it should be interpreted that it is more probable that respondents who rate complexity higher would be in the Operated organisations rather than the Consolidated or Integrated organisations.

Further analysis using the Kruskal-Wallis test to determine factor complexity found significant differences across the three groups of organisations. Moreover, the mean rank of complexity has an inverse trend to the other factors: Operated organisations have the highest mean rank and Integrated organisations have the lowest. Owing to the p-value of complexity being 0.00 provided by the Kruskal-Wallis test, it can be concluded that the perceptions of complexity across three groups of organisations are different from each other.

H3: *BI's compatibility affects BI adoption in Thai SMEs.*

According to the likelihood ratio test, compatibility is found to be non-significant. Due to having a significance level of 0.320 which is greater than 0.05, the existence of a relationship between compatibility and BI adoption is not supported. As a result, Hypothesis 3 proposing that BI's compatibility affects BI adoption in Thai SMEs is rejected.

Since there is no significant relationship between compatibility and BI adoption, this factor is not able to be used to distinguish the reference organisational group with other groups. Therefore, results from the parameter estimates table are pointless and not taken into account for this factor.

Besides non-significance of the compatibility factor in affecting BI adoption, results from the Kruskal-Wallis test also show no significant differences of this factor across the three groups of organisations. As the p-value of compatibility is non-significant at 0.203, it can be deduced that there are no difference in compatibility across the three organisational groups.

H4: *BI's trialability affects BI adoption in Thai SMEs.*

The likelihood ratio test found that trialability has no significant effect on the BI adoption decision due to having a significance level of 0.231, which is greater than 0.05. This provides evidence that there is no significant relationship between trialability and the adoption of BI. Consequently, Hypothesis 4, proposing that BI's trialability affects BI adoption in Thai SMEs, is not supported.

As there is not a significant relationship between the factor of trialability and BI adoption, this factor is not able to be used to distinguish between the reference organisational group and other groups. Therefore, results from the parameter estimates table are pointless and not taken into account for this factor.

Trialability has been found no significant in affecting BI adoption using multinomial logistic regression; the Kruskal-Wallis test also found no significant differences in trialability across the three organisational groups due to having a p-value of 0.126. Therefore, it can be deduced that there is no difference in trialability across the three organisational groups.

H5: *BI's observability affects BI adoption in Thai SMEs.*

With a significance level of 0.000, observability is found to be significant in the likelihood ratio test. This implies that the relationship between observability and BI adoption is significant. Consequently, as BI's observability affects BI adoption in Thai SMEs, Hypothesis 5 is confirmed.

Considering the parameter estimates table, observability is found to be significant in distinguishing both the categories between the Operated with Consolidated organisations, and the Operated with Integrated organisations due to having a significance level of 0.043 and 0.000, respectively. Moreover, the corresponding Exp (B) values are displayed as 3.215 and 11.686, respectively, as both are more than 1, so it can be concluded that the respondents who rate observability higher are more likely to be in the Consolidated or the Integrated organisations rather than the Operated organisations.

In addition to the multinomial logistic regression that found observability as a significant factor in affecting BI adoption and in distinguishing between Operated with Consolidated organisations, the Kruskal-Wallis test found observability as having significant differences across the three organisational groups of BI adoption with a p-value of 0.00. Respondents in the Integrated organisations rated observability with the highest scores followed by Consolidated and Operated with the lowest. As a result, it can be deduced that observability of organisations across the three groups is different.

Environmental characteristics

H6: *Competitive pressure affects BI adoption in Thai SMEs.*

The likelihood ratio test verifies the significance of competitive pressure, which has a significance level of 0.000. This test implies that the adoption of BI is affected by competitive pressure, which consequently supports Hypothesis 6.

Having shown that competitive pressure has an impact on BI adoption decisions, the potential of competitive pressure in distinguishing the reference organisations with others is analysed more deeply. From the parameter estimates table, competitive pressure has an acceptably significant level in distinguishing between the Operated with Consolidated organisations and the Operated with Integrated organisations due to having a significance level of 0.000 and 0.001, respectively. Additionally, the corresponding Exp (B) values are displayed as 15.446 and 13.084, respectively, as both are more than 1. Therefore, it can be deduced that respondents rating a high competitive pressure are more likely to be in the Consolidated or Integrated organisations rather than Operated organisations.

Further analysis using the Kruskal-Wallis test to determine factor competitive pressure found significant differences across the three groups of organisations. Again, the results of the Kruskal-Wallis test for this factor have the same pattern as the other factors. The lowest mean rank of competitive pressure is in the Operated organisations, followed by Consolidated and then Integrated organisations. Owing to the p-value of competitive pressure being 0.00 provided by the Kruskal-Wallis test, it can be concluded that the importance of competitive pressure across three groups of organisations is different in each.

H7: *Vendor selection affects BI adoption in Thai SMEs.*

According to the likelihood ratio test, vendor selection is found to be significant. Because of having a significance level of 0.001 which is less than 0.05, the existence of a relationship between vendor selection and BI adoption is supported. Consequently, Hypothesis 7 proposing that vendor selection affects BI adoption in Thai SMEs is confirmed.

Considering the parameter estimates table, vendor selection is found to be significant in distinguishing both the categories between the Operated with Consolidated organisations, and the Operated with Integrated organisations due to having a significance level of 0.001 and 0.009, respectively. Moreover, the corresponding Exp (B) values are displayed as 7.669 and 6.388, respectively, as both are more than 1, so it can be concluded that the respondents, who rate vendor selection higher, are more likely to be in the Consolidated or the Integrated organisations rather than the Operated organisations.

In addition to significant effects in BI adoption, vendor selection is found to be significantly different across the three groups of organisations. Again, the Operated organisations have the lowest mean rank of vendor selection and the Consolidated has the middle mean rank, whereas the Integrated organisations have the highest mean rank. Also, the Kruskal-Wallis test shows the p-value of vendor selection as 0.00, consequently it can be concluded that the importance of vendor selection across the three groups of organisations is different in each.

Organisational characteristics

H8: *Absorptive capacity affects BI adoption in Thai SMEs.*

Absorptive capacity is found to be no significant in the likelihood ratio test. Due to having a significance level of 0.123, which is greater than the confidence level required, the existence of a relationship between absorptive capacity and BI adoption is not supported. As a result, Hypothesis 8, proposing that absorptive capacity affects BI adoption in Thai SMEs, is rejected.

Since a relationship between the factor of absorptive capacity and BI adoption has not been found in the likelihood ratio test, the results from the parameter estimates table can be overlooked because the factor absorptive capacity does not have the capability to distinguish between the reference organisational group with other groups.

Not only the multinomial logistic regression found no significant of absorptive capacity in affecting BI adoption, but the results from a Kruskal-Wallis test also found no significant differences in absorptive capacity across the three groups of organisations. The results show that the absorptive capacity has a p-value of 0.542, so it can be implied that absorptive capacity across the three groups of organisations does not differ.

H9: *Organisational resource availability affects BI adoption in Thai SMEs.*

With a significance level of 0.000, organisational resource availability is found to be significant in the likelihood ratio test. This implies that the relationship between organisational resource availability and BI adoption exists. Consequently, Hypothesis 9 proposing that organisational resource availability affects BI adoption in Thai SMEs is supported.

According to the parameter estimates table, organisational resource availability is found to be no significant in distinguishing the organisations between Operated and Consolidated due to the significance level of organisational resource availability not meeting the 95% confidence level required. However, this conclusion does not apply when distinguishing the organisations between Operated and Integrated, since their significance level is 0.002. Also, it is found that respondents who rate this factor higher are more likely to be in the Integrated organisations than the Operated organisations due to having an Exp (B) value as 6.729 which is more than 1. Hence, it can be deduced that organisational resource availability is a significant factor that can distinguish organisations between the Operated and Integrated but cannot distinguish between the Operated and Consolidated organisations.

Further analysis using the Kruskal-Wallis test to determine factor organisational resource availability found significant differences across the three organisational categories of BI adoption. Again, the results of the Kruskal-Wallis test for this factor have the same pattern as the other factors. The lowest mean rank is in the Operated organisations, followed by the Consolidated and then Integrated organisations. Owing to the p-value of organisational resource availability being 0.00, it can be implied that organisational resource availability across the three groups of organisations is different in each.

Owner-manager characteristics

H10: *Owner-managers' innovativeness affects BI adoption in Thai SMEs.*

According to the likelihood ratio test, owner-managers' innovativeness is found to be significant. Due to the significance level of owner-managers' innovativeness as 0.018, which is less than 0.05, the existence of a relationship between owner-managers' innovativeness and BI adoption is supported. As a result, Hypothesis 10 proposing that owner-managers' innovativeness affects BI adoption in Thai SMEs, is confirmed.

Having shown that owner-managers' innovativeness has an impact on BI adoption decisions, the potential of owner-managers' innovativeness in distinguishing the reference organisations with others is analysed more deeply. From the parameter estimates table, owner-managers' innovativeness has an acceptably significant level in distinguishing between the Operated with Consolidated organisations and the Operated with Integrated organisations due to having a significance level of 0.008 and 0.019, respectively. Additionally, the corresponding Exp (B) values are displayed as 3.980 and 4.273, respectively, as both are more than 1. Therefore, it can be deduced that respondents rating a high owner-managers' innovativeness are more likely to be in the Consolidated or Integrated organisations rather than Operated organisations.

Further analysis using the Kruskal-Wallis test to determine factor owner-managers' innovativeness found significant differences across the three groups of organisations. Again, the results of the Kruskal-Wallis test for this factor have the same pattern as the other factors. The lowest mean rank of owner-managers' innovativeness is in the Operated organisations, followed by Consolidated and then Integrated organisations. Owing to the p-value of competitive pressure being 0.00 provided by the Kruskal-Wallis test, it can be concluded that the importance of owner-managers' innovativeness across three groups of organisations is different in each.

H11: *Owner-managers' IT knowledge affects BI adoption in Thai SMEs.*

The last hypothesis proposes that owner-managers' IT knowledge affects BI adoption in Thai SMEs. However, according to the likelihood ratio test, owner-managers' IT knowledge is found to be no significant. Due to having a significance level of 0.083, which is greater than 0.05, the existence of a relationship between owner-managers' IT knowledge and BI adoption is not supported, which leads to the rejection of Hypothesis 11.

As there is no significant relationship between owner-managers' IT knowledge and BI adoption, this factor is not able to be used to distinguish the reference organisational group from other groups. Therefore, the results from the parameter estimates table are pointless and not taken into account for this factor.

Not only the multinomial logistic regression found no significant of owner-managers' IT knowledge in affecting BI adoption, but the results from a Kruskal-Wallis test also found no significant differences in owner-managers' IT knowledge across the three groups of organisations. The results show that the owner-managers' IT knowledge has a p-value of 0.077, so it can be implied that owner-managers' IT knowledge across the three groups of organisations does not differ.

From the results mentioned above, there were seven factors, including Relative advantages, Complexity, Observability, Competitive pressure, Vendor selection, Organisational resource availability and Owner-managers' innovativeness that were statistically significant in BI adoption of Thai SMEs. The results suggest that all hypotheses except H3, H5, H8 and H11 were supported. The hypothesis testing is summarised in Table 8.29.

Table 8.29: Summary of hypothesis testing

Hypotheses	Determinant factors	Results
Technological characteristics		
H1	Relative advantages	Supported
H2	Complexity	Supported
H3	Compatibility	Not supported
H4	Trialability	Supported
H5	Observability	Not supported
Environmental characteristics		
H6	Competitive pressure	Supported
H7	Vendor selection	Supported
Organisational characteristics		
H8	Absorptive capacity	Not supported
H9	Organisational resource availability	Supported
Owner-manager characteristics		
H10	Owner-managers' innovativeness	Supported
H11	Owner-managers' IT knowledge	Not supported

8.9 Chapter summary

The overall objective of this chapter has been to present the results from data analysis. This chapter began with the process of administering questionnaires, followed by the evaluation of non-response bias. Then the process of data preparation for converting the raw data from questionnaires into information was provided to ensure that data obtained was of a good standard, consistent and accurate. The measurement model of this study was evaluated in three steps. First, the correlation of items in the dependent variable was tested by Spearman correlation, second the convergent and discriminant validity were confirmed using factor analysis, third the reliability analysis of independent variables was verified by calculating the coefficient scores for Cronbach's alpha. Both validity and reliability from these three steps were demonstrated as acceptable for further analysis. Next, the research results were provided based on a number of statistical techniques, including descriptive statistics, multinomial logistic regression, and the non-parametric test of Kruskal-Wallis.

Descriptive statistics were used in presenting demographic information of the respondents, characteristic of responding organisations, and the proportion of BI adoption at each level. Inferential statistics including multinomial logistic regression and non-parametric of Kruskal-Wallis were used to make predictions and generalise the result of analysis. The likelihood ratio test in multinomial logistic regression was employed to examine the hypotheses of this study, whereas a parameter estimates table was used to measure the ability of each enabling factor in distinguishing the organisational groups of BI adoption levels. The Kruskal-Wallis test was then used as a further analysis to observe associations between the enabling factors and the organisational groups based on BI adoption levels. Based on the results of this study, findings confirmed that seven out of eleven factors under four characteristics, including technological, environmental, organisational and owner-manager, are significant factors impacting BI adoption in Thai SMEs including Relative advantage, Complexity, Observability, Competitive pressure, Vendor selection, Organisational resource availability and Owner-managers' innovativeness. Moreover, levels of BI adoption from the Kruskal-Wallis test further suggested that all seven factors had significant differences across the organisational groups of BI adoption in Thai SMEs. Finally, a summary of the hypotheses testing was provided based on all techniques using inferential statistics.

Research findings will be discussed in more detail and overall conclusions of the study presented in the next chapter. This chapter will also show the significance of theoretical and practical implications from these research findings. Limitations and future research directions are also provided.

CHAPTER 9: DISCUSSION AND CONCLUSION

9.0 Introduction

Chapter 8 of this thesis presented the statistical results used to examine the hypotheses identified in Chapter 6. This final chapter now interprets the findings of the study and fulfils the research purpose by answering the three research questions outlined in Chapter 1. The first section of this chapter begins with a discussion of the descriptive statistic results. Then moving into the level of BI, this section presents the state of BI adoption by Thai SMEs. Next, the main findings of this study are presented, with the results of all eleven hypotheses being discussed and summarised. The research limitations and directions for future research are identified and discussed before concluding with an overall summary of the thesis findings.

9.1 Descriptive statistic results

In employing a stratified sampling technique, this study selected 2,000 organisations leading to a large sample size. From these, usable responses for data analysis emanated from 427 organisations, which number is fully adequate to represent the target population of SMEs across Thailand. Descriptive statistics conducted in the previous chapter presented the basic features of these organisations to use as data for the study. Based on the details of the demographic aspects of BI adoption, the results have been divided into two parts. First are the general characteristics of owner/manager, and second the general characteristics of SMEs. Results of findings from these two parts are discussed next.

9.1.1 General characteristics of owner/manager

As the role of owner-manager/manager sets the direction of an organisation, particularly in SMEs where the management hierarchy is smaller and more flexible, it can be argued that the attitude and actions of owner-managers/managers in SMEs will impact on the organisational performance. In this study the majority of respondents (63.7%) held owner-manager positions, with 33.6% being managers and only 2.1% holding other positions such as family business successor or senior employee. As the gender of these owner-managers/managers was male at around 60%, with females at around 40%, gender representation in business management was relatively balanced, with females playing a key role in leading organisations in Thailand.

In terms of age, although the range is dispersed across all groups, respondents tended to be young, with around half being between 21–40 years. In terms of education, the owner-managers/managers in this study were well educated, with more than half having at least a bachelor degree, and most of the rest holding vocational certificates or diplomas. Only a small number (12.6%) of owner-managers/managers held high school or equivalent qualifications. This indicates that the results throughout this study were made by 'informed' respondents.

In terms of the usefulness of the findings obtained in this study survey, findings are all useful for government agencies and IT providers launching new technology projects dealing with SMEs. Their SME projects need to initially target owner-managers/managers of both genders who are young and hold some form of professional qualification. However, in projects aimed at further promoting IT adoption among SMEs, target participants need to be owner-managers/managers who are older and high-school leavers with experience, rather than only having professional qualifications.

9.1.2 General characteristics of SMEs

Based on the Thailand Ministry of Industry, SMEs in this study have been categorised into four main industry sectors, including retail, service, manufacturing and wholesale, with the list of SMEs used in the sampling frame being retrieved from the Office of Small and Medium Enterprises Promotion (OSMEP). As mentioned in Chapter 7, the proportion of organisations in industry sectors were retail at 39%, service at 33%, manufacturing at 18.71% and wholesale at 8.53%. Here, the proportions of industry sectors from returned responses were consistent with the sampling frame, and the majority of returned responses were from the retail sector at 37.5%, service sector at 23.4%, manufacturing sector at 20.6%, and wholesale sector at 18.5%. Overall, returned response rates in each sector were around 20%, except in the wholesale sector which was more than 45%. As a result of this disparity in the rate of questionnaire responses, it can be noted that wholesalers responded more readily to the information system survey than other industry sectors. However, although the survey findings reflect a current diffusion of technology at the industry sector level, analysis did not go deeply into details about each specific industrial sector type of SMEs as comparison is only between the industry sectors of SMEs.

In regard to the sizes of surveyed organisations, 64% of responding SMEs were categorised as small-sized businesses, with almost half being classified as micro businesses with less than 10 employees. Only 36% of the responding organisations were medium-sized. In terms of length of time in business, the proportion of responses was equally dispersed at approximately 30%, ranging from less than one year to more than ten years, with only 14% of responses being operational for less than one year. These findings indicate that although there is room to encourage small start-up businesses to pay more attention to the implementation of IT, utilisation of computer software to support business activities among Thai SMEs is still lower. Here, results from respondents show that the majority of SMEs limit the use of computer software to support their businesses, with the majority of them using computer software in only a few business activities. Also, they mainly used software for basic administrative activities such as financial accounting and stock control. Although these findings hold for both small and medium-sized organisations, the latter tends to put higher emphasis on the use of IT than their smaller counterparts. These findings are similar to prior observations that SMEs do not use the full potential of IT in their businesses for reasons of limited resources, lack of knowledge and ignorance of the benefits of IT (Chuang, Nakatani & Zhou 2009). Therefore, more encouraging programs need to be launched to make SMEs better understand the advantages of IT in supporting their business activities.

9.2 The current state of BI adoption levels in Thai SMEs

In this study, the technological innovation of BI is perceived as an IT tool that SMEs can use to support their business operations to increase business performance. Findings reveal that Thai SME respondents can be categorised into three major levels of BI adoption, Operate, Consolidate and Integrate+, based on an enhanced information evolution model (IEM). The first level, Operate, was the lowest level in BI adoption, with organisations typically focusing on general information processing from day-to-day operations and operating in a chaotic information environment in which information access, analysis and implementation were not standardised. In Consolidate, the second level of BI adoption, organisations store, integrate, and consolidate information to allow increased data analysis capability when information is not centralised but distributed among each group of users. The third and highest level of BI adoption is Integrate+. At this level, organisations operate in a standardised information environment that allows new knowledge to be gained from an enterprise-wide analysis that supports the organisation in making business decisions.

Further analysis of data found that almost half of the participating organisations are in the lowest level of BI, Operate (48.25%). This is followed by Consolidate (31.85 %), and then Integrate+ (19.90%). Due to the high number of organisations classified in the lowest level of BI, it is clear that Thai SMEs are at an early stage of BI technology adoption. The Operate level can be seen as the starting point in adoption of BI technologies, because BI applications used by organisations in this level are not complicated and do not require high IT infrastructure or knowledge to implement. For organisations to extend to the more advanced Consolidate and Integrate+ levels that focus on analytical processes, they need to develop their IT infrastructure, knowledge processes, human capital, and culture that supports information sharing. However, as such resources are not readily available to Thai SMEs, only a small number was classified in the upper levels of BI. With these results, there is ample scope to elevate Thai SMEs into higher levels of BI, and government or other parties wishing to encourage the use of BI technology need to consider the enabling factors that influence SMEs' decisions to adopt BI technologies. In this study, the eleven enabling factors involved in the adoption decision process have been tested, and the effects of each factor are discussed in the following section.

9.3 Summary of the factors affecting the adoption of BI in Thai SMEs

The key objective of this study was to investigate the primary research questions aimed at identifying the key factors influencing BI adoption in SMEs. In relation to the proposed hypotheses which were derived from previous studies related to the areas of IS, BI, decision support systems and SMEs, BI adoption was tested utilising a hypothesis-testing methodology. Using multinomial logistic regression, the study findings indicate the effect of each of the eleven proposed determinant factors. Based on the results analysing the hypotheses (see section 8.7), seven out of these eleven hypotheses are confirmed as displaying a significant influence on the participating SMEs' decision to adopt BI as follows: Hypotheses H1, H2 and H5 (Technological characteristics of relative advantage, complexity and observability), H6 and H7 (Environmental characteristics of competitive pressure and vendor selection), H9 (Organisational characteristics of organisational resource availability) and H10 (Owner-managers' characteristics of owner-managers' innovativeness). From these results, the model in Figure 6.1, Chapter 6, is revised and presented in Figure 9.1.

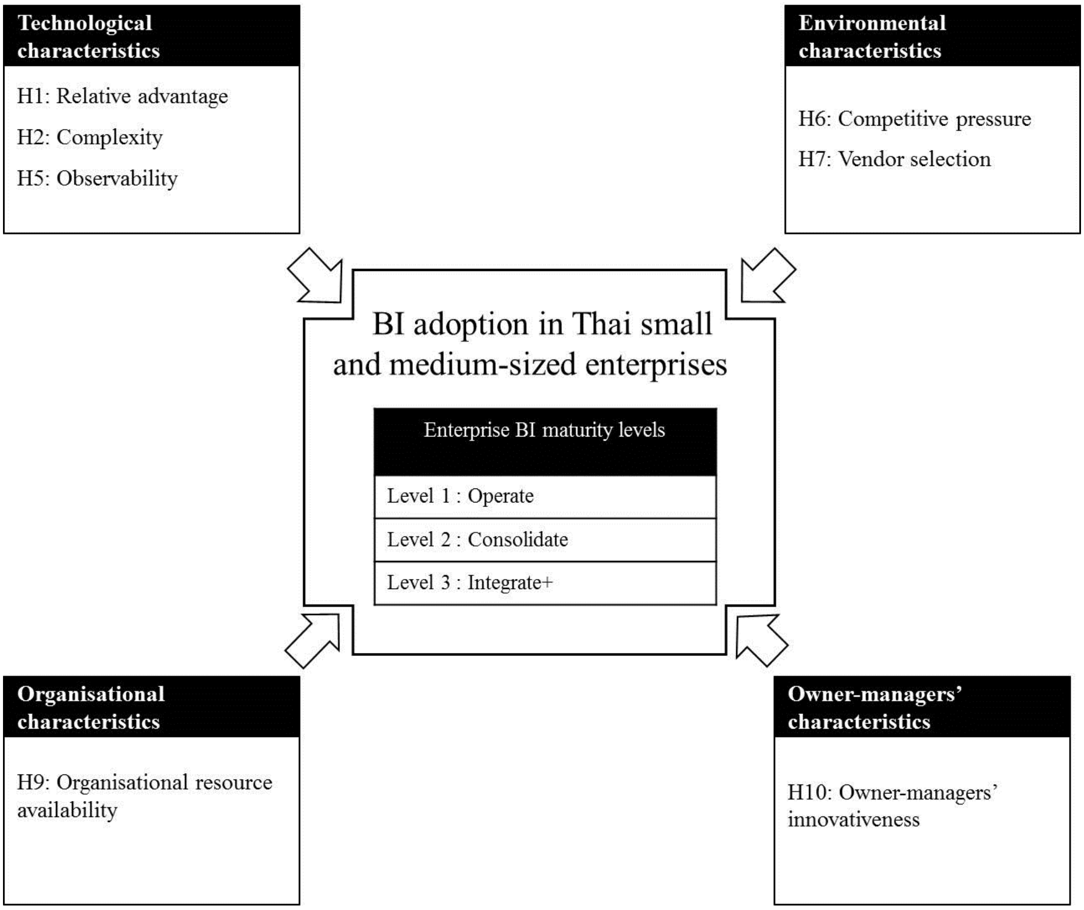


Figure 9.1: Key determinants of BI adoption in Thai SMEs

Due to their no significance, four out of the eleven hypotheses were rejected. Hypotheses H3 and H4 (Technological characteristics of compatibility and trialability), H8 (Organisational characteristics of absorptive capability) and H11 (Owner-managers' characteristics of owner-managers' IT knowledge) were found to have a non-significant relationship with BI adoption among Thai SMEs. Results from testing of these hypotheses derived from the research model are summarised in Table 9.1. Possible explanations with regard to the findings of each proposed hypothesis in comparison with previous study findings are discussed later in this section.

Table 9.1: Summary of hypothesis testing of this study comparing it with prior research

No.	Hypotheses	Results of this study	Conclusion	Results of prior studies on IT adoption in SMEs	IT
Technological factors					
H1	BI's relative advantage affects BI adoption in Thai SMEs	Supported	BI's relative advantage significantly influenced BI adoption in Thai SMEs	**Supported** • 150 SMEs in Malaysia (Alam & Noor 2009) • 268 SMEs in Iran (Ghobakhloo & Hong Tang 2013) • 100 SMEs in USA (Grandon & Pearson 2004) • 508 SMEs in Thailand (Sophonthummapharn 2009) • 146 SMEs in Malaysia (Alla, Rahman & Ismil 2012) **Unsupported** • 139 SMEs in Taiwan (Chang et al. 2010)	 ICT E-commerce E-commerce CRM AIS ERP
H2	BI's complexity affects BI adoption in Thai SMEs	Supported	BI's complexity significantly influenced BI adoption in Thai SMEs	**Supported** • 139 SMEs in Taiwan (Chang et al. 2010) • 508 SMEs in Thailand (Sophonthummapharn 2009) • 204 SMEs in Korea (Jeon, Han & Lee 2006) • 107 SMEs in Malaysia (Hussin & Noor 2005)	 ERP CRM E-commerce E-commerce
H3	BI's compatibility affects BI adoption in Thai SMEs	Not Supported	BI's compatibility did not significantly influence BI adoption in Thai SMEs	**Supported** • 139 SMEs in Taiwan (Chang et al. 2010) • 100 SMEs in USA (Grandon & Pearson 2004) • 268 SMEs in Iran (Ghobakhloo & Hong Tang 2013) • 58 SMEs in Singapore (Kendall et al. 2001) • 67 SMEs in Nigeria (Lal 2007) • 508 SMEs in Thailand (Sophonthummapharn 2009) • 102 SMEs in England (Ramdani, Chevers & Williams 2013) **Unsupported** • 107 SMEs in Malaysia (Hussin & Noor 2005) • 146 SMEs in Malaysia (Alla, Rahman & Ismil 2012) • 210 SMEs in Canada (Ifinedo 2011)	 ERP E-commerce E-commerce E-commerce ICT CRM Enterprise systems E-commerce AIS E-business technologies

Table 9.1: Summary of hypothesis testing of this study comparing it with prior research (continued)

No.	Hypotheses	Results of this study	Conclusion	Results of prior studies on IT adoption in SMEs	IT
H4	BI's trialability affects BI adoption in Thai SMEs	Not Supported	BI's trialability did not significantly influence BI adoption in Thai SMEs	**Supported** • 58 SMEs in Singapore (Kendall et al. 2001) • 102 SMEs in England (Ramdani, Chevers & Williams 2013) • 145 SMEs in Taiwan (Chen 2004) **Unsupported** • 508 SMEs in Thailand (Sophonthummapharn 2009) • 107 SMEs in Malaysia (Hussin & Noor 2005)	 E-commerce Enterprise systems E-commerce CRM E-commerce
H5	BI's observability affects BI adoption in Thai SMEs	Supported	BI's observability significantly influenced BI adoption in Thai SMEs	**Supported** • 508 SMEs in Thailand (Sophonthummapharn 2009) • 157 SMEs in Australia and Singapore (Chong 2008) • 107 SMEs in Malaysia (Hussin & Noor 2005) • 95 SMEs in Brunei (Seyal & Rahman 2003)	 CRM E-commerce E-commerce E-commerce
Environmental factors					
H6	Competitive pressure affects BI adoption in Thai SMEs	Supported	Business competition significantly influenced BI adoption in Thai SMEs	**Supported** • 139 SMEs in Taiwan (Chang et al. 2010) • 235 SMEs in Iran (Ghobakhloo, Arias-Aranda & Benitez-Amado 2011) • 30 SMEs in UK (Alshawi, Missi & Irani 2011) • 263 SMEs in Australia (Duan, Deng & Corbitt 2012)	 ERP E-commerce CRM E-commerce
H7	Vendor selection affects BI adoption in Thai SMEs	Supported	Vendor selection significantly influenced BI adoption in Thai SMEs	**Supported** • 235 SMEs in Iran (Ghobakhloo, Arias-Aranda & Benitez-Amado 2011) • 206 SMEs in Taiwan (Lin & Hsu 2007) • 206 SMEs in Hong Kong (Chau & Hui 2001) • 35 SMEs in Indonesia (Sarosa & Underwood 2005)	 E-commerce Data warehouse EDI IT

Table 9.1: Summary of hypothesis testing of this study comparing it with prior research (continued)

No.	Hypotheses	Results of this study	Conclusion	Results of prior studies on IT adoption in SMEs	IT
Organisational factors					
H8	Absorptive capacity affects BI adoption in Thai SMEs	Not Supported	Absorptive capacity did not significantly influence BI adoption in Thai SMEs	**Supported** • 882 SMEs in Thailand (Lertwongsatien & Wongpinunwatana 2003) • 92 SMEs in Hong Kong (Khalifa & Davison 2006)	 E-commerce E-commerce
H9	Organisational resource availability affects BI adoption in Thai SMEs	Supported	Organisational resource availability significantly influenced BI adoption in Thai SMEs	**Supported** • 100 SMEs in USA (Grandon & Pearson 2004) • 146 SMEs in Malaysia (Alla, Rahman & Ismil 2012) • 102 SMEs in the Northwest of England (Ramdani, Chevers & Williams 2013) • 92 SMEs in Hong Kong (Khalifa & Davison 2006) **Unsupported** • 35 SMEs in Indonesia (Sarosa & Underwood 2005) • 263 SMEs in Australia (Duan, Deng & Corbitt 2012)	 E-commerce AIS Enterprise System E-commerce IT Electronic market
Owner-managers factors					
H10	Owner-managers' innovativeness affects BI adoption in Thai SMEs	Supported	Owner-managers' innovativeness significantly influenced BI adoption in Thai SMEs	**Supported** • 166 small businesses in Singapore (Thong & Yap 1995) • 171 small businesses in Australia (Fogarty & Armstrong 2009) • 268 SMEs in Iran (Ghobakhloo & Hong Tang 2013) • 204 SMEs in Korean (Jeon, Han & Lee 2006)	 IT CBIS E-commerce E-commerce
H11	Owner-managers'IT knowledge affects BI adoption in Thai SMEs	Not Supported	Owner-managers' IT knowledge did not significantly influence BI adoption in Thai SMEs	**Supported** • 166 small businesses in Singapore (Thong & Yap 1995) • 217 SMEs in the USA (Chao & Chandra 2012) • 139 SMEs in Taiwan (Chang et al. 2010) • 171 small businesses in Australia (Fogarty & Armstrong 2009) • 204 SMEs in Korea (Jeon, Han & Lee 2006) **Unsupported** • 187 SMEs in Malaysia (Lip-Sam & Hock-Eam 2011) • 187 SMEs in UK (Windrum & Berranger 2003)	 IT IT ERP CBIS E-commerce E-commerce Intranet

Source: Developed for this research based on prior studies

9.3.1 Technological characteristics:

This section discusses the findings of BI technology characteristics in comparison with previous studies. Here, reference is made to the three groups of SMEs based on their BI adoption levels – Operated, Consolidated and Integrated.

9.3.1.1 BI's relative advantage (H1)

Relative advantage of BI was found to be a significant factor in influencing SMEs' decision in BI adoption, which supports Rogers' DOI theory. The findings in this study are expected as earlier research had consistently shown that relative advantage has a significant and positive influence on the adoption for a number of technologies such as electronic commerce (Ghobakhloo, Arias-Aranda & Benitez-Amado 2011; Grandon & Pearson 2004), Accounting Information Systems (Alla, Rahman & Ismil 2012), Information and Communication Technologies (Alam & Noor 2009) and CRM systems (Sophonthummapharn 2009).

Perceived relative advantage is the expected benefit that innovation technologies will bring to a company when there is a need for adoption. This relative advantage would encourage a company to meet economic profitability, time and effort savings, and cost reduction (Clemons 1991). The fundamental role of relative advantage of innovation in motivating the acceptance of new ideas is based on the argument that companies will not adopt any new technologies unless they obtain information showing substantive benefit from the innovation, or when an immediate disadvantage pushes them to use the technologies (Clarke 1997). This concept can be applied to the SME context. SMEs will be motivated to adopt BI if they perceive the advantages of BI. Usage of BI technologies in business brings numerous advantages for the user. Based on this study, implementing BI in the organisation offers businesses a wide range of relative advantages, including operations cost reduction operations, provision of competitive information, enhanced business strategies, and provides customer solutions in real-time.

In this study, the relative advantage factor has been found to have a positive effect on BI adoption. Even though relative advantage is important for SMEs' decision in adoption of BI, Thai SMEs still have a lower perception of the potential advantages of BI adoption due to the overall low average (below neutral assessment) relative advantage levels of the three BI adopter groups. The results of this study indicated a lack of perception of relative advantage from BI among the adopters. The majority of participating respondents did not agree that BI technologies can help their companies to reduce the cost of operation. This finding is in line with prior studies that BI is not used as the main operation and thus not easily linked directly to either reducing costs or increasing revenue, but rather BI is used to support the operation and to streamline and increase effectiveness (Sahay & Ranjan 2008). However, when comparing across the three levels of BI adopter groups, the owner-managers in the Integrated organisations perceive a higher level of relative advantage than the Operated and Consolidated organisations. This may be a result of the advanced level of BI they use. A highly advanced level of BI can support not only information to the users but the users can also gain diverse aspects of business views and reveal meaningful trends and hidden patterns for the managers, which finally allow them to design an effective strategic plan and make suitable decisions (Hannula & Pirttimaki 2003; Dutta, Wierenga & Dalebout 1997). Therefore, it is not surprising that owner-managers of organisations that adopt a higher level of BI are more likely to perceive the advantages of BI technologies.

9.3.1.2 BI's complexity (H2)

The findings of this research show that the complexity of BI plays an important role in influencing SMEs' decision in BI adoption, which supports Rogers' DOI theory. The proposed hypothesis of this study is also supported by a number of prior studies (Chang et al. 2010; Sophonthummapharn 2009; Jeon, Han & Lee 2006) that have highlighted the negative impact of complexity of technology on the adoption decision by the organisation.

According to Rogers (1995), complexity is determined by the degree to which an innovation is perceived to be difficult to understand and utilise. Past researchers have indicated that innovation with considerable complexity requires increased technical skills and greater implementation and operational effort to raise its likelihood of adoption (Alam & Noor 2009; Alam et al. 2008; Bradford & Florin 2003). As BI technologies have been considered as innovation that is more complex than most other technological applications, including their products and interfaces, this complexity could set up significant challenges for organisations to adopt BI. Organisations generally need to develop technological skills and additional competency within the firm in order to set up and use BI effectively (Sahay & Ranjan 2008). In this study, the complexity of BI is indicated through the owner-managers' perception of BI related to the complexity in implementation, the difficulty in learning and the resistance towards the use of BI.

The results of the current study show that complexity adversely influences BI adoption in SMEs. The majority of participating SMEs (more than half) were categorised at the Operate level, the lowest level of BI. This proportion could indicate that a high number of SMEs still adopt only simple BI applications rather than the advanced. This result is supported by the findings from previous studies that found that innovations that are simple, easy to apply and operate, and cause less disruption for the firms' current operation are more likely to be adopted and used by organisations (Rogers 2005; Agarwal & Prasad 1998). In this study there are also some SMEs that are categorised in the high level of BI adoption. When comparing the levels of perceived complexity across the three BI adopter groups, the analysis found differences in complexity across the three groups. The more advanced the adopted BI technologies, the more the owner-managers perceive that using BI technologies is difficult. In other words, organisations categorised at the Integrate+ level of BI (highest level) perceived that BI technologies that they are using are complex, while the Operated organisations (lowest level of BI) think oppositely. Therefore, the complexity of BI technologies can be an important barrier to BI adoption and to the extent of BI adoption. The research suggests that vendors and government can increase the number of SMEs adopting higher levels of BI by making it less complex in the SMEs' view or by providing technological knowledge through adequate training programs.

9.3.1.3 BI's compatibility (H3)

Compatibility was not found to be a significant predictor of BI adoption. This finding is at variance with Rogers' DOI theory and the finding of a majority of prior studies. Many previous studies have found the adoption of innovations within SMEs to be significantly affected by the compatibility between innovation and organisational operation practices, past experiences, existing values, and IT infrastructure (Ghobakhloo, Arias-Aranda & Benitez-Amado 2011; Chang et al. 2010; Sophonthummapharn 2009; Lal 2007; Grandon & Pearson 2004; Kendall et al. 2001). For example, the study of Ghobakhloo, Arias-Aranda and Benitez-Amado (2011) on electronic commerce adoption among manufacturing SMEs found that SMEs that have adopted web technologies before perceive electronic commerce application to be compatible with their business and has become one the most influential factors of electronic commerce adoption.

Currently, organisations recognise that effective and strategic decision support of enterprise-wide functions are fundamental to their success, and thus decision support activities are becoming more integrated with their business functions. This requires BI systems to be more compatible with existing systems, standards, and work procedures of the organisation (Matei & Bank 2010). However, the compatibility among innovative technologies, its users, and operational procedures of the enterprise are able to influence the organisation's adoption of technology but it may also delay the adoption process and discourage the users (Thong 1999; Kwon & Zmud 1987).

Surprisingly, compatibility was not found to be a significant determinant of BI adoption in SMEs. This is a significant finding as it did not support the findings of existing technology adoption studies which have found compatibility an important determinant of innovation adoption. However, the finding from this research is not without precedent as prior adoption studies on e-business technologies adoption among Canadian SMEs from Ifinedo (2011) have also found a lack of significance in compatibility. Similarly, Alla, Rahman and Ismil (2012) found that compatibility is not significant to accounting information systems adoption among Malaysian SMEs. Although compatibility was found to have no significant impact on BI adoption in SMEs, this does not necessarily mean that BI technology is not compatible with the SMEs' businesses. The analysis shows that the overall average perceived compatibility levels of three BI adopter groups were relatively high (much more above neutral assessment). This could indicate that all groups perceived BI technologies as compatible with not only their existing operating practices but also the firm's values and beliefs. A possible explanation for the high mean values may be that the BI technologies are not the main technologies that operate the business but they are technologies that support the users' access, analysis and sharing of information that be needed (Sahay & Ranjan 2008). Therefore, the use of this technology may not require radical change in routine business practices within the firm. This could be the reason why the majority of owner-managers see BI technologies as compatible with their current business practices.

9.3.1.4 BI's trialability (H4)

Trialability was not found as a significant factor impacting BI adoption in Thai SMEs. This finding does not support Rogers' DOI theory. It is also inconsistent with both the proposed hypothesis and a number of prior research findings that trialability has a significant impact on technological innovation adoption in SMEs (Ramdani, Chevers & Williams 2013; Chen 2004; Kendall et al. 2001).

Introducing technological innovation often comes with uncertainty that usually influences the adoption rate. To minimise uncertainty, an organisation that introduces such technological innovation should permit potential users or customers to test it before they make a purchase decision. Greve (1996) and Rogers (1995) argue that the individuals and organisations that had tried and tested the innovations generally adopt more quickly than those that have not.

Contrary to expectations, this study did not find trialability to be a significant factor influencing BI adoption in SMEs. However, the findings in this research are not without precedence. A study of Thai SMEs conducted by Sophonthummapharn (2009) found that the level of trialability cannot predict the level of CRM adoption. Another study by Hussin and Noor (2005) conducted a survey among 107 Malaysian SMEs to find that the adoption of electronic commerce was not impacted by trialability. However, although trialability was not found as a predictor to the adoption of BI in this study, it does not necessarily mean that trialability has no influence on adoption decisions as demonstration software is commonly provided by the computer software vendors. Software users generally request the demonstration version to test and appraise the software package prior to making any decision to purchase. Therefore, as BI technologies also include computer software, demonstration versions need to be provided to all potential users. In this study, the results from the Kruskal-Wallis test indicate that all three groups of BI adoption generally have a chance to trial BI applications before making decisions, regardless of the level of BI. This finding is supported by the mean value of trialability in the middle of the measurement scale in all three groups, and no significant differences in BI adoption across the three groups. Participating respondents agreed that most software providers permit them to use applications on a trial basis long enough to evaluate their usefulness. This indicates that software users clearly prefer testing trial versions before making purchase decisions. Thus trialability is still necessary for SMEs who wish to adopt technological innovations.

9.3.1.5 BI's observability (H5)

The findings of this research show that the observability of BI played an important role in influencing SMEs' decision in BI adoption, which supports Rogers' DOI theory. This finding is also in agreement with the proposed hypothesis and findings from prior studies (Chong et al. 2009; Sophonthummapharn 2009; Hussin & Noor 2005; Seyal & Rahman 2003; Rogers 1995), that reported that observability influences the decision of technological innovations' adoption.

Observability refers to whether the outcomes of technological innovation are visible to the users. It is also known as visibility (Karahanna, Straub & Chervany 1999). In the ability to observe the relative advantage of technology, organisations may have already observed success in the initiatives taken by other companies, trading partners or competitors. When owner-managers perceive the outcome upon deploying technological innovation systems, they were more likely to fully adopt the systems (Rogers 1995). Furthermore, observability can not only affect the adoption of that technology, but also the satisfaction of its use. For example, Chong (2008) conducted a study on electronic commerce adoption and found that the degree to which the results of electronic commerce are more visible to SMEs leads to higher satisfaction in its implementation. In this study, owner-managers evaluated the degree of observability through their awareness of the existence of BI in the market and perception of the results in using BI after seeing it in operation.

Based on the results in this study, observability has been found to have a positive effect on the levels of BI adoption. In the comparison of the observability factor among three groups differentiated by their levels of BI adoption, the analysis reported that organisations at the higher level of BI adoption (Integrated+ level) are more aware of the availability of BI technologies and the results from using BI technologies than the organisations in the lower level (Operated and Consolidated level). This finding could indicate that the more the owner-managers are aware of the availability of BI technologies in the marketplace, the more likely they will adopt BI technologies in their firms. As SMEs have limited resources and investment in IT, BI adoption is regarded as a risky undertaking (Hustad & Olsen 2014; Laukkanen, Sarpola & Hallikainen 2007; Thang 2001). Therefore, when owner-managers have important information about BI, this information can support them to make a decision to adopt or ignore it.

9.3.2 Environmental characteristics:

This section discusses the findings of environmental characteristics in comparison with previous studies. Here, reference is made to the three groups of SMEs based on their BI adoption levels – Operated, Consolidated and Integrated.

9.3.2.1 Competitive pressure (H6)

The findings of this research show that competitive pressure has an important role in influencing SMEs' decision to adopt BI in the Thai context. Thai SMEs active in a more competitive environment are more likely to adopt BI technologies. This result is in agreement with the technology-organisation-environment (TOE) model and findings from prior studies that found that the intensity level of competition is a driving force influencing a firm's decision to adopt a particular innovation (Duan, Deng & Corbitt 2012; Alshawi, Missi & Irani 2011; Ghobakhloo, Arias-Aranda & Benitez-Amado 2011; Chang et al. 2010; Dholakia & Kshetri 2004).

SMEs now face more competitive challenges with the rapid development of IT altering the operational behaviour of many businesses. These competitive pressures signify that other SMEs have begun to use advanced technologies to improve their competitive advantages (Beheshti et al. 2007). According to Hocevar and Jaklic (2010), it was found that managers cannot maintain competitiveness by merely depending on their intuition. The process of decision-making in organisations has changed due to new information needs. Decision-making must be based on accurate information. As the decisions of SMEs' managers are usually intuition-based (MacGregor & Vrazalic 2005), the strategies formed are based on the limited essential skills of the owner-manager, and thus SMEs frequently fail to meet and achieve their business objectives and this leads to their loss of competitiveness (McLarty 1999). SMEs not using BI or other decision support systems could fail to compete effectively. Thus an intense competition positively affects the utilisation of BI technologies.

Based on the findings in this study, competitive pressure has been found to positively affect the levels of BI adoption. The more the firm perceives the competitive pressure, the more likely it is that the firm will adopt higher levels of BI technologies. This finding was confirmed by a comparison study of competitive pressure among three groups based on the levels of BI adoption. The results show the difference among these three groups where the integrated group perceives a higher level of competitive pressure than the organisation group with lower levels of BI adoption (Operated and Consolidated). In perceiving the low level of competition, it is possible that SMEs in the Operated level are focusing only on administrative task using basic software programs to generate reports. On the other hand, SMEs at the Integrate+ level, which perceive a high level of competition, indicated that they used software programs that allow them a multi-dimensional view of data. SMEs in this level would gain competitive advantage by converting data into right information that can support their business decision-making. For example, SMEs in the Consolidated level could typically report on daily sales for a given category, drill down to the product level and roll up to the month level for determining monthly sales of promoted items. These abilities allow SMEs to have a different way of conducting business and to stay ahead of the competition. Thus it can be concluded that SMEs in a more competitive environment would have a greater need of BI to gain a competitive advantage.

9.3.2.2 Vendor selection (H7)

Vendor selection is consistently found to be a factor influencing the adoption of technologies in the SMEs context, such as electronic commerce (Ghobakhloo, Arias-Aranda & Benitez-Amado 2011), data warehouse (Lin & Hsu 2007), EDI (Chau & Hui 2001) and information technologies (Sarosa & Underwood 2005). It is suggested that IT vendors have an impact on the firms' decision to adopt technological innovation. The findings in this study provide support for the technology-organisation-environment (TOE) model and are consistent with previous studies.

According to Chau (1995), SMEs focus on selecting software packages provided by vendors rather than developing information systems in-house, and SMEs rely more on packaged software than large enterprises. Therefore, if firms decide to outsource the implementation of information technologies, then they must be careful in selecting the vendors (Kimball et al. 2008). As there are many BI vendors in the business analytics market, the selection of a suitable BI vendor is very significant, as a good vendor can provide not only support ranging from technical assistance to training but also a source of information on the availability of solutions that fit their needs (Hiziroglu & Cebeci 2013). The professional abilities of the IT vendor can significantly compensate for the lack of internal IT experts and the difficulty in recruiting and retaining IT professionals, as well as affording the costs of providing IT training for employees which is a requirement in SMEs (Thang 2001).

In this study, owner-managers indicated the importance of the vendor through the vendor's reputation, relationships with customers, project planning capabilities and technical competency. The results show that the variable 'vendor selections' have obvious influence on the adoption of BI in terms of the significant values in multinomial logistic regression. Furthermore, it also indicates differences among the three organisational groups of BI adoption levels – Operate, Consolidate and Integrate+. The Operated firms paid less attention in selecting the vendor than the Integrated firms, which can be interpreted that the higher the firms' levels of BI adoption, the more important the vendor selection factor. This finding can be supported as the higher the BI level, the higher the complexity, thus leading to a higher cost of implementation risk (Liyang et al. 2011; Legodi & Barry 2010). The owner-managers in SMEs need to ensure the BI vendors can complete the BI project in time with limited financial resources and to their satisfaction. As a result, owner-managers would not adopt BI if they perceive that their BI technology needs and the technical support cannot be met by the vendors. For Thai SMEs, it was found that vendor selection has influence on the adoption of BI technologies.

9.3.3 Organisational characteristics:

This section discusses the findings of organisational characteristics in comparison with previous studies. Here, reference is made to the three groups of SMEs based on their BI adoption levels – Operated, Consolidated and Integrated.

9.3.3.1 Absorptive capacity (H8)

Absorptive capacity was not found to be a significant determinant of the adoption of BI, with the absorptive capacity not influencing SMEs' decisions to adopt BI. This finding is at variance with other studies in which the absorptive capacity of organisations was significant in the adoption of technological innovation (Lal 2007; Khalifa & Davison 2006; Lertwongsatien & Wongpinunwatana 2003; Cohen & Levinthal 1990). This outcome is dissimilar to the technology-organisation-environment (TOE) model and previous studies reporting that the absorptive capacity of an organisation's members can drive their organisations to adopt technological innovations (Khalifa & Davison 2006; Lertwongsatien & Wongpinunwatana 2003; Cohen & Levinthal 1990).

Although previous studies have found that absorptive capacity is a significant determinant of successful adoption of innovation in IT areas, including electronic commerce (Lertwongsatien & Wongpinunwatana 2003), electronic trading systems (Khalifa & Davison 2006) and telecommunication technologies (Lal 2007), it has been shown as non-significant in predicting BI adoption in SMEs. A possible explanation for no significant absorptive capacity in BI adoption is that the SME owner-managers are also the IT decision-makers (Fulantelli & Allegra 2003). Even though some researchers found that a lack of knowledge-based employees might hinder adoption in technologies (MacGregor, Waugh & Bunker 1996), Reynolds et al. (2000) and Wong (2003) have argued that small business owner-managers are likely to make the decisions in adopting sophisticated technologies depending on their familiarity with basic technological operations and necessity. As SME owners have a strong influence in their enterprises (Smith 2007; Fuller-Love 2006), decisions to adopt technologies are centred around them. Results from participating respondents in this study reveal that the organisations categorised at the Integrate+ level of BI perceived their organisations as having some degree of absorptive capacity in BI technologies (around neutral assessment), as do Operated organisations. This may be the reason why conducting the Kruskal-Wallis test in this study found no differences in absorptive capacity among the three groups of BI adoption. Thus it is possible to assume that owner-managers in all three levels of BI adoption could have adopted IT with little regard to their organisations' absorptive capability. As a result, it can be concluded that the absorptive capacity derived from employees was not an important factor in influencing BI adoption among SMEs.

Dissimilar to earlier research, this study found no evidence that absorptive capacity is a factor in driving decisions of BI adoption in Thai SMEs. However, as this study has only focused on the organisational level from the owner-managers' perspectives by assessing key users of BI, further research could use this factor to ask the key users of BI to evaluate their absorptive capacity. This could reveal the actual influence of absorptive capacity in SMEs' adoption of BI and help confirm the results of this study.

9.3.3.2 Organisational resource availability (H9)

Organisational resource availability was found to be one of the significant predictors in influencing SMEs' decisions to adopt BI. This finding is in agreement with the technology-organisation-environment (TOE) model as well as the majority of prior study findings that reported that organisational resource availability positively influences the decision of innovations adoption (Alla, Rahman & Ismil 2012; Khalifa & Davison 2006; Grandon & Pearson 2004; Iacovou, Benbasat & Dexter 1995).

As most SMEs suffer from insufficient financial and technological resources, they are forced to be highly vigilant in their investment and capital expenditure (Ghobakhloo, Arias-Aranda & Benitez-Amado 2011). This is because a suboptimal decision in IT investment could have seriously negative financial consequences leading to bankruptcy and economic failure (Ghobakhloo, Arias-Aranda & Benitez-Amado 2011). Furthermore, the implementation of new IT and its components require long-term investment involving high cost IT infrastructure (Walczuch, Van Braven & Lundgren 2000). Moreover, SMEs are generally unable to meet the other associated and additional expenses of IT adoption, such as hiring IT consultants (Ghobakhloo, Arias-Aranda & Benitez-Amado 2011), providing employee training, and organisational restructuring (Caldeira & Ward 2002). Consequently, only SMEs with adequate financial resources regard the adoption of IT as a feasible project to undertake (Thong & Yap 1995). In decisions of BI adoption, owner-manager respondents in this study determined the levels of importance of organisational resource availability according to their technological and financial resources, training and IT support, and difficulties in finding these resources.

Consistent with the majority of prior studies in the field of technology adoption, this study found that organisational resource availability impacted on BI adoption. However, other researchers have found that some factors related to organisational resources are no significant in determining the adoption of technologies (Duan, Deng & Corbitt 2012; Buonanno et al. 2005; Sarosa & Underwood 2005). For example, Dibrell, Davis and Craig (2008) and Sarosa and Underwood (2005) found that as the price of computer hardware and software has declined considerably in recent years, IT implementation expenses are not a major factor hindering IT adoption in SMEs, despite them having limited financial resources. Duan, Deng and Corbitt (2012) also found that financial and technological resource factors were not raised as issues stopping SMEs in adopting online technologies because most internet adoption can be accomplished in-house with no substantial expenses incurred. The possible explanation for these conflicting results can be explained by the different types of technologies that SMEs have adopted. For example, Duan, Deng and Corbitt (2012) conducted a study on low-end technologies and found that organisational resource availability has no significant impact on e-commerce adoption. However, in this study, as the technology is BI, it is typically more complicated and expensive to adopt (Hwang et al. 2004), requiring more financial and technical involvement than low-end technologies. For this reason, it is possible that some Thai SMEs perceive BI as affordable and suitable only for large enterprises. They perceive this technology as a risk to investment and not suitable for them. Therefore, results from this study support organisational resource availability as important in SMEs decisions to adopt BI. When comparing across the three levels of BI adopter groups, there are significant differences in organisational resource availability across the three groups of BI adoption. Here, SMEs with high organisational resource availability are more likely to be categorised in the Integrate+ level (high level of BI), while SMEs with low organisational resource availability are more likely to be categorised in the Operate level (lowest level of BI). Therefore, it can be concluded that organisational resource availability has an impact on the adoption of BI technologies in Thai SMEs.

9.3.4 Owner-manager characteristics:

This section discusses the study findings of owner-manager characteristics compared to those of previous studies. Here, reference is made to the three groups of SMEs based on their BI adoption levels – Operated, Consolidated and Integrated.

9.3.4.1 Owner-managers' innovativeness (H10)

The findings of this study reveal that owner-managers' innovativeness plays a significant role in affecting SMEs' decisions to adopt BI. In agreement with the majority of prior studies into SMEs' decision to adopt IT (Ghobakhloo & Hong Tang 2013; Chao & Chandra 2012; Chang et al. 2010; Fogarty & Armstrong 2009; Jeon, Han & Lee 2006; Thong & Yap 1995), this result supports the proposed H10 in this study.

Due to the specific characteristics and organisational structures of SMEs, owner-managers have the ultimate role in most functions of their enterprises, including business decisions and activities (Bruque & Moyano 2007). Regarding the significant role of owner-managers in determining the innovative attitude of their businesses, SMEs with innovative and risk-averse owners are more likely to apply distinctive and risky solutions, such as IT systems that require significant changes within the organisation. This is especially so in the case of BI, where organisations investing in these technologies find it difficult to quantify their returns on investment (ROI), because most benefits are intangible due to being aimed at in improving the performance and efficiency of traditional activities in order to perform properly and efficiently (Hannula & Pirttimaki 2003; Irani & Love 2000). For this reason, owner-managers who lack innovativeness may see the adoption of BI as a risky investment.

Owner-managers' innovativeness has been found to significantly impact on their adoption of various technologies in many previous studies (Ghobakhloo & Hong Tang 2013; Fogarty & Armstrong 2009; Al-Qirim 2007; Jeon, Han & Lee 2006). For example, according to the results of a study on electronic commerce adoption by Al-Qirim (2007), owner-managers' innovativeness is a significant determinant of electronic commerce adoption. Fogarty and Armstrong (2009) found that SMEs with CEOs who are more innovative are likely to adopt computer based information systems (CBIS). Similarly, in this study the researcher found that BI adoption within SMEs is significantly impacted by owner-managers' innovativeness. From the descriptive statistic analyses, perceptions of owner-managers' innovativeness in all three groups of BI adoption are not low, as all mean values of innovations are above neutral. However, when comparing owner-managers' innovativeness across the three levels of BI adopter groups, results showed significant differences with the highest mean rank of owner-managers' innovativeness being in the Integrated organisations, followed by Consolidated and then Operated. This seems to indicate that SMEs with more innovative owner-managers are more likely to adopt advanced BI technologies and are therefore categorised as having higher levels of BI adoption. Thus it can be concluded that owner-managers' innovativeness is a key factor affecting the adoption of BI in Thai SMEs.

9.3.4.2 Owner-managers' IT knowledge (H11)

The findings of this study reveal that SME owner-managers' IT knowledge does not have a significant role in affecting their decisions to adopt BI. This result is inconsistent with both the proposed hypothesis and the majority of prior research findings that owner-managers' IT knowledge has an effect on IT adoption in SMEs (Chang et al. 2010; Fogarty & Armstrong 2009; Jeon, Han & Lee 2006; Thong & Yap 1995).

Even though the majority of researchers have found that SMEs with owner-managers who are familiar with IT and have higher levels of computing skills are more likely to adopt IT and be satisfied with its implementation (Palvia 1996; Thong & Yap 1995), in agreement with a small number of studies (Lip-Sam & Hock-Eam 2011; Mehrtens, Cragg & Mills 2001), results of this study reveal no significant effect of owner-managers' IT knowledge on BI adoption. For example, Lip-Sam and Hock-Eam (2011) found that the IT knowledge of owners does not reflect the extent of e-commerce adoption among SMEs in Malaysia. They determined that the majority of leaders in Malaysian SMEs are owner-managers who envision e-commerce adoption as more likely advised by their assistants. This finding is in line with a study by Mehrtens, Cragg and Mills (2001) which found that SME owners with low levels of IT knowledge can seek advice from either staff within their organisations who have some IT knowledge, or hired IT experts. In this way, owner-managers with both low and high IT knowledge can access similar information on IT adoption.

In finding an explanation for the non-significance of owner-managers' IT knowledge in the adoption of BI as found in this study, the demographic profile of respondents may be of significance. As the majority of participants were young owner-managers below the age of 40 and who held at least a bachelor's degree, it is possible that the participants were technology-savvy and had higher computing skills than their more elder peers. This assumption is consistent with previous studies showing that younger managers are more experienced in IT than older managers (Cragg & King 1992), and owner-managers with university qualifications are more likely to adopt advanced IT into their enterprises (Lip-Sam & Hock-Eam 2011). Furthermore, no differences were found when comparing IT knowledge across the three groups of owner-managers. SMEs categorised in the Operate level of BI had a high perception of owner-manager's IT knowledge (above neutral) and so did those SMEs in Integrate+ level (the highest level of BI). Hence, due to these non-significant results, the owner-managers' IT knowledge construct was not found to be an important factor in the BI adoption of SMEs.

Due to the above findings of non-significance in owner-managers' IT knowledge affecting BI adoption in SMEs with primarily young and educated respondents, the impact of this factor needs to remain a subject of future enquiry. For example, this new aspect can be addressed in research focusing on direct investigations into the differences between young and older managers' adoption of BI in their SMEs. Specific industry types and/or sizes of organisations could also be investigated to confirm the actual influence of these owner-managers' IT knowledge on decisions to adopt BI in SME.

9.4 Overall consequences of the enabling factors affecting BI adoption

The proposed research model in Figure 6.1 consists of eleven factors in four different characteristics. The data analysis indicates that seven of these eleven factors are significant and can be regarded as predictor factors in BI adoption in the context of Thai SMEs. According to the likelihood ratio tests in the multinomial logistic regression, this section answers the research questions in this study on which enablers are the most important in BI adoption by Thai SMEs. All seven significant factors can be ranked according to their importance from high to low starting with Complexity, Organisational resource availability, Relative advantages, Competitive pressures, Observability, Vendor selection, and Owner-managers' innovativeness.

Complexity, Organisational resource availability, and Relative advantage are the top three important factors. Both government and private agencies should give high priority to these three factors. As complexity was found to negatively influence the adoption of BI among Thai SMEs, the involved agencies should consider BI products that are more user-friendly and easier to use for the users who are not as IT savvy, like SMEs. The lower complexity of the technology, the higher the adoption rate of BI technologies and the further advanced the level of BI adoption. In dealing with the relative advantage issue, the involved agencies need to launch marketing and advertising campaigns to persuade the owner-managers of SMEs on the perceived potential advantage from using BI technologies. Furthermore, as SME firms have resource constraints, both human and financial, this study suggests that IT vendors should customise their products to suit the SMEs' resources or offer training and after-sales support with the aim of increasing the users' technological knowledge. Government agencies should also provide financial support to incentivise and encourage SMEs to adopt technological innovations such as BI.

Competitive pressure is ranked fourth, which is in the middle of the ranks in this study. It is rational to suggest that competitive pressure impacts the adoption of BI technologies when SMEs perceive that these technologies could reinforce their competitive position and support them to attain superior firm performance. In order to increase the adoption rate of BI, this study suggests that the involved agencies may facilitate SMEs to be aware of the existing competitive pressures. Once SMEs perceive such competitive pressure and realise the necessity of having BI, the adoption rate could increase.

Observability, Vendor selection, and Owner-managers' innovativeness are the bottom three in the rankings. Although, Observability is ranked in the lower part of the list, government agencies and IT providers should not overlook this factor. This finding suggests that any campaigns that encourage the use of BI technologies should direct the advertising message showing how BI technologies are being used by successful SMEs. This campaign can stimulate SMEs to adopt and use more technologies in their organisations. As SMEs lack IT expertise, IT vendors have an important role for SMEs' adoption of BI because SMEs usually adopt technologies from vendors rather than developing in-house solutions. This can make SMEs rely heavily on IT vendors. Support from IT vendors is essential for SMEs to provide a complete product solution, better technological capability and knowledge that in turn can assist them to adopt and continue to use BI technologies. The last factor of the list is owner-managers' Innovativeness. Since the decision in adopting innovations of SMEs is greatly dependent on the owner-managers, if the owner-managers have no innovativeness and no inclination to implement IT in their organisations, there is a lesser chance that they will adopt IT. This is especially the case for BI technology, which is normally expensive when compared to other technologies, and thus the owner-managers with low innovativeness will perceive BI as a risky investment. To enhance the widespread adoption of BI technologies, IT vendors are advised to target their products at SMEs with innovative owner-managers who have a positive attitude towards the advantages of BI adoption. For owner-managers with less innovativeness and a less-than-positive attitude towards BI adoption benefits, it is suggested that the involved agencies facilitate and encourage the attitudes and innovativeness of owner-managers through improving their awareness of BI, such as providing training and workshops. In SMEs, as the innovativeness and attitudes of owner-managers toward BI adoption become more positive, their receptiveness of BI technologies will improve.

9.5 Theoretical implications

The role of IT is important in the competitive pressure of today (Drucker 2001). It is clear that the organisations that adopt suitable technology can have greater business competency, performance improvement, and competitive advantage retention. The adoption of IT has been widely examined in many research studies and many adoption models have been developed in the literature. However, three adoption models that have been used regularly in the context of innovation and SMEs are diffusion of innovation (DOI), technology-organisation-environment (TOE), and the information system adoption model for small business. Nevertheless, this study has demonstrated that these models only partially explain the phenomena of the adoption decision as they lack the ability to explain some possible aspects when the technology is broad and evolve from simple to complex levels, such as BI technologies. This leads to the main theoretical contribution of this study.

First, this study expands the IT theory by integrating the three adoption models mentioned above with an IEM that classifies organisations into different levels according to how they use the information. A comprehensive research framework is thus drawn to represent the association between the eleven potential determinant factors and five levels of IT adoption. Comprehensible definitions of all factors are then categorised into four characteristics: technological, environmental, organisational, and owner-manager. As a result, this study suggests eleven enabling factors that necessitate being taken into consideration when investigating the adoption of a technological innovation.

Second, the proposed comprehensive research framework is empirically tested with BI technologies in the context of SMEs. Findings provide the evidence supporting the validity and reliability of the framework. More than half of the enabling factors in the framework have a significant influence on BI adoption, and all of these enabling factors can indicate the differences between levels of BI adoption. The importance ranking of enabling factors is also possible. For that reason, it could be asserted that this comprehensive research framework can be used as a research tool in examining enabling factors in decisions to adopt other technological innovations as well.

9.6 Practical implications

As the technological innovation empirically examined in this study is BI technology, there are two practical implications which can be acknowledged.

Firstly, this study has categorised the organisations into five groups based on their levels of BI adoption. Here, results show that the state of BI adoption by Thai SMEs can only be classified in the lower four levels of BI adoption in an IEM model. However, there is one level that has a sample size less than the required number for analysis. As a result, this level needs to integrate with the lower level of BI adoption. Final levels to represent the current state of BI adoption by Thai SMEs are Operate, Consolidate and Integrate+. Also, the descriptive statistics of the respondents' profile indicate that these three groups of SMEs have different characteristics. It suggests that each group requires a different kind of attention in prolonging their use of BI technologies.

Secondly, the unique findings in this study can offer guidance to Government bodies and IT providers, especially those who attempt to encourage the use of BI technologies or to influence the decision support systems of SMEs. Since the majority of SMEs surveyed are classified in the lowest level of BI adoption, pointing to Thai SMEs at an early stage of BI technology adoption; there is ample scope to elevate Thai SMEs into higher levels of BI and a focus on understanding the enabling factors of BI adoption would be an advantageous strategy to drive SMEs to adopt higher levels of BI. The highlight findings in this study indicate that factors that encourage SMEs to adopt higher levels of BI technology are high relative advantage, observability, organisational resource availability, competitive pressure, vendor selection, owner-managers' innovativeness and low levels of complexity. Moreover, the resulting analysis indicates which factors have more impact on BI adoption. As a result, involved agencies can recognise which factors should be given more or less attention based on their importance. The implication is that to successfully encourage this type of technological innovation necessitates a comprehensive understanding of the importance of each enabling factor. Government agencies can develop strategies to increase BI adoption among SMEs and achieve a higher level of BI maturity by launching marketing and advertising campaigns to persuade SME owner-managers on the perceived potential advantage of using BI technologies. Providing financial support to incentivise and encourage SMEs to adopt BI while setting up educational seminars to increase owner-managers' innovativeness can also increase the rate of BI adoption. SMEs who have already adopted BI technologies and have found that BI did not perform as expected need to assess their use of information. The assessment should be based on five dimensions including IT infrastructure, knowledge processes, human capital, and culture that were proposed in this study model to determine which dimension is weak or missing. The weak dimension should be developed to increase effective implementation and utilization of BI. In regards to IT vendors, they can help advance SMEs to higher BI levels by offering trial periods before full implementation. This would promote awareness and demonstrate the benefits of advanced BI for SMEs and can additionally contribute to the relationship between SMEs and IT vendors to help SMEs navigate through the complexities of BI choice and implementation.

9.7 Limitations and future research direction

Although the results of this study find some interesting insights regarding the enabling factors impacting on the adoption of technological innovation, there are a few limitations that need to be addressed.

First, although the enabling factors in this study are based on comprehensively reviewing the literature, this study may not include all factors that impact on the SME's decision to adopt BI such as government support, internal need and employees' capabilities. Therefore, future research can use this study as the foundation and find other factors that may have an affect on BI adoption. This would be of great assistance in supporting the results of this research. Future studies could also apply the same survey tool conducted in this study, after considering appropriate amendments to suit the time period and business location in which the study is conducted.

Second, this study focuses only on the adoption decision, but not on how BI is implemented. A study of the implementation issue is recommended in order to assist the understanding of BI implementation in SMEs. Additionally, although the terms 'adoption' and 'implementation' are used interchangeably in the literature, adoption in this study refers to accepting and obtaining technologies, while implementation can refer to sequential phases of using technologies. Therefore, further research looking at the effect of enabling factors in each implementation phase is recommended.

Third, this study used a quantitative approach using survey based questionnaire to investigate the enabling factors that affecting BI adoption. Thus, further research that applies qualitative research methodology such as case studies and interviews is encouraged to offer many clear explanations about the issues of BI adoption in SMEs.

Fourth, since SMEs in this study were classified based on information from the Thailand Ministry of Industry, this study sample was drawn from SMEs in only four main industry sectors, including manufacturing, service, wholesale and retail. Therefore, findings may only be generalised to these industry sectors due to their characteristics being different from other industries. In this case, it would be interesting to conduct further studies examining BI adoption in other industry sectors to see if differences exist. This would help expand our understanding about engagement processes in the adoption of BI. Moreover, as the SME samples for this study were not separately analysed in regard to the size of enterprise, further research could consider the differences in BI adoption between small and medium-sized enterprises as separate homogenous groups.

Fifth, even though this study has employed the Kruskal-Wallis test to investigate which independent variables have different distribution across the three levels of BI adoption, the investigation of which pair of BI adoption levels differ significantly from another is out of scope in this study. Further studies are encouraged to take post-hoc analysis, such as a Mann Whitney U test and then using qualitative research methodologies to provide clear explanations of these issues in BI adoption.

Sixth, as this study was conducted in Thailand, results are only applicable to countries that have similar industrial infrastructure and economic background, particularly the developing countries of South East Asia. Therefore, further comparative research could investigate BI adoption among SMEs in other countries that have different patterns to the Thailand context. This could help verify the extent to which the present results can be applied to other regions in the world. This, in turn, could serve in determining the extent to which BI adoption is affected by cultural, economical, political, and technological patterns in SMEs.

9.8 Summary of research

BI systems have become an important part of enterprise decision support for more than two decades. BI implementation in large enterprises has reached a stage of maturity, while SMEs are still slow in the adoption of BI. Applied BI technologies in organisations are expected to assist firms to gain a competitive advantage by transforming operational data into a business asset that drives strategic decisions and bolsters performance, but this study points to a lack of an inclusive research framework for examining the factors affecting the adoption of BI, particularly in the context of SMEs. This leads the research aims of this study to explore the factors affecting the adoption of BI in Thai SMEs and the current state of BI adoption by Thai SMEs.

The three most widely used adoption models: DOI, TOE, and the information system adoption model for small business were reviewed, together with previous studies in this research domain. Furthermore, this study integrated the IEM model with the research framework in order to categorise SMEs into five groups according to their levels of BI adoption – Operate, Consolidate, Integrate, Optimise, and Innovate. Based on the review of prior studies, eleven possible determinant factors were suggested in a developed research framework in Figure 6.1. All eleven factors are covered in four different characteristics – five factors under the technological characteristics, two under the environmental characteristics, two under the organisational characteristics, and two under the owner-managers' characteristics.

The quantitative methodology through a survey technique was chosen and conducted in this study. The sample was drawn by means of a systematic sampling technique. The empirical data were collected using self-administered questionnaires and the data analysis was based on 427 SMEs in Thailand. From the descriptive statistics, the results show that the majority of participating SMEs (48.2%) was classified in the Operate level (the lowest level of BI adoption) while only one-third of SMEs (31.9%) was classified at the Consolidate level and less than a quarter (17.1%) at the Integrate level. Only a few SMEs (2.8%) were categorised at the Optimise level and the sample size was too small for inferential statistics. As a result, only three BI adoption levels can represent the current state of BI in Thai SMEs – Operate, Consolidate and Integrate. Analysing for determinant factors using multinomial logistic regression indicated seven out of the eleven factors have the ability to discriminate among the levels of BI adoption and have significance to BI adoption. Additionally, the results from the Kruskal-Wallis test confirm that the perceptions of these seven factors across the three groups of organisations are different from each other. From these results, the conceptual framework in Figure 6.1 is revised and presented in Figure 9.1, representing the overall conclusion of this study.

In the final analysis, the study has answered all research questions, fulfilled the research aims and proposed a research model that indicates the enabling factors affecting BI adoption. It is believed that the research model developed in this study can serve as a base for future studies on SMEs' adoption of technological innovation, especially the technologies relating to decision support systems. The results of this study present the current state of BI adoption in Thai SMEs and the important factors that impact on the decision to adopt BI technologies. Interestingly, the findings reveal that the majority of Thai SMEs have only adopted the lowest level of BI technologies. This finding indicates that there is room for growth in the use of BI technologies for many SMEs in Thailand. Furthermore, the findings of this study indicate factors for BI technologies adoption by ranking in importance. Complexity was found to have highest impact on Thai SMEs' decision in BI adoption, followed by Organisational resource availability, Relative advantage, Competitive pressure, Observability, Vendor selection, and Owner-managers' innovativeness. In light of these findings, researchers, government agencies and IT providers should consider these factors, and give appropriate focus and attention to BI adoption by Thai SMEs in order to increase the rate of BI adoption. Moreover, the researcher hopes that from the validated models, the empirical findings in this study provide a further understanding of the benefits of BI adoption by Thai SMEs. The researcher also hopes that the models used in this study can be applied to examining the adoption of other technological innovations in the context of SMEs.

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LIST OF APPENDICES

Appendix A: English questionnaire

SURVEY

Enablers affecting the adoption of business intelligence: a study of Thai SMEs

***** Please Note ****
This questionnaire will take approximately **15 minutes** to complete. Your answers will be treated with the strictest confidence by **Victoria University** (*Melbourne, VICTORIA*) and used solely for this research project. No individual information will be forwarded to any external organisations. By completing the survey, you will be providing consent to participate in this study. This questionnaire is aimed at the primary decision-maker in the adoption of information technology in your organisation (e.g. *owner-managers or managers*). As I am aware that your time is valuable, I sincerely appreciate your consideration in participation. There are THREE parts to the survey questionnaire. Please read the questions in each section carefully and complete your answers according to the given instructions.

Definitions
A Business Intelligence (BI) system is a set of technologies *that support organisational decision-making through data analysis, query and reporting.* *A BI system has two* fundamental components: 1) Information technologies for collecting, accessing and storing data 2) Information technologies for analysing and presenting data.

Section I: Background Information

Please tick ☒ for the box that best describes yourself and your organisation.

About you

1. Gender

☐ Male ☐ Female

2. Age group

☐ 18–20 ☐ 31 to 40

☐ 21 to 30 ☐ 41 to 50 ☐ More than 50 years old

3. Highest level of education

☐ High school or equivalent ☐ Vocational or diploma

☐ Bachelor Degree ☐ Master Degree or higher

4. Position in your organisation

☐ Owner-manager ☐ Manager ☐ Other (please specify)_________

About your organisation

5. Industry sector of your company

☐ Manufacturing ☐ Service ☐ Wholesale ☐ Retail

6. Number of employees employed in your company

☐ Sole proprietor ☐ 2–9 ☐ 10–49

☐ 50–100 ☐ 101–200 ☐ More than 200

7. Years your company has been in business

☐ Less than 1 year ☐ 1–5 years

☐ 6–10 years ☐ More than 10 years

8. Main area in which your company is located

☐ Bangkok and Vicinity ☐ Central Regions and Eastern Regions

☐ Northern Region ☐ Northeast region

☐ Southern Region

9. Areas in which your organisation uses computer software to support business activities

☐ Financial accounting ☐ Stock control ☐ Production planning

☐ Customer management ☐ Marketing mix ☐ Market research

☐ Profit forecasting ☐ Strategic analysis ☐ Cash flow forecasting

☐ Sales planning ☐ Staff planning

☐ Other (please specify)___________

Section II: The information characteristics of your enterprise

Please select *one answer* that best describes your organisation:

1. Where is your organisational data stored?

(a) Staff members keep data in their own personal desktop computers.

(b) Data in the same functional area is stored in a functional desktop computer or a functional server.

(c) All data resides in a central database that can be easily shared between functional areas.

(d) Data is integrated with internal and external sources, and stored in an enterprise system that supports multiple databases.

(e) Data is stored in flexible systems that can keep structured and unstructured data such as text files, graphics, e-mail, and digitised voice.

2. What is the knowledge process within your organisation?

(a) Individual employees develop their own processes to manage data.

(b) Employees in the same functional area share the same processes in managing data (that is, different functional areas have different processes to manage data).

(c) All functional areas in the enterprise use the same processes to manage data.

(d) The processes for managing data are standardised and in line with outside enterprises (e.g. business partners and networks within the industry).

(e) In addition to the standardised processes for managing information, enterprise plans aim to establish new processes to support forthcoming new innovations.

3. How do your employees use the decision-making software?

(a) Most employees lack computer skills, and do not use decision-making software and often make decisions based on their experience.

(b) A few employees have skills in using computer software for managing and analysing data – these employees are used as a resource to help others.

(c) Most employees have the ability to use computer software in managing and analysing data.

(d) The majority of employees are knowledge workers who have the ability to use advanced decision-making software (e.g. advanced statistical and financial functions in Excel).

(e) Employees are expert in using decision-support software with most employees having critical thinking skills, and some even challenging the old paradigms and finding new ways to work.

4. To what extent is your organisation open to change?

(a) Change is feared among employees.

(b) Employees will accept change if it leads to benefits for them or their group and resisted when it benefits others.

(c) Employees are used to change due to improvements being frequently implemented. They accept change when it is clearly understood.

(d) Employees view change as an opportunity rather than a threat.

(e) Previous changes to business process that have failed, but that lead to learning, are accepted without rebuke or punishment.

5. What is the most advanced analytical application your organisation has implemented?

(a) Basic software programs to generate reports or spreadsheets.

(b) Software programs to keep data in standardised format and allow queries with limited user view (i.e. marketing function would have subjects limited to sales).

(c) Data is kept in a standardised format throughout the enterprise and software programs allow users a multi-dimensional view of data (i.e. sales data can be viewed by geographical dimension or time).

(d) Software programs that can identify useful information, detect relationships in the data, provide predictive results or generate multidimensional analysis.

(e) Software programs that allow users to keep track of what is currently happening and can generate an automated exception reporting when something unusual occurs.

Section III: Critical driving factors in BI adoption

Please indicate the extent to which you agree or disagree with each of the following statements.
Circle (**O**)a number from 1 to 5 that best represents your level of agreement with the statement, where 1 = ‘strongly disagree’, 2 = ‘disagree’, 3 = ‘Neutral’, 4 = ‘agree’ and 5 = ‘strongly agree’

Note: The term ‘technology’ refers to the most advanced analytical application that your organisation has implemented as mentioned in Question five of section II.

Enablers affecting the adoption of BI	strongly disagree 1	← 2	Neutral 3	→ 4	strongly agree 5
Relative advantage					
1. This technology enables your company to reduce the cost of operations.	1	2	3	4	5
2. This technology provides competitive information and improves decision-support.	1	2	3	4	5
3. This technology accomplishes tasks that allow us to enhance business strategies.	1	2	3	4	5
4. This technology monitors problems and provides solutions in real-time.	1	2	3	4	5
Complexity					
1. The process of introducing this technology was complicated.	1	2	3	4	5
2. The operation of this technology was considerably complicated to implement and use within your firm.	1	2	3	4	5
3. This technology was difficult to learn.	1	2	3	4	5
4. Considerable resistance existed within the firm towards the use of this technology.	1	2	3	4	5
Compatibility					
1. Using this technology fits well with how the company functions.	1	2	3	4	5
2. Using this technology is consistent with our firm's values and beliefs.	1	2	3	4	5
3. This technology is compatible with the organisation's IT infrastructure.	1	2	3	4	5
4. The changes introduced by this technology are compatible with existing operating practices.	1	2	3	4	5
Trialability					
1. Company employees were able to trial this technology before the adoption decision was made.	1	2	3	4	5
2. Company employees were able to **adequately** trial this technology before the adoption decision was made.	1	2	3	4	5
3. I was able to try out this technology before the adoption decision was made.	1	2	3	4	5
4. I was able to try out this technology **adequately** before the adoption decision was made.	1	2	3	4	5
Observability					
1. I have seen this technology used in other firms.	1	2	3	4	5
2. I was aware of the existence of this technology in the market.	1	2	3	4	5
3. I would have no difficulty telling others (employees, business partners) about the results of using this technology after seeing it in operation.	1	2	3	4	5
4. The results of using this technology were apparent to me before it was adopted.	1	2	3	4	5

Enablers affecting the adoption of BI	strongly disagree 1	← 2	Neutral 3	→ 4	strongly agree 5
Competitive pressure					
1. The degree of competition in our industry placed pressure on the firm's decision to adopt this technology.	1	2	3	4	5
2. I knew that my competing rivals were already using this technology.	1	2	3	4	5
3. The firm needed to utilise this technology to maintain its competitiveness in the market.	1	2	3	4	5
4. It was a strategic necessity to use this technology.	1	2	3	4	5
Vendor selection					
1. The vendors' reputation was important in selecting this technology.	1	2	3	4	5
2. The relationship between technology vendor and customers was important.	1	2	3	4	5
3. The capability of the technology vendor to plan and complete the project was important.	1	2	3	4	5
4. The technological competency of the vendor was significant.	1	2	3	4	5
Absorptive capacity					
1. Key users of this technology understood what this technology could do for the company.	1	2	3	4	5
2. Key users needed extensive training to develop skills and to understand the use of this technology.	1	2	3	4	5
3. There were hardly any major knowledge barriers in using this technology.	1	2	3	4	5
4. Key users were technically knowledgeable in exploiting these technology capabilities.	1	2	3	4	5
Organisational resource availability					
1. The firm had the technological resources to adopt this technology.	1	2	3	4	5
2. The firm provided financial resources to adopt this technology.	1	2	3	4	5
3. Other organisational resources (e.g. training, IS support) contributed to build higher levels of this technology adoption.	1	2	3	4	5
4. There were no difficulties in finding all of the necessary resources (e.g. funding, people, time) to implement this technology.	1	2	3	4	5
Owner-managers' innovativeness					
1. I always introduce new and original ideas.	1	2	3	4	5
2. I always look for something new rather than improving something existing.	1	2	3	4	5
3. I would sooner create something new than to improve something existing.	1	2	3	4	5
4. I often have a fresh perspective on old problems.	1	2	3	4	5
Owner-managers' IT knowledge					
1. I use a computer at home.	1	2	3	4	5
2. I use a computer at work.	1	2	3	4	5
3. I attended computer classes in the past.	1	2	3	4	5
4. I have a sound level of understanding of IT when compared to the other owners of business.	1	2	3	4	5

Thank you. I sincerely appreciate your time and cooperation to complete this survey.

Please return the completed questionnaire in the post-paid envelope provided.

Appendix B: English Cover Letter

VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

1 May 2013

Mr Waranpong Boonsiritomachai, DBA candidate
School of Management and Information Systems
Victoria University City Flinders Campus
PO BOX 14428 Melbourne, Australia 8001
PHONE +613 9919 1295
FAX + 613 9919 1064

Dear Owner manager/manager

My name is Waranpong Boonsiritomachai. I am currently carrying out research for the degree of Doctor of Business Administration (DBA) through the School of Management and Information Systems at Victoria University, Melbourne, Australia. The aim of this study is to examine the adoption of Business Intelligence (BI) and Information Technology by Thai Small and Medium-sized Enterprises (SMEs). The outcomes of this study will be useful in developing and implementing successful BI systems.

This questionnaire is designed to examine the current state of BI adoption and the enablers and barrier factors affecting the adoption of BI in Thai SMEs. Your assistance in this matter would be greatly appreciated as it will lead to a greater understanding of the use of BI and assist in detecting what could be recommended to improve the SME sector in Thailand.

In order to produce a meaningful research outcome, a systematic sampling research technique was applied to draw a sample and your firm was selected to be representative of your industry. In order to participate in this study, you will need to fill out the enclosed questionnaire. Please be assured that all information given by your company will be treated in ***strict confidence*** and only used for the purpose of this study.

The questionnaire contains 5 pages which will take around ***15 minutes to complete***. A postage-paid reply envelope is enclosed. Please fill out the form and return the completed questionnaire at your earliest convenience or before the 30 May 2013.

If you have any queries regarding this research project, please feel free to contact me by e-mail at Waranpong.Boonsiritomachai@live.vu.edu.au, or my principal supervisor Professor Michael McGrath at Michael.McGrath@vu.edu.au.

Thanking you in advance for your participation.
Yours faithfully

Waranpong Boonsiritomachai
DBA Candidate
School of Information Systems
Victoria University, Melbourne, Australia

Appendix C: Consent form for participants involved in research (English version)

VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

CONSENT FORM FOR PARTICIPANTS INVOLVED IN RESEARCH

INFORMATION TO PARTICIPANTS:

We would like to invite you to be a part of a study **'Enablers affecting the adoption of Business Intelligence (BI): a study of Thai SMEs'**. The study aims to investigate the current state of BI adoption by Thai SMEs. Also, it aims to examine the enablers and barrier factors affecting the adoption of Business Intelligence in Thai SMEs. The key finding of this study is expected to contribute to better understanding the SME characteristics that determine the adoption of BI in Thailand. It is also expected to assist in further comprehending the trends and developments of Thai SMEs in implementing innovation technology. All information is only for research purposes and will be treated as private and confidential, hence it will not be revealed under any circumstances. There are no risks involved in participating in this project.

CERTIFICATION BY SUBJECT

I, …………………………………………………………….. of………………………………………………………………………

certify that I am at least 18 years old and that I am voluntarily giving my consent to participate in the study 'Enablers affecting the adoption of Business Intelligence (BI): a study of Thai SMEs' being conducted at Victoria University by Waranpong Boonsiritomachai as part of a Doctor of Business Administration (DBA) under the supervision of Professor Michael McGrath and Associate Professor Stephen Burgess.

I certify that the objectives of the study, together with any risks and safeguards associated with the research procedures listed hereunder have been fully explained to me by Waranpong Boonsiritomachai, and that I freely consent to participation involving the below mentioned procedures:

- Completion of survey questionnaires

I certify that I have had the opportunity to have any questions answered and that I understand I can withdraw from this study at any time, and that this withdrawal will not jeopardise me in any way.

I have been informed that the information I provide will be kept confidential.

Signed:…………………………………..

Date: ……………………………………

Any queries about your participation in this project may be directed to the Principal Researcher, Professor G Michael McGrath **Michael.McGrath@vu.edu.au** telephone +613 9919 4627, or Associate Researcher Associate Professor Stephen Burgess **Stephen.Burgess@vu.edu.au** telephone +613 9919 4353. If you have any queries or complaints about the way you have been treated, you may contact the Research Ethics and Biosafety Manager, Victoria University Human Research Ethics Committee, Victoria University, PO Box 14428, Melbourne, VIC, 8001 or phone (03) 9919 4148.

Appendix D: English reminder cover letter

VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

1 June 2013
Mr Waranpong Boonsiritomachai, DBA candidate
School of Management and Information Systems
Victoria University City Flinders Campus
PO BOX 14428 Melbourne, Australia 8001
PHONE +613 9919 1295
FAX + 613 9919 1064

Dear Owner manager/manager

Referring to initial letter on 1 May 2013, you were asked to fill out the questionnaire on the research topic relation to the adoption of Business Intelligence (BI) in Thai Small and Medium-sized Enterprises (SMEs). Based on my record, your questionnaire has not been returned so far. So I would like to notify you to return the questionnaire.

The Business Intelligence (BI) application is a tool that aggregates, manages and analyses data in order to support a wide range of firms in decision-making processes. Not only large enterprises but also SMEs can take advantage of BI implementations. However, although BI implementations in large enterprises have now reached a stage of maturity, SMEs are still slow in the adoption of BI even though these technologies can assist them to enhance performance by utilising information more strategically. As a result, this questionnaire is designed to examine the current state of BI adoption and the enablers and barrier factors affecting the adoption of BI in Thai SMEs. The outcomes of this study will be useful in developing and implementing successful BI systems. Your assistance in this matter would be greatly appreciated as it will lead to a greater understanding of the use of BI and assist in detecting what could be recommended to improve the SME sector in Thailand.

Accordingly, your answer is an important need for completing this research. A new questionnaire and a postage-paid reply envelope are enclosed in this letter. The questionnaire contains 5 pages which will take around ***15 minutes to complete***. I reaffirm again that all information given by your company will be treated in ***strict confidence*** and only used for the purpose of this study. Please fill out the form and return the completed questionnaire at your earliest convenience or before the 30 June 2013.

I am so sorry if you have already returned the questionnaire before receiving this letter. In case you have any questions, please feel free to contact me by e-mail at Waranpong.Boonsiritomachai@live.vu.edu.au, or my principal supervisor Professor Michael McGrath at Michael.McGrath@vu.edu.au.

Thanking you in advance for your participation.
Yours faithfully

Waranpong Boonsiritomachai
DBA Candidate
School of Information Systems
Victoria University, Melbourne, Australia

Appendix E: Thai questionnaire

VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

แบบสอบถาม

ปัจจัยที่มีผลต่อการนำระบบ Business Intelligence (BI) มาใช้งาน กรณีศึกษา บริษัทขนาดกลาง และ ขนาดย่อม (SMEs) ในประเทศไทย

******* โปรดทราบ *******

แบบสอบถามนี้จะใช้เวลาประมาณ 15 นาที ข้อมูลจากท่านจะมีผลอย่างยิ่งต่อความถูกต้องของงานวิจัยชิ้นนี้ ทั้งนี้ข้อมูลของท่านจะถูก เก็บไว้เป็นความลับอย่างสูงสุด ภายใต้ระเบียบของมหาวิทยาลัยวิคตอเรีย เมืองเมลเบิร์น รัฐวิคตอเรีย ประเทศออสเตรเลีย โดยจะไม่มี การส่งข้อมูลส่วนบุคคล ส่วนหนึ่งส่วนใดไปให้กับหน่วยงานภายนอกทั้งสิ้น ข้อมูลทั้ง หมดจะถูกนำมาใช้ในงานวิจัยชิ้นนี้เท่านั้น

แบบสอบถามนี้มีวัตถุประสงค์เพื่อสอบถามบุคคลที่มีอำนาจการตัดสินใจในการนำระบบ Information Technology (IT) มาใช้งาน เช่น เจ้าของกิจการ หรือผู้จัดการ เป็นต้น ผู้วิจัยตระหนักดีว่า เวลาของท่านนั้นมีค่ามาก ผู้วิจัยจึงขอขอบคุณเป็นอย่างสูงที่ท่านสละเวลามา ตอบแบบสอบถามฉบับนี้

แบบสอบถามฉบับนี้ประกอบด้วย 3 ส่วน เพื่อความสมบูรณ์ของผลการวิจัย ขอความกรุณาอ่านคำถามแต่ละส่วน โดยละเอียด และกรอกข้อความตามคำชี้แนะที่ระบุไว้

คำจำกัดความ

ระบบ Business Intelligence (BI) เป็นชุดของเทคโนโลยีคอมพิวเตอร์ สำหรับการรวบรวม จัดเก็บ วิเคราะห์ข้อมูล และ ทำการจัดแสดงผลเพื่อสนับสนุนการตัดสินใจขององค์กร ซึ่งก่อให้เกิดการเพิ่มประสิทธิภาพของกระบวนการทำงาน

ระบบ BI นั้นปกติประกอบด้วย 2 องค์ประกอบพื้นฐาน ได้แก่

1) เทคโนโลยีที่เกี่ยวข้องกับการรวบรวมข้อมูล การเข้าถึงข้อมูล และ การเก็บข้อมูล
2) เทคโนโลยีที่เกี่ยวข้องกับการวิเคราะห์ และการนำเสนอข้อมูล

ส่วนที่ 1: ข้อมูลทั่วไปขององค์กร และผู้ตอบแบบสอบถาม

สำหรับแต่ละคำถามโปรดกากบาท X ลงในกล่องที่บรรยายหรือช่องว่างที่อธิบายถึงตัวท่าน และองค์กรของท่านมากที่สุด

คำถามที่เกี่ยวกับข้อมูลของท่าน

1. เพศ

☐ ชาย ☐ หญิง

2. อายุ

☐ 18 ถึง 20 ปี ☐ 21 ถึง 30 ปี
☐ 31 ถึง 40 ปี ☐ 41 ถึง 50 ปี ☐ มากกว่า 50 ปี

3. ระดับการศึกษาสูงสุดของท่าน

☐ ระดับมัธยมหรือเทียบเท่า ☐ ประกาศนียบัตรวิชาชีพ
☐ ระดับปริญญาตรี ☐ ระดับปริญญาโท หรือสูงกว่า

4. ตำแหน่งของท่านในองค์กรนี้

☐ เจ้าของกิจการ ☐ ผู้จัดการ ☐ อื่นๆ (โปรดระบุ)____

คำถามที่เกี่ยวกับข้อมูลขององค์กร

5. ท่านจัดองค์กรของท่านอยู่ในกลุ่มประเภทอุตสาหกรรมใดต่อไปนี้

☐ การผลิต ☐ การบริการ
☐ การค้าส่ง ☐ การค้าปลีก

6. จำนวนพนักงานในองค์กรของท่านมีจำนวนเท่าใด

☐ เจ้าของคนเดียว ☐ 2-9 ☐ 10-50
☐ 51-100 ☐ 101-200 ☐ มากกว่า 200

7. องค์กรของท่านมีการดำเนินการมาแล้วกี่ปี

☐ น้อยกว่า 1 ปี ☐ ตั้งแต่ 1 ปีขึ้นไปถึง 5 ปี
☐ ตั้งแต่ 5 ปีขึ้นไปถึง 10 ปี ☐ มากกว่า 10 ปี

8. องค์กรของท่านตั้งอยู่ที่ใด กรุณาเลือกหนึ่งคำตอบเท่านั้น

☐ กรุงเทพฯ และปริมณฑล ☐ ภาคกลาง และภาคตะวันออก
☐ ภาคเหนือ ☐ ภาคตะวันออกเฉียงเหนือ ☐ ภาคใต้

9. องค์กรของท่านได้มีการใช้โปรแกรมคอมพิวเตอร์ในการสนับสนุนการดำเนินธุรกิจด้านใด สามารถเลือกตอบได้มากกว่าหนึ่งคำตอบ

☐ การบัญชีการเงิน ☐ การควบคุมสินค้า ☐ การวางแผนการผลิต
☐ การบริหารลูกค้า ☐ การดำเนินการทางการตลาด ☐ การวิจัยการตลาด
☐ การกำหนดกำไร ☐ การวิเคราะห์เชิงกลยุทธ์ ☐ การคาดการณ์ทางการเงิน
☐ การวางแผนการขาย ☐ การวางแผนพนักงาน ☐ อื่นๆ (โปรดระบุ)________

ส่วนที่ 2: ลักษณะการบริหารการจัดการข้อมูลขององค์กร

โปรดทำเครื่องหมายกากบาท X ที่คำตอบ เพียงคำตอบเดียวเท่านั้นที่สามารถอธิบายองค์กรของท่าน:

1. องค์กรของท่านมีการจัดเก็บข้อมูลขององค์กรไว้ที่ใด

ก: ข้อมูลขององค์กรถูกจัดเก็บแยกกระจายลงบนเครื่องคอมพิวเตอร์ของพนักงานแต่ละบุคคล

ข: ข้อมูลขององค์กรถูกแบ่งแยกตามหน่วยงาน หรือ แผนก และถูกจัดเก็บในเครื่องคอมพิวเตอร์ หรือ เซิฟเวอร์ของแต่ละหน่วยงานนั้นๆ

ค: ข้อมูลขององค์กรส่วนใหญ่จะถูกจัดเก็บในฐานข้อมูลส่วนกลางขององค์กร ซึ่งง่ายต่อการเข้าถึง

ง: ข้อมูลถูกรวบรวมจากทั้งภายในและภายนอกองค์กร และจัดเก็บในระบบคอมพิวเตอร์ส่วนกลางขององค์กรที่เดียวที่ซึ่งรองรับและเชื่อมต่อหลายฐานข้อมูล

จ: ข้อมูลจะถูกจัดเก็บในระบบคอมพิวเตอร์ที่มีความยืดหยุ่น และเป็นอิสระ ที่ซึ่งรองรับข้อมูลที่เป็นแบบมีโครงสร้างและแบบไม่มีโครงสร้าง เช่น ข้อมูลที่เป็นแบบกราฟฟิก E-mail และเสียงดิจิทัล

2. โครงสร้างกระบวนการจัดการข้อมูลในองค์กรของท่านเป็นอย่างไร

ก: พนักงานแต่ละบุคคลมีวิธีการที่แตกต่างกันในการเข้าถึงและจัดการข้อมูล

ข: พนักงานที่มีหน้าที่รับผิดชอบแบบเดียวกัน จะมีวิธีการเหมือนกันในการจัดการข้อมูล

ค: พนักงานทุกคนในองค์กรมีวิธีการแบบเดียวกันในการบริหารจัดการข้อมูล

ง: องค์กรมีวิธีการจัดการข้อมูลเป็นมาตรฐาน และสอดคล้องกับหน่วยงานภายนอกองค์กร เช่น คู่ค้าทางธุรกิจ

จ: นอกเหนือจากวิธีการจัดการข้อมูลที่เป็นมาตรฐาน องค์กรยังมีการเตรียมแผนการเพื่อรองรับเทคโนยีใหม่ๆ ในอนาคต

3. พนักงานในองค์กรของท่านมีการใช้โปรแกรมคอมพิวเตอร์ที่ช่วยในการสนับสนุนการตัดสินใจทางธุรกิจอย่างไร

ก: พนักงานส่วนใหญ่ขาดทักษะทางคอมพิวเตอร์ และมักจะตัดสินใจบนพื้นฐานประสบการณ์ของตนเอง

ข: พนักงานบางส่วนสามารถใช้คอมพิวเตอร์ในการจัดการข้อมูล และนำข้อมูลเหล่านั้นมาประกอบการตัดสินใจ

ค: พนักงานส่วนใหญ่มีทักษะคอมพิวเตอร์ในการจัดการข้อมูลเป็นอย่างดี และนำข้อมูลเหล่านั้นมาช่วยในการตัดสินใจ

ง: พนักงานส่วนใหญ่ขององค์กรมีความสามารถในการใช้โปรแกรมคอมพิวเตอร์ที่ช่วยสนับสนุนในการตัดสินใจทาง ธุรกิจ เช่น สถิติขั้นสูงเพื่อดูแนวโน้มของตลาด

จ: พนักงานส่วนใหญ่มีความเชี่ยวชาญในการใช้โปรแกรมคอมพิวเตอร์ที่ช่วยในการตัดสินใจ และพนักงานส่วนใหญ่มีแนวความคิดนอกกรอบ หรือนอกเหนือไปจากแนวทางเดิม และพยายามที่จะสร้างสรรค์รูปแบบใหม่ในการทำงาน

4. องค์กรของท่านมีระดับการเปลี่ยนแปลงอย่างไร

ก: พนักงานมีความกลัวต่อการเปลี่ยนแปลง

ข: พนักงานจะยอมรับการเปลี่ยนแปลงเมื่อเห็นว่าการเปลี่ยนแปลงนั้นส่งผลดีต่อพวกเขา หรือกลุ่มของเขา

ค: พนักงานคุ้นเคยกับการเปลี่ยนแปลงเนื่องจากมีการปรับปรุงการทำงานอยู่เป็นประจำ และการเปลี่ยนแปลงจะได้รับการยอมรับก็ต่อเมื่อมีการสื่อสารที่ดี

ง: พนักงานเห็นการเปลี่ยนแปลงเป็นโอกาสมากกว่าเป็นปัญหา

จ: พนักงานและองค์กรเชื่อว่าความล้มเหลวที่นำไปสู่การเรียนรู้ จะได้รับการยอมรับ โดยไม่ถูกตำหนิหรือลงโทษ

5. โปรแกรมคอมพิวเตอร์ในการวิเคราะห์จัดการข้อมูลที่ดีที่สุด (ขั้นสูงสุด) ที่กำลังถูกใช้งานในองค์กรของท่านคืออะไร

ก: โปรแกรมคอมพิวเตอร์พื้นฐานทั่วไปในการสร้างรายงาน

ข: โปรแกรมคอมพิวเตอร์ที่ใช้เก็บข้อมูลให้อยู่ในรูปแบบเดียวกัน และสามารถดึงรายงานแสดงผล แต่การดึงข้อมูลอยู่ในมุมมองที่จำกัด เช่น ฝ่ายการตลาดดูข้อมูลได้เฉพาะรายงานสรุปการขายเท่านั้น

ค: โปรแกรมคอมพิวเตอร์ที่ใช้เก็บข้อมูลให้อยู่ในรูปแบบมาตรฐานทั่วทั้งองค์กร และผู้ใช้งานสามารถเรียกดูข้อมูลได้หลายมิติ เช่น ข้อมูลปริมาณการขายที่สามารถแสดงผลในมุมมองของผลิตภัณฑ์ สถานที่ หรือวันที่ขาย

ง: โปรแกรมคอมพิวเตอร์ที่สามารถชี้ให้เห็นข้อมูลที่เป็นประโยชน์ และชี้ให้เห็นความสัมพันธ์ของข้อมูลรวมถึงสามารถคาดการณ์ผลลัพธ์ในอนาคต

จ: ระบบที่สนับสนุนให้ผู้ใช้งานสามารถตรวจสอบสถานะของเหตุการณ์ในปัจจุบัน และทำการเตือนผู้ใช้งานทันทีเมื่อมีสิ่งผิดปกติเกิดขึ้น

ส่วนที่ 3: ปัจจัยสำคัญที่ผลักดันให้เกิดการนำ BI มาใช้งาน

โปรด O ล้อมรอบตัวเลขซึ่งแสดงระดับความเห็นที่ตรงกับความคิดเห็นของท่านมากที่สุดโดยที่หมายเลข 1 = ไม่เห็นด้วยอย่างยิ่ง 2 = ไม่เห็นด้วย 3 = ปานกลาง 4 = เห็นด้วย 5 = เห็นด้วยอย่างยิ่ง

หมายเหตุ: คำว่าเทคโนโลยีในที่นี้ หมายถึง โปรแกรมหรือเครื่องมือทางคอมพิวเตอร์ ที่ท่านกำลังใช้ในการจัดเก็บและวิเคราะห์ข้อมูล ซึ่งได้กล่าวถึงในแบบสอบถามส่วนข้อที่ 2 ข้อที่ 5

ปัจจัยที่มีผลต่อการนำ BI มาใช้งาน	ไม่เห็นด้วยอย่างยิ่ง 1	← 2	ปานกลาง 3	→ 4	เห็นด้วยอย่างยิ่ง 5
ข้อได้เปรียบของเทคโนโลยี					
1. เทคโนโลยีนี้ช่วยลดค่าใช้จ่ายในการดำเนินงานขององค์กร	1	2	3	4	5
2. เทคโนโลยีนี้สนับสนุนข้อมูลที่เป็นประโยชน์ และช่วยสนับสนุนการตัดสินใจ	1	2	3	4	5
3. เทคโนโลยีนี้ช่วยให้งานสำเร็จเร็วขึ้น และช่วยเพิ่มกลยุทธ์ด้านธุรกิจการค้า	1	2	3	4	5
4. เทคโนโลยีนี้ช่วยตรวจสอบปัญหาทางธุรกิจที่เกิดขึ้น และเสนอแนวทางแก้ไขได้ทันที	1	2	3	4	5
ความสลับซับซ้อนของเทคโนโลยี					
1. ภาพลักษณ์และการรับรู้เทคโนโลยีนี้มีความซับซ้อน	1	2	3	4	5
2. การติดตั้งและการใช้งานเทคโนโลยีนี้มีความซับซ้อน	1	2	3	4	5
3. เทคโนโลยีนี้เรียนรู้ได้ยาก	1	2	3	4	5
4. มีการต่อต้านการนำเทคโนโลยีนี้มาใช้ในองค์กร	1	2	3	4	5
ความสอดคล้องของเทคโนโลยี					
1. การใช้เทคโนโลยีนี้มีความสอดคล้องกับวิธีการทำงานในองค์กร	1	2	3	4	5
2. การใช้เทคโนโลยีนี้มีความสอดคล้องกับค่านิยมและความเชื่อของพนักงานในองค์กร	1	2	3	4	5
3. พนักงานในองค์กรสามารถใช้เทคโนโลยีนี้ทำงานร่วมกับโครงสร้างพื้นฐานด้านไอทีขององค์กร	1	2	3	4	5
4. การเปลี่ยนแปลงของกระบวนการทำงานที่เกิดจากเทคโนโลยีนี้มีความเหมาะสมกับแนวทางที่ องค์กรปฏิบัติอยู่	1	2	3	4	5
ความสามารถในการทดลองใช้งานเทคโนโลยี					
1. พนักงานในองค์กรได้มีการทดลองใช้งานเทคโนโลยีนี้ก่อนที่จะตัดสินใจรับเทคโนโลยีนี้มาใช้งาน	1	2	3	4	5
2. พนักงานในองค์กรได้มีการทดลองใช้งานเทคโนโลยีนี้อย่างเพียงพอก่อนที่จะตัดสินใจรับเทคโนโลยีนี้มาใช้งาน	1	2	3	4	5
3. ฉันได้มีการทดลองใช้งานเทคโนโลยีนี้ก่อนที่จะตัดสินใจรับเทคโนโลยีนี้ มาใช้งาน	1	2	3	4	5
4. ฉันได้มีการทดลองใช้งานเทคโนโลยีนี้อย่างเพียงพอก่อนที่จะตัดสินใจรับเทคโนโลยีนี้ มาใช้งาน	1	2	3	4	5
ความสามารถในการสังเกตการณ์เทคโนโลยี					
1. ฉันได้เห็นเทคโนโลยีนี้ถูกใช้งานในบริษัทอื่น ๆ	1	2	3	4	5
2. ฉันตระหนักว่าเทคโนโลยีนี้มีอยู่ทั่วไปในท้องตลาด	1	2	3	4	5
3. มันเป็นเรื่องง่ายที่จะบอกผลของการใช้งานเทคโนโลยีนี้ต่อคนอื่น ๆ (เช่น พนักงานและคู่ค้าทางธุรกิจ)	1	2	3	4	5
4. ผลของการใช้งานเทคโนโลยีนี้เป็นที่เด่นชัดแก่ฉัน	1	2	3	4	5
การแข่งขันทางธุรกิจ					
1. ระดับของการแข่งขันในอุตสาหกรรมส่งผลให้เกิดการใช้งานเทคโนโลยีนี้	1	2	3	4	5
2. ฉันรู้ว่าคู่แข่งของฉันได้นำเทคโนโลยีนี้มาใช้งานแล้ว	1	2	3	4	5
3. องค์กรจำเป็นที่จะต้องใช้เทคโนโลยีนี้ในการรักษาศักยภาพในการแข่งขัน	1	2	3	4	5
4. เทคโนโลยีนี้มีความสำคัญต่อยุทธศาสตร์ขององค์กร	1	2	3	4	5

ปัจจัยที่มีผลต่อการนำ BI มาใช้งาน	ไม่เห็นด้วยอย่างยิ่ง 1	← 2	ปานกลาง 3	→ 4	เห็นด้วยอย่างยิ่ง 5
ความสำคัญของผู้ให้บริการด้านไอที					
1. ชื่อเสียงของผู้ให้บริการด้านไอทีเป็นสิ่งสำคัญในการเลือกใช้เทคโนโลยีนี้	1	2	3	4	5
2. ความสัมพันธ์ที่ดีระหว่างผู้ให้บริการด้านไอที และผู้ใช้งานเป็นสิ่งจำเป็นต่อการเลือกใช้เทคโนโลยีนี้	1	2	3	4	5
3. ความสามารถของผู้ให้บริการด้านไอทีในการวางแผน และดำเนินการให้สำเร็จลุล่วงมีผลต่อการนำเทคโนโลยีนี้มาใช้งาน	1	2	3	4	5
4. ความสามารถในการทำความเข้าใจเทคโนโลยีนี้ของผู้ให้บริการด้านไอทีมีผลต่อการนำเทคโนโลยีนี้มาใช้งาน	1	2	3	4	5
ความสามารถในการเข้าถึงเทคโนโลยีของผู้ใช้งาน					
1. ผู้ใช้งานรับรู้ถึงขีดความสามารถของเทคโนโลยีนี้ในการตอบสนองต่อองค์กร	1	2	3	4	5
2. ผู้ใช้งานจำเป็นที่จะต้องมีการฝึกอบรมเพื่อใช้เทคโนโลยีนี้	1	2	3	4	5
3. ผู้ใช้งานพบว่าแทบจะไม่มีอุปสรรคเกิดขึ้นในการใช้เทคโนโลยีนี้	1	2	3	4	5
4. ผู้ใช้งานมีความสามารถเพียงพอในการใช้ประโยชน์จากเทคโนโลยีนี้	1	2	3	4	5
ความพร้อมด้านทรัพยากรขององค์กร					
1. องค์กรมีทรัพยากรเพียงพอในการนำเทคโนโลยีนี้มาใช้งาน	1	2	3	4	5
2. องค์กรได้จัดสรรงบประมาณทางการเงินเพื่อนำเทคโนโลยีนี้มาใช้	1	2	3	4	5
3. ทรัพยากรอื่น ๆ ขององค์กร (เช่น การฝึกอบรม, การสนับสนุนด้านไอที) มีส่วนกระตุ้นให้เกิดการใช้เทคโนโลยีนี้	1	2	3	4	5
4. องค์กรไม่เจอความยากลำบากในการจัดหาทรัพยากรที่จำเป็น (เช่น เงินทุน, คน, เวลา) เพื่อสนับสนุนการใช้ เทคโนโลยีนี้	1	2	3	4	5
ความคิดริเริ่มด้านไอทีของเจ้าของกิจการ					
1. ฉันมักจะแนะนำความคิดริเริ่มใหม่ ๆ และเป็นต้นแบบให้กับองค์กรเสมอ	1	2	3	4	5
2. ฉันมักจะมองหาสิ่งใหม่ ๆ มากกว่าการพัฒนาสิ่งที่มีอยู่	1	2	3	4	5
3. ฉันมักจะสร้างสรรค์สิ่งใหม่ ๆ มากกว่าการปรับปรุงสิ่งที่มีอยู่	1	2	3	4	5
4. ฉันมักจะมีมุมมองใหม่ ๆ สำหรับการแก้ปัญหาเดิมในองค์กร	1	2	3	4	5
ความรู้ด้านไอทีของเจ้าของกิจการ					
1. ฉันได้มีการใช้งานคอมพิวเตอร์ที่บ้าน	1	2	3	4	5
2. ฉันได้มีการใช้งานคอมพิวเตอร์ในที่ทำงาน	1	2	3	4	5
3. ฉันได้เข้าร่วมชั้นเรียนคอมพิวเตอร์ในอดีตที่ผ่านมา	1	2	3	4	5
4. ฉันมีความเข้าใจด้านไอทีเท่ากับคนอื่น ๆ ที่อยู่ในระดับเดียวกับฉัน	1	2	3	4	5

ขอขอบคุณทุกท่านอย่างสูงที่กรุณาสละเวลาในการตอบแบบสอบถามนี้

ท่านสามารถส่งแบบสอบถามกลับมาด้วยซองจดหมายที่แนบมาโดยมิต้องติดแสตมป์

Appendix F: Thai cover letter

VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

1 พฤษภาคม 2013

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เรียน ท่านเจ้าของผู้จัดการ / ผู้จัดการ

กระผม นาย วรัญพงศ์ บุญศิริธรรมชัย ขณะนี้ผมกำลังศึกษาอยู่ในระดับปริญญาเอก สาขาวิชา การจัดการ และ เทคโนโลยีสารสนเทศ มหาวิทยาลัย Victoria University ที่เมือง เมลเบริน์ ประเทศ ออสเตรเลีย ขณะนี้กระผมกำลังทำ วิทยานิพนธ์ในหัวข้อเรื่อง 'Enablers affecting the adoption of Business Intelligence: a study of Thai SMEs' จุดมุ่งหมายของการวิจัยครั้งนี้คือ การศึกษาปัจจัยที่ส่งผลต่อการนำระบบ Business Intelligence (BI) และ เทคโนโลยีสารสนเทศ มาใช้งานในองค์กรขนาดกลาง และ ขนาดย่อม (SMEs) ในประเทศไทย ผลของการศึกษาครั้งนี้ จะเป็นประโยชน์ในการ พัฒนา และ ส่งเสริมการใช้งานระบบ BI ให้ประสบความสำเร็จ

แบบสอบถามฉบับนี้ถูกออกแบบมาเพื่อใช้ในการประเมิน สถานะปัจจุบันของการนำระบบ BI มาใช้ และ ประเมิน ปัจจัยส่งเสริมและอุปสรรค์ต่อ การนำระบบ BI มาใช้งานในธุรกิจขนาดกลาง และ ขนาดย่อม ในประเทศไทย ความช่วยเหลือของท่านในการตอบ แบบสอบถามในครั้งนี้ จะช่วยส่งเสริมความเข้าใจมากขึ้น ในการใช้นำระบบ BI มาใช้ และนำไปสู่การพัฒนาสำหรับธุรกิจขนาดกลางและขนาดย่อม ในประเทศไทย

เพื่อให้ผลการวิจัยมีความถูกต้องและสมบูรณ์สามารถนำไปใช้ประโยชน์ได้จริง ผู้วิจัยได้ทำการสุ่มเลือก กลุ่มตัวอย่างอย่างเป็นระบบตามกระบวนการวิจัย ซึ่งบริษัทของท่านได้รับการสุ่มเลือกเป็นหนึ่งในกลุ่มตัวอย่างนี้ ฉะนั้นผู้วิจัยจึงขอความอนุเคราะห์จากท่านซึ่งเป็นผู้บริหารขององค์การในการกรอกแบบสอบถามที่แนบมาพร้อมกันนี้ คำตอบและข้อมูลส่วนตัวของท่านจะถูกเก็บไว้เป็นความลับอย่างสูงสุดและจะนำไป ใช้สำหรับงานวิจัยนี้เท่านั้น

แบบสอบถามนี้ประกอบไปด้วยคำถามจำนวน 5 หน้า ซึ่งใช้เวลาตอบไม่เกิน 15 นาที ทั้งนี้ผู้วิจัยได้แนบซอง จดหมายที่ติดแสตมป์ไว้แล้วมาพร้อมกันนี้ จึงขอความอนุเคราะห์จากท่านสละเวลาอันมีค่าของท่านกรอกแบบสอบถาม และ ส่งกลับคืนมายังผู้วิจัย เมื่อท่านทำเสร็จแล้ว โดยขอให้ท่านส่งกลับมาภายในวันที่ 30 พฤษภาคม 2557 หากท่านมีข้อสงสัยหรือคำถาม กรุณาติดต่อกระผมได้ที่ Waranpong.Boonsiritomachai@live.vu.edu.au หรือติดต่ออาจารย์ที่ปรึกษาของกระผม ศาสตราจารย์ ดร. Michael McGrath ที่ Michael.McGrath@vu.edu.au

ด้วยความเคารพอย่างสูง,
นาย วรัญพงศ์ บุญศิริธรรมชัย
นักศึกษาระดับปริญญา เอก
Victoria University, Melbourne, Australia

Appendix G: Consent form for participants involved in research (Thai version)

VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

ใบยินยอมสำหรับผู้ตอบแบบสอบถามเพื่อการศึกษาวิจัย

เรียน ผู้ตอบแบบสอบถาม

ทางมหาวิทยาลัย Victoria University ณ ประเทศออสเตรเลีย ขอเรียนเชิญท่านเข้าร่วมในการตอบแบบสอบถามเพื่องาน วิจัยภายใต้ หัวข้อเรื่อง ปัจจัยที่มีผลต่อการนำระบบ Business Intelligence (BI) มาใช้งาน กรณีศึกษา บริษัทขนาดกลาง และ ขนาดย่อม (SMEs) ในประเทศไทย จุดประสงค์ของการวิจัยในครั้งนี้ เพื่อศึกษา สภาพปัจจุบันของการนำระบบ BI มาใช้งานใน SMEs ในประเทศไทย นอกจากนี้งานวิจัยยังมีจุดมุ่งหมายที่จะศึกษาหาปัจจัย และ อุปสรรค ที่มีผลต่อการ นำระบบ BI มาใช้งาน ผลของการวิจัยในครั้งนี้ คาดว่าจะนำไปสู่การทำความเข้าใจที่ดีขึ้นต่อคุณลักษณะของ SME ที่ เป็นตัวกำหนด การนำ BI ไปใช้ในประเทศไทย และ เพิ่มความเข้าใจต่อแนวโน้ม และ การพัฒนาผู้ประกอบการ SMEs ในการใช้เทคโนโลยี ข้อมูลทั้งหมดที่ท่านให้มาจะถูกใช้เพื่อการวิจัยในครั้งนี้เท่านั้น และ จะถูกเก็บไว้เป็นความลับ ซึ่งจะไม่มีการเปิดเผยในกรณีใด ๆ การเข้าร่วมโครงการในครั้งนี้จะไม่มีความเสี่ยงใดๆเกิดขึ้นทั้งสิ้น

การรับรองของผู้ตอบแบบสอบถาม

ข้าพเจ้า นาย/นาง/นางสาว ………………………………………………………………………………………………………

ขอรับรองว่า ข้าพเจ้ามีอายุมากกว่า 18 ปีบริบูรณ์ และยินยอมโดยสมัครใจที่จะเข้าร่วมงานวิจัย เพื่อศึกษาถึงปัจจัยที่มีผลต่อ การนำระบบ Business Intelligence (BI) มาใช้งาน กรณีศึกษา บริษัท ขนาดกลาง และ ขนาดย่อม (SMEs) ในประเทศไทย โดย นายวรัญพงศ์ บุญศิริธรรมชัย นักศึกษาระดับปริญญาเอก จากมหาวิทยาลัย Victoria University ภายใต้การกำกับดูแลของ ศาสตราจาย์ ดร. ไมเคิล แมคการ์ด (Professor Michael McGrath) และ รองศาสตราจาย์ ดร. สตีเฟ่น เบอร์เกส (Associate Professor Stephen Burgess)

ข้าพเจ้าขอรับรองว่า นาย วรัญพงศ์ บุญศิริธรรมชัย ได้ทำการอธิบายถึงวัตถุประสงค์หลักของงานวิจัย รวมไปถึงความเสี่ยง และ มาตรการในการป้องกันความเสี่ยงที่เกี่ยวข้องกับงานวิจัยในครั้งนี้ และ ข้าพเจ้ายินยอมที่จะเข้าร่วมงานวิจัย โดยการ ตอบแบบสอบถามในครั้งนี้

ข้าพเจ้าขอรับรองว่า ข้าพเจ้าได้มีโอกาสซักถามถึงข้อสงสัยต่างๆ ที่เกี่ยวข้องกับงานวิจัยในครั้งนี้ และ ข้าพเจ้าทราบว่า ข้าพเจ้ามีสิทธิ์ที่จะถอนตัวออกจากการเข้าร่วมตอบแบบสอบถามในเวลาใดก็ได้ โดยการถอนตัวนี้จะไม่มีผลกระทบใดๆ ต่อตัวข้าพเจ้า

ข้าพเจ้าได้รับการชี้แจ้งว่า ข้อมูลที่ข้าพเจ้าให้เพื่องานวิจัยในครั้งนี้ จะถูกเก็บเป็นความลับ

ลงนาม………………………………………………………… วันที่ …………………………………………………

ทั้งนี้ หากท่านมีข้อสงสัยเกี่ยวกับการเข้าร่วมงานวิจัยข้างต้น ท่านสามารถติดต่อสอบถาม ดร ไมเคิล แมคการ์ด (Michael McGrath) โทรศัพท์ +613 9919 4627 หรือ Michael.McGrath@vu.edu.au หรือหากท่านมีข้อสักถามเพิ่มเติม หรือ ต้องการ ร้องเรียนเกี่ยวกับการเข้าร่วมงานวิจัยในครั้งนี้ ท่านสามารถติดต่อไปยัง คณะกรรมการสิทธิมนุษย์และจรรยาบรรณเพื่องานวิจัย แห่งมหาวิทยาลัย Victoria University ตามที่อยู่ดังต่อไปนี้ Research Ethics and Biosafety Manager, Victoria University Human Research Ethics Committee, Victoria University, PO Box 14428, Melbourne, VIC, 8001 or phone (03) 9919 4148.

Appendix H: Thai Reminder Cover Letter

VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

1 มิถุนายน 2013

นาย วรัญพงศ์ บุญศิริธรรมชัย, DBA candidate

School of Management and Information Systems
Victoria University City Flinders Campus
PO BOX 14428 Melbourne, Australia 8001
PHONE +613 9919 1295
FAX + 613 9919 1064

เรียน ท่านเจ้าของผู้จัดการ / ผู้จัดการ

ตามที่ผู้วิจัยได้ส่งแบบสอบถามลงวันที่ 1 พฤษภาคม 2556 ขอความอนุเคราะห์จากท่านในการกรอกแบบสอบถามสำหรับงานวิจัยในหัวข้อเรื่อง 'Enablers affecting the adoption of Business Intelligence: a study of Thai SMEs' ตามแบบบันทึกการติดตามของผู้วิจัยพบว่า ยังไม่ได้รับแบบสอบถามคืนจากท่าน จึงขอแจ้งมายังท่านเพื่อขอความ อนุเคราะห์ กรอกแบบสอบถามและส่งคืนกลับมายังผู้วิจัย

ระบบ Business Intelligence หรือ BI เป็นเครื่องมือที่ช่วยในการจัดเก็บข้อมูล และวิเคราะห์ข้อมูล เพื่อสนับสนุนกระบวนการตัดสินใจในทางธุรกิจ ไม่เพียงแต่องค์กรขนาดใหญ่เท่านั้น องค์กรขนาดกลางและขนาดย่อม สามารถที่จะใช้ประโยชน์จากระบบ BI แต่การนำ BI มาใช้ในองค์กรขนาดกลางและย่อมยังจำกัดอยู่ ทั้งๆที่ระบบ BI สามารถช่วยเพิ่มกลยุทธ์และประสิทธิ์ภาพในการดำเนินธุรกิจให้แก่องค์กร การใช้เทคโนโลยีที่ช่วยสนับสนุนในการตัดสินใจนั้นย่อมสำคัญอย่างมากต่อเจ้าของกิจการ จุดมุ่งหมายของการวิจัยครั้งนี้คือ การศึกษาปัจจัยที่ส่งผลต่อการนำระบบ Business Intelligence (BI) และเทคโนโลยีสารสนเทศมาใช้งานในองค์กรขนาดกลางและขนาดย่อม (SMEs) ในประเทศไทย ผลของการศึกษาครั้งนี้ จะเป็นประโยชน์ในการพัฒนา และส่งเสริมการใช้งานระบบ BI ให้ประสบความสำเร็จ แบบสอบถามฉบับนี้ถูกออกแบบมาเพื่อใช้ในการประเมิน สถานะปัจจุบันของการนำระบบ BI มาใช้ และประเมินปัจจัยส่งเสริม และอุปสรรค์ต่อการนำระบบ BI มาใช้งานในธุรกิจขนาดกลางและขนาดย่อมในประเทศไทย ความช่วยเหลือของท่านในการตอบแบบสอบถาม ในครั้งนี้จะช่วยส่งเสริมความเข้าใจมากขึ้น ในการใช้นำระบบ BI มาใช้ และ นำไปสู่การพัฒนาสำหรับ ธุรกิจขนาดกลาง และ ขนาดย่อม ในประเทศไทย

ฉะนั้นคำตอบของท่านจึงมีความสำคัญเป็นอย่างยิ่งสำหรับงานวิจัยนี้ ทั้งนี้แบบสอบถามชุดใหม่ และซองจดหมายที่ติดแสตมป์ไว้แล้ว ได้แนบมากับจดหมายฉบับนี้ แบบสอบถามนี้ประกอบไปด้วยคำถามจำนวน 5 หน้า ซึ่งใช้เวลาตอบไม่เกิน 15 นาที ขอความกรุณาท่านกรอกคำตอบให้ครบทุกส่วนของแบบสอบถาม เพื่อความถูกต้องและความน่าเชื่อถือของผลการวิจัย ผู้วิจัยขอยืนยัน อีกครั้งหนึ่งว่า คำตอบและข้อมูลส่วนตัวของท่านจะถูกเก็บไว้เป็นความลับอย่างสูงสุด และจะนำไปใช้สำหรับงานวิจัยนี้เท่านั้น ขอความอนุเคราะห์จากท่านสละเวลาอันมีค่าของท่านกรอกแบบสอบถาม และส่งกลับคืนมายังผู้วิจัย เมื่อท่านทำเสร็จแล้ว โดยขอให้ท่านส่งกลับมาภายในวันที่ 30 มิถุนายน 2557 หากท่านมีข้อสงสัย หรือคำถาม กรุณาติดต่อกระผมได้ที่ Waranpong.Boonsiritomachai@live.vu.edu.au หรือติดต่ออาจารย์ที่ปรึกษาของกระผม ศาสตราจารย์ ดร. Michael McGrath ที่ Michael.McGrath@vu.edu.au

ด้วยความเคารพอย่างสูง,
นาย วรัญพงศ์ บุญศิริธรรมชัย
นักศึกษาระดับปริญญา เอก
Victoria University, Melbourne, Australia

Appendix I: The statement of the completion of the translation (English to Thai)

Chulalongkorn University

Dr. Sujin Khomrutai, Ph.D.
Chulalongkorn University
Address: 309(23) Mahamakut Room Department of Mathematics, Faculty of Science
Chulalongkorn University, Bangkok 10330
Tel : +66-2-218-5158
Fax : +66-2-255-2287
Email: sujin.k@chula.ac.th

January 27, 2013

Mr. Waranpong Boonsiritomachai
Victoria University
City Flinders Campus
300 Flinders Street, Melbourne
PO Box 14428

SUBJECT: MR. WARANPONG BOONSIRITOMACHAI

I would like to confirm that the translation of the questionnaire titled "Enablers affecting the adoption of Business Intelligence: a study of Thai small and medium-sized enterprises" has been verified. The content and the meaning are accurately equivalent to the original version.

If you have any queries, please contact me at the above contact details.

Yours faithfully,

Sujin Khomrutai

Dr. Sujin Khomrutai, Ph.D.
Translator (English to Thai)
Lecturer
Department of Mathematics
Faculty of Science
Chulalongkorn University

Appendix J: The statement of the completion of the translation (Thai to English)

Dr. Keng Wiboonton, Ph.D.
Chulalongkorn University
Address: 309(23) Mahamakut Room Department of Mathematics, Faculty of Science
Chulalongkorn University, Bangkok 10330
Tel : +66-2-218-5158
Fax : +66-2-255-2287
Email: sujin.k@chula.ac.th

January 27, 2013

Mr. Waranpong Boonsiritomachai
Victoria University
City Flinders Campus
300 Flinders Street, Melbourne
PO Box 14428

SUBJECT: MR. WARANPONG BOONSIRITOMACHAI

I would like to confirm that the translation of the questionnaire titled "Enablers affecting the adoption of Business Intelligence: a study of Thai small and medium-sized enterprises" has been verified. The content and the meaning are accurately equivalent to the original version.

If you have any queries, please contact me at the above contact details.

Keng Wiboonton

Yours faithfully,

Dr. Keng Wiboonton, Ph.D.
Translator (Thai to English)
Lecturer
Department of Mathematics
Faculty of Science
Chulalongkorn University

Appendix K: Curriculum vitae of translators

CHULALONGKORN UNIVERSITY

DR. SUJIN KHOMRUTAI, Ph.D.

Department of Mathematics, Faculty of Science
Chulalongkorn University, Bangkok, Thailand
http://pioneer.netserv.chula.ac.th/~ksujin

EDUCATION

Chulalongkorn University, B.Eng in Electrial Engineering	1996-2001
Chulalongkorn University, M.Sc. in Mathematics	2002-2003
University of Notre Dame, Indiana, Ph.D. in Mathematics	2004-2009

AWARDS AND HONORS

Silver Medal, the 36th International Mathematical Olympiad, Canada 1995

PUBLICATIONS

1. S. Khomrutai, *Regularity of the sigma_k Yamabe problem: the negative-cone case*, submitted.
2. S. Khomrutai, *A Local gradient estimate for the sigma_k -Yamabe problem: the negativecone case*, submitted.

WORK EXPERIENCE

Lecturer, Department of Mathematics, Chulalongkorn University 2002-2003
Teaching Assistant, Department of Mathematics, University of Notre Dame 2005-2009
Lecturer, Department of Mathematics, Chulalongkorn University 2009-2011

1

CHULALONGKORN UNIVERSITY

DR. Keng Wiboonton, Ph.D.

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EDUCATION

Ph.D. in mathematics, Lousiana State University, August 2009

M.S. University of Wisconsin, May 2005

M.Sc. Chulalongkorn University, March 2002

B.S. (Second class honor) Chulalongkorn University, March 2000

SCHOLARSHIPS AND AWARDS

1. A Chulalongkorn University scholarship, 1996-2000.
2. An award for the highest GPA in Mathematics Program at Chulalongkorn University, 1997-1998.
3. An award for the highest GPA in Mathematics Program at Chulalongkorn University, 1998-1999.
4. An award for the highest GPA in Mathematics Program at Chulalongkorn University, 1999-2000.
5. An award for the highest GPA in 4 years (1996-2000) for Mathematics Program given by The Faculty of Science at Chulalongkorn University.
6. An award from Dr. Tab Neeraniti Foundation in 2001.
7. A scholarship from The Development and Promotion of Science and Technology Talents Project, 2002-2007.
8. A scholarship from NSF (National Science Foundation), USA, May 2008 -August 2008
9. A scholarship from NSF (National Science Foundation), USA, May 2009 -August 2009

ACADEMIC ACTIVITIES

1. Member of the Mathematical Association of Thailand, 1994- present.
2. Member of the American Mathematical Society, 2002 - present.

TALKS AND COLLOQUIA

1. *Representation theory and Hydrogen Atoms,* Harmonic Analysis Seminar, Lousiana State University, March 2009.
2. *Uniform Distribution in Function Fields,* International Conference of Algebra 2002, Bangkok, Thailand, May 2002

TEACHING EXPERIENCES

1. 2007 - 2009: Teaching Assistant, Lousiana State University, teaching Calculus I, Calculus II, College Algebra.

2. August 2008: Teaching *Mathematical Analysis* to incoming graduate students to prepare them for entering the Ph.D. Program at Louisiana State University.

3. 2009: Lecturer, teaching Engineering Maths II, Business Calculus I and Graduate Seminar.

RESEARCH INTERESTS

Abstract harmonic analysis, analysis on Lie groups, representation theory, gyrogroups and relativity.

EXPOSITORY ARTICLES

1. Techniques for Solving Equations, in Journal of Mathematical Association of Thailand under the Patronage of His Majesty the King.

2. Quadratic Equations and Their Graphs, in Journal of Mathematical Association of Thailand under the Patronage of His Majesty the King.

3. Polynomial Equations, in Journal of Mathematical Association of Thailand under the Patronage of His Majesty the King.

4. Problems about Angle Bisector, in Journal of Mathematical Association of Thailand under the Patronage of His Majesty the King.

Appendix L: Coding of measurement scale

Full variable name	SPSS variable name	Coding instructions
Identification number	ID	Number assigned to each questionnaire
Gender	GEN	1= Male 2 = Female
Age group	AGE	1 = 18–20 years 2 = 21–30 years 3 = 31–40 years 4 = 41–50 years 5 = more than 50 years
Education	EDU	1 = High School or equivalent 2 = Vocational or diploma 3 = Bachelor Degree 4 = Master Degree or higher years old
Position	POS	1 = Owner-manager 2 = Manager 3 = Other
Industry sector	IND	1 = Manufacturing 2 = Service 3 = Wholesale
Employee number	EMP	1 = Sole proprietor 2 = 2–9 3 = 10–50 4 = 51–100 5 = 101–200 6 = More than 200
Years in business	YEA	1 = Less than 1 year 2 = 1–5 years 3 = 6–10 years 4 = More than 10 years
Location	ARE	1 = Bangkok and Vicinity 2 = Central Regions and Eastern Regions 3 = Northern Region 4 = Northeast region 5 = Southern Region
Financial accounting	ITS1	1 = Yes 2 = No
Stock control	ITS2	1 = Yes 2 = No
Production planning	ITS3	1 = Yes 2 = No
Customer management	ITS4	1 = Yes 2 = No
Marketing mix	ITS5	1 = Yes 2 = No
Market research	ITS6	1 = Yes 2 = No
Profit forecasting	ITS7	1 = Yes 2 = No
Strategic analysis	ITS8	1 = Yes 2 = No
Cash flow forecasting	ITS9	1 = Yes 2 = No
Sales planning	ITS10	1 = Yes 2 = No
Staff planning	ITS11	1 = Yes 2 = No
Other (please specify)_____	ITS12	1 = Yes 2 = No
Infrastructure	INF	1 = Operate level 2 = Consolidate level 3 = Integrate level 4 = Optimise level 5 = Innovative level
Knowledge process	PRO	1 = Operate level 2 = Consolidate level 3 = Integrate level 4 = Optimise level 5 = Innovative level
Human capital	HRM	1 = Operate level 2 = Consolidate level 3 = Integrate level 4 = Optimise level 5 = Innovative level
Culture	CUL	1 = Operate level 2 = Consolidate level 3 = Integrate level 4 = Optimise level 5 = Innovative level
Application	APP	1 = Operate level 2 = Consolidate level 3 = Integrate level 4 = Optimise level 5 = Innovative level
Level of BI	LEV	1 = Operate level 2 = Consolidate level 3 = Integrate level 4 = Optimise level 5 = Innovative level

Full variable name	SPSS variable name	Coding instructions
Relative advantage	RAD1 to RAD 4	1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 Strongly agree
Complexity	COM1 to COM4	1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 Strongly agree
Compatibility	COP1 to COP4	1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 Strongly agree
Trialability	TRI1 to TRI 4	1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 Strongly agree
Observability	OBS1 to OBS4	1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 Strongly agree
Competitive pressure	CPP1 to CPP4	1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 Strongly agree
Vendor selection	VEN1 to VEN4	1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 Strongly agree
Absorptive capacity	ABS1 to ABS4	1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 Strongly agree
Organisational resource availability	ORE1 to ORE4	1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 Strongly agree
Owner-managers' innovativeness	OIN1 to OIN4	1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 Strongly agree
Owner-managers' IT knowledge	OIT1 to OIT4	1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 Strongly agree

Appendix M: Calculation and interpretation of BI classification levels

Survey responses were analysed to determine which of the five BI levels: Operate, Consolidate, Integrate, Optimise and Innovate predominates in the organisation. Here, the lowest is Operate, and the highest is Innovate. To classify organisations into a BI level, five questions were posed based on the dimensions of the modified IEM model, Infrastructure, Knowledge process, Human capital, Culture and Application. Each question contains five possible responses, each one representing a level of BI. Respondents could only select one answer that best described their organisation. The responses were then counted to determine the BI level of the organisation. Analysis of the responses revealed three main patterns: Pattern 1 – respondents chose to answer at the same level for all questions (see Table 1); Pattern 2 – respondents chose the same answer for three or more questions in the same level (see Table 2); and Pattern 3 – answers choices were mixed, with no answers being chosen more than two times (see Table 3).

Question Number	Choice of answer / Dimension	a (operate level)	b (consolidate level)	c (integrate level)	d (optimise level)	e (innovate level)
1	Infrastructure	X				
2	Knowledge process	X				
3	Human capital	X				
4	Culture	X				
5	Application	X				

Table 1: Typical example of a 'Pattern 1' survey response

Table 1 shows a typical 'Pattern 1' response. As the respondent chose 'a' that represents the Operate level for all questions, their organisation is classified as 'Operate'.

Question Number	Choice of answer / Dimension	a (operate level)	b (consolidate level)	c (integrate level)	d (optimise level)	e (innovate level)
1	Infrastructure		X			
2	Knowledge process		X			
3	Human capital		X			
4	Culture	X				
5	Application	X				

Table 2: Typical example of a 'Pattern 2' survey response

Table 2 shows a typical 'Pattern 2' response. As the respondent chose 'b' a majority of the time (a minimum of three times) that represents the Consolidate level, the organisation is classified at this level. Even though this respondent chose 'a' that represents Operate level for the two questions related to Culture and Application dimensions, this organisation is classified at the Consolidate level due to this level having the highest answer count (3 out of 5).

Question Number	Choice of answer / Dimension	a (operate level)	b (consolidate level)	c (integrate level)	d (optimise level)	e (innovate level)
1	Infrastructure		X			
2	Knowledge process		X			
3	Human capital			X		
4	Culture			X		
5	Application				X	

Table 3: Typical example of a 'Pattern 3' survey response

Table 3 shows a typical 'Pattern 3' response. Here, the respondent has chosen 'b' (Consolidate level) in the two questions related to Infrastructure and Knowledge process, 'c' (Integrate level) in the two questions related to Human capital and Culture, and 'd' (Optimise level) in the question related to Application. However, when no answer has been chosen three or more times, the concept of maturity is applied to classify the organisational level of BI. According to this concept, organisations at higher levels of maturity inherently possess all properties of the lower levels (Klimko 2011). In applying this concept, a point system is employed in which responses are converted into points in order to determine the BI level, with each lower response being counted as one (see Table 4). Therefore, using this concept, this survey response becomes ‘Integrate’ (as shown in Table 4).

Question Number	Choice of answer / Dimension	a (operate level)	b (consolidate level)	c (integrate level)	d (optimise level)	e (innovate level)
1	Infrastructure	**1**	1			
2	Knowledge process	**1**	1			
3	Human capital	**1**	**1**	1		
4	Culture	**1**	**1**	1		
5	Application	**1**	**1**	**1**	1	
N		**5**	**5**	**3**	**1**	

***1** indicates points as converted from survey responses in Table 3

Table 4: Survey response converted to points

Table 4 shows the count conducted across each level of BI for the example presented in Table 3 to determine the organisational BI level. As the highest level of BI shows a count of three or more at the Integrate level, this organisation is categorised as ‘Integrate’.

Appendix N: The mean values of each question across the three groups of SMEs based on BI levels

Descriptive statistics						
Items under each factor	**Operate n = 206**		**Consolidate n = 136**		**Integrate+ n = 85**	
	M	SD	M	SD	M	SD
Relative advantage						
This technology enables your company to reduce the cost of operations.	2.00	.722	3.14	.854	3.34	1.086
This technology provides competitive information and improves decision-support.	3.05	.738	4.06	.707	4.21	.709
This technology accomplishes tasks that allow us to enhance business strategies.	2.32	.643	3.29	.887	3.42	1.004
This technology monitors problems and provides solutions in real-time.	1.94	.730	2.60	.670	2.89	1.058
Complexity						
The process of introducing this technology was complicated.	3.33	.600	2.32	.698	1.54	.628
The operation of this technology was considerably complicated to implement and use within your firm.	3.53	.590	2.28	.805	1.58	.643
This technology was difficult to learn.	3.40	.668	2.53	.788	1.95	.754
Considerable resistance existed within the firm towards the use of this technology.	3.66	.714	3.34	.762	2.93	.842
Compatibility						
Using this technology is consistent with our firm’s values and beliefs.	3.34	.679	3.24	.623	3.53	.733
This technology is compatible with the organisation’s IT infrastructure.	3.27	.665	3.30	.863	3.34	.765
The changes introduced by this technology are compatible with existing operating practices.	3.34	.618	3.31	.715	3.33	.679
Trialability						
Company employees were able to trial this technology before the adoption decision was made.	3.38	.816	3.45	.850	3.34	.795
Company employees were able to **adequately** trial this technology before the adoption decision was made.	2.63	.900	3.01	.923	2.99	.587
I was able to try out this technology before the adoption decision was made.	3.44	.985	3.49	.878	3.65	.948
I was able to try out this technology **adequately** before the adoption decision was made.	2.87	.991	2.96	.950	3.15	.880
Observability						
I was aware of the existence of this technology in the market.	3.21	.953	3.81	.775	3.91	.796
I would have no difficulty telling others (employees, business partners) about the results of using this technology after seeing it in operation.	3.05	.822	3.49	.740	3.67	.714
The results of using this technology were apparent to me before it was adopted.	2.94	.916	3.34	.691	3.92	.759
Competitive pressure						
The degree of competition in our industry placed pressure on the firm’s decision to adopt this technology.	2.70	.630	3.63	.719	4.08	.805
I knew that my competing rivals were already using this technology.	2.85	.610	3.72	.685	3.91	.684
The firm needed to utilise this technology to maintain its competitiveness in the market.	2.70	.659	3.67	.721	3.68	.743
It was a strategic necessity to use this technology.	2.63	.662	3.22	.696	3.47	.796

Descriptive statistics						
Items under each factor	**Operate n = 206**		**Consolidate n = 136**		**Integrate+ n = 85**	
	M	SD	M	SD	M	SD
Vendor selection						
The vendors' reputation was important in selecting this technology.	3.41	.894	4.02	.970	3.35	.767
The relationship between technology vendor and customers was important.	2.45	.621	3.68	.814	3.86	.774
The capability of the technology vendor to plan and complete the project was important.	2.36	.646	3.56	.867	3.89	.887
The technological competency of the vendor was significant.	2.35	.666	3.33	.919	3.94	.956
Absorptive capacity						
Key users of this technology understood what this technology could do for the company.	3.18	.659	3.26	.669	3.46	.609
There were hardly any major knowledge barriers in using this technology.	3.02	.592	2.93	.579	2.85	.748
Key users were technically knowledgeable in exploiting these technology capabilities.	3.14	.793	3.07	.651	3.26	.657
Organisational resource availability						
The firm had the technological resources to adopt this technology.	2.46	.836	2.69	.830	3.61	.888
The firm provided financial resources to adopt this technology.	2.50	.854	2.81	.890	3.73	.808
Other organisational resources (e.g. training, IS support) contributed to build higher levels of this technology adoption.	2.60	.744	2.87	.933	3.76	.826
There were no difficulties in finding all of the necessary resources (e.g. funding, people, time) to implement this technology.	2.32	.975	2.63	.851	3.09	.840
Owner-managers' innovativeness						
I always introduce new and original ideas.	3.15	.974	3.32	.737	3.54	.839
I always look for something new rather than improving something existing.	3.04	1.011	3.37	.824	3.45	.919
I would sooner create something new than improve something existing.	2.96	.957	3.17	.865	3.53	.907
I often have a fresh perspective on old problems.	2.94	.940	3.20	.868	3.29	.911
Owner-managers' IT knowledge						
I use a computer at home.	4.06	1.003	3.46	.958	3.28	1.042
I use a computer at work.	3.12	.808	3.59	.890	4.11	.988
I attended computer classes in the past.	3.56	.896	3.57	.925	3.66	.880
I have a sound level of understanding of IT when compared to the other owners of business.	3.33	1.048	3.13	.954	3.41	.955

Appendix O: Results from multinomail logistic regression

Case Processing Summary

		N	Marginal percentage
New Level of BI	Operate	206	48.2%
	Consolidate	136	31.9%
	Integrate+	85	19.9%
Valid		427	100.0%
Subpopulation		427[a]	

a. The dependent variable has only one value observed in 427 (100.0%) subpopulations.

Model Fitting Information

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-square	df	Sig.
Intercept Only	885.916			
Final	257.835	628.081	22	.000

Goodness-of-Fit

	Chi-square	df	Sig.
Pearson	6848.589	830	.000
Deviance	257.835	830	1.000

Pseudo R-square

Cox and Snell	.770
Nagelkerke	.881
McFadden	.709

Classification

Observed	Predicted			
	Operate	Consolidate	Integrate+	Per cent Correct
Operate	200	6	0	97.1%
Consolidate	4	114	18	83.8%
Integrate+	1	16	68	80.0%
Overall Percentage	48.0%	31.9%	20.1%	89.5%

Likelihood Ratio Tests

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-square	df	Sig.
Intercept	267.606	9.772	2	.008
MRAD	284.482	26.647	2	.000
MRCOM	330.650	72.816	2	.000
MCOP	260.111	2.277	2	.320
MTRI	260.767	2.932	2	.231
MOBS	273.989	16.154	2	.000
MBUC	279.829	21.995	2	.000
MVEN	272.097	14.263	2	.001
MABS	262.026	4.192	2	.123
MORE	296.429	38.595	2	.000
MOIN	265.907	8.072	2	.018
MOIT	262.815	4.981	2	.083

The Chi-square statistic is the difference in –2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

Parameter Estimates

New Level of BI[a]		B	Std Error	Wald	df	Sig.	Exp (B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Consolidate	Intercept	–12.605	4.342	8.426	1	.004			
	MRAD	2.891	.685	17.796	1	.000	18.010	4.701	69.000
	MRCOM	–2.545	.552	21.277	1	.000	.078	.027	.231
	MCOP	–.746	.557	1.795	1	.180	.474	.159	1.413
	MTRI	–.731	.450	2.644	1	.104	.481	.199	1.162
	MOBS	1.168	.576	4.106	1	.043	3.215	1.039	9.951
	MBUC	2.737	.646	17.962	1	.000	15.446	4.355	54.775
	MVEN	2.037	.628	10.518	1	.001	7.669	2.239	26.265
	MABS	–.712	.616	1.335	1	.248	.491	.147	1.641
	MORE	–.285	.470	.367	1	.545	.752	.300	1.889
	MOIN	1.381	.518	7.099	1	.008	3.980	1.441	10.995
	MOIT	–1.037	.481	4.648	1	.031	.354	.138	.910
Integrate+	Intercept	–14.329	5.168	7.689	1	.006			
	MRAD	2.507	.759	10.913	1	.001	12.265	2.772	54.276
	MRCOM	–4.936	.713	47.885	1	.000	.007	.002	.029
	MCOP	–.935	.659	2.012	1	.156	.393	.108	1.429
	MTRI	–.848	.570	2.214	1	.137	.428	.140	1.309
	MOBS	2.458	.692	12.631	1	.000	11.686	3.012	45.335
	MBUC	2.571	.759	11.465	1	.001	13.084	2.953	57.962
	MVEN	1.854	.710	6.826	1	.009	6.388	1.589	25.677
	MABS	–1.467	.756	3.763	1	.052	.231	.052	1.015
	MORE	1.906	.608	9.836	1	.002	6.729	2.044	22.147
	MOIN	1.452	.622	5.459	1	.019	4.273	1.264	14.448
	MOIT	–1.032	.582	3.144	1	.076	.356	.114	1.115

a. The reference category is: Operate.