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STRATEGIC IMPLICATIONS OF E-BUSINESS IN THE CONSTRUCTION INDUSTRY

By

YONG JIE CHEN

A Doctoral Thesis submitted in partial fulfilment of the requirement of the award of Doctor of Philosophy of Loughborough University

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ABSTRACT

Electronic Business (e-Business) is recognised as being able to help organisations in the construction industry to achieve competitiveness and substantial benefits. However, the uptake of e-business in the construction industry has been relatively limited and ineffective. Previous research covers the body of knowledge about how to identify the value of e-business once it has been created or how to identify the capabilities that can create value. There is no guidance available to help organisations to maximise their leverage by investing intelligently and matching the size of their demand for e-business solutions to the size of the market they plan to supply.

This research aims to identify the strategic e-business needs and requirements of organisations in the construction industry; it helps them to scan or position their current situation, and provide a holistic approach to assist them in developing an executable e-business strategy. In order to achieve the aim and the formulated objectives, a multi-methodological research design and a pragmatic mixed-methods approach, involving a combination of both quantitative and qualitative datasets, were adopted to investigate the e-business practices of organisations in the industry. These include an exploratory investigation (an industry survey with 250 industry organisations), and an explanatory investigation (four case studies with specific industry end-user companies). The collected data was analysed and problems were identified; the elements for a holistic approach to manage e-business implementation emerged.

Subsequently, a Strategic e-Business Framework was developed to provide a holistic approach for organisations in the construction industry to plan, execute and review their e-business strategies. The Framework enables organisations to consider the medium term (three to five years), long-term (over five to ten years), and emergent needs to derive business value. The key features of the Framework include six phases and phase gates, five functional factors, and 23 activities. The six phases include Analyse Situation, Establish Vision, Define Critical Success Factors (CSFs), Develop Action Plan, Implement Action Plan, and Review Strategy. The phases were defined to guide the IT leaders in carrying out consistent e-business planning. The outputs of each phase (phase gates) were defined to assist IT leaders in the review of procedures during their e-business implementation. The functional factors include management, people, process, technology and external environment. The factors were identified to address

every facet of an organisation, and obtain collaboration efforts from both internal and external. They also ensure organisations have the opportunities to improve capabilities in these areas, and make them ready for immediate e-business implementation. Five groups of people or teams were assigned to the activities. The five groups were the Senior Management Board, IT Managers and their teams, Middle Level Management, Lower Level Management and other End-users, and external collaborators. The activities were categorised in order to provide a basis for organisations to utilise their resources, specifically human resource. Finally, a feedback loop was defined to enable the Framework to act as a cycle for going through repeatedly, which makes the continuous improvement of e-business implementation possible within organisations and provides a learning and feedback function that ensures lessons to be learned from past e-business implementation.

The evaluation of the Framework was conducted via six structured interviews with industry practitioners. The findings indicated that the industry practitioners welcomed the Framework and considered it as a positive step towards e-business management.

Key words: electronic business, construction industry, strategy, framework

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ABBREVIATIONS

3D	Three-Dimension
4D	Four-Dimension
A2A	Administration-to-Administration
A2B	Administration-to-Business
A2C	Administration-to-Customer
AGC	Associated General Contractors of America
ASPs	Application Service Providers
ARCOM	Association of Researchers in Construction Management
AutoCAD MEP	a version of AutoCAD for mechanical, electrical and pluming systems
B2A	Business-to-Administration
B2B	Business-to-Business
B2C	Business-to-Consumer
BEC	Business and Enterprise Committee
BERR	Department for Business, Enterprise, Regulation Reform (old DTI)
BIM	Building Information Modelling
BIS	Department for Business and Innovation & Skills
BIW	Building Information Warehouse, also BIW Technologies
BSG	Building Systems Group
C2A	Consumer-to-Administration
C2B	Consumer-to-Business
C2C	Consumer-to-Consumer
CAD	Computer-aided Design
CEO	Chief Executive Officer
CIC	Construction Industry Council
CICA	Construction Industry Computing Association
CRM	Customer Relationship Management
CSA	Construction Statistics Annual
CSFs	Critical Success Factors
DTI	Department of Trade and Industry (now BERR)
DETR	Department of the Environment, Transport and the Regions

e-Business	Electronic Business
e-Commerce	Electronic Commerce
EDI	Electronic Data Exchange
Email	Electronic Mail
e-Procurement	Electronic Procurement
e-Readiness	Electronic Readiness
ERP	Enterprise Resource Planning
e-Skill	Electronic Business Skill
FM	Facility Management
GBN	Global Benchmarking Network
GCS	Government Construction Strategy
GDP	Gross Domestic Product
GSA	General Service Administration
GSL Team	GNU Scientific Library Team
HM Government	Her Majesty' Government
HTML	Hyper Text Mark-up Language
IAI	International Alliance for Interoperability
IBM	International Business Machines Corporation
IBS	International Benchmarking Study
ICE	Institution of Civil Engineers
IDC	International Data Corporation
ICT	Information and Communication Technologies
IFC	Industry Foundation Classes
IFS	Industrial and Financial Systems
IPD	Integrated Project Delivery
IT	Information Technologies
IS	Information Systems
MPBW	Ministry of Public Building and Works
M&E	Mechanical and Electrical Engineering
NCC	National Computer Centre
NCCTP	Network for Construction Collaboration Technology Providers
NePP	National e-Procurement Project
OCED	Organisation for Economic Co-operation and Development

OIC	Online Information Capabilities
PDSA	Plan-Do-Study-Act
PIECC	Planning and Implementing Effective Collaboration in Construction
PREST	Practitioner Research and Evaluation Skills Training in Open and Distance Learning
RICS	Institution of Royal Charted Surveyors
RMS	Resource Management Systems
ROI	Return-On-Investment
SaaS	Software-as-a-Service
SCM	Supply Chain Management
SECT	Survey of Electronic Commerce and Technology
SME	Small and Medium Enterprises
SPICE	Standardised Process Improvement for Construction Enterprises
SWOT	Strengths-Weaknesses-Opportunities-Threats
UK	United Kingdom
VANs	Value-added Networks
VERDICT	Verify End-user e-Readiness using a Diagnostic Tool
WWW	World Wide Web
W3C	The World Wide Web Consortium

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CHAPTER ONE INTRODUCTION

1.1 Introduction

The construction sector is a major part of the UK economy, representing some 7% of the GDP or £110 billion in annual economic activities (GCS, 2011). Improved productivity and a higher level of efficiency in the industry would have significant impact on the national economy (Gordon, 2003). However, it is widely acknowledged that the industry as a whole has been under-achieving (Egan, 1998). Challenges the industry faces include client dissatisfaction, a need to modernise, health and safety concerns, and a need to achieve sustainable design and construction (Latham, 1994; Egan, 1998; Egan, 2002; BEC, 2008; HM Government, 2008; Wolstenholme, 2009). Information and communication technologies (ICT) and electronic business (e-business) initiatives have been proven to have the potential to improve many industry processes through time saving and reduced costs (Ruikar et al., 2003; Chen, 2006; Chaffey, 2009; Schneider, 2010). The construction industry has applied e-business initiatives throughout the information intensive processes inherent in construction projects from the building materials supply chain to construction management (Ruikar and Anumba, 2008). However, there are a variety of factors that need to be considered in order to effectively implementing e-business in this industry. This research will review the major issues associated with e-business implementation in the construction industry and create a holistic approach for organisations in the industry to continuously improve their e-business implementation.

This chapter presents an overview of the research, including the research background, problem statement, aim and objectives, research scope, research methodology, contribution to knowledge, and a guide to the thesis.

1.2 Background

Electronic business (e-business) can be defined as doing business electronically, primarily using the Internet (Ruikar and Anumba, 2008). E-business is transforming most industries and, despite its short history, is becoming a key component of business operations (Schneider, 2010). With the continuous introduction of new technologies, new business models and new communication approaches, e-business offers the potential for organisations in all industry sectors to improve their competitive advantage

(Chaffey, 2009). Therefore, to sustain competitive, all businesses need to review the emerging opportunities carefully and organisations in the construction industry are no exception (Ruikar and Anumba, 2008).

The benefits of e-business have been known to organisations in the construction industry for a decade. E-business can change the fundamental structure of the industry through reengineering the workflow and the way information is shared, which suggests many opportunities for improvement in the area of procurement, communication and project management (Beaudry, et al., 2003; Ruikar et al., 2003; Issa et al., 2008). The main benefits of e-business include improved quality of work, better financial control, faster communications, and faster access to common information (Rivard, 2000; DTI, 2003; Issa et al., 2003; Europe Commission, 2005I).

Practitioners in the industry have started to recognise that e-business technologies that are currently available would bring substantial benefits to their organisations (Issa et al. 2003; DTI, 2004; Alshawi et al., 2008). However, the uptake of e-business in the construction industry has been relatively limited and ineffective compared to other engineering sectors, such as automotive or aerospace (DTI, 2004; Europe Commission, 2005a; Ruikar and Anumba, 2008). Several reasons have been cited for this slow uptake. The limited resources available to small and medium enterprises (SMEs) to invest in ICT, and lack of readiness of the people, processes and legacy systems are all factors that have impeded adoption (Lewis, 1999; Ugwu et al., 2000; Cheng et al., 2001; Badii and Sharif, 2003; Zou and Seo, 2006).

Moreover, technologies alone are not sufficient to assure the success of e-business implementation. E-business solutions must be accompanied with business processes reengineering, change management, and interaction with business partners (Chaffey, 2009; Laudon and Laudon, 2009). Supposed benefits and gains resulting from new technologies are only anecdotal until their value has been proven in actual practice. Organisations that are currently using e-business and those that have yet to use it, both need to assess their business practices, and take strategic measures to ensure a productive and beneficial implementation (Chen, 2006; Ruikar et al., 2006; Chaffey, 2009).

1.3 Problem Statement

E-business solutions are said to have the most potential to have immediate positive impact if the products that an industry produces are easy to standardise or customise, and easy to aggregate (Schneider, 2010). Unfortunately, this description is not true of the construction industry, which is characterised as strongly project-focused (each project is unique) and fragmented in structure, discipline and processes (Blokpoel, et al., 2004; Morton, 2008).

Strategic e-business solutions, such as construction collaboration technologies (project extranets) and building information modelling (BIM), are designed specifically for the construction industry based on the idea of partnering and whole-life construction project management (Lu and Li, 2010; Grilo and Jardim-Goncalves, 2010; Wilkinson, 2012). However, given the short history of the technologies (for example, construction collaboration technologies were only launched in mid-2000), there can be risks associated with their adoption. These risks represent barriers and challenges to their implementation. The barriers and challenges to implementation would need to be managed when applying these strategic e-business solutions in the construction organisations.

The barriers and challenges to implementation exist both inside and outside of the organisations and include large initial investment associated with building essential infrastructure and training of personnel, quantifying the anticipated return on investment, security of data for transactions, integration with legacy systems, and interoperability of distributed software applications (Lewis, 1999; Ugwu et al., 2000; Cheng et al., 2001; Badii and Sharif, 2003; Love et al., 2004; Rankin et al., 2006; Zou and Seo, 2006). Additionally, the transient nature of construction project teams could lead to one-off implementation of e-business tools or applications within organisations, and this normally inhibits investment in long-term e-business solutions (Ruikar and Anumba, 2008). Furthermore, the investment required in order to implement such e-business solutions is not easily affordable for most organisations, specifically SMEs (Wilkinson, 2005; Ruikar and Anumba, 2008). Very few construction organisations have sufficient resources to invest in IT, establish professional development for staff, or rationalise processes to improve organisational performance (Elliman and Orange, 2000; Wolstenholme, 2009). Those that do have the required purchasing power fail to maximise their leverage by investing intelligently and matching the size of their demand

for e-business solutions to the size of the market they plan to supply (Salah, 2003; Wolstenholme, 2009). The cost of funding such IT investments and the missed opportunities of not benefiting from their intended capabilities constituted a great loss for organisations (Alshawi et al., 2008; Chaffey, 2009). Organisations in the industry need to consider a holistic approach to make full utilisation of their existing investment in e-business including effective benefits realisation planning. Strategic development and management theories are introduced to e-business implementation to address this specific need for organisations to improve their e-business implementation (Ruikar et al., 2006; Chaffey, 2009). Many firms fail to realise that if they install an IT system without considering the strategic implications, they are likely to end-up with a software installation rather than an implementation of a comprehensive solution to business problems. Therefore, more research is required to investigate the strategic requirements and practices of organisations when implementing e-business in the construction industry.

1.4 Research Aim and Objectives

The main aim of this research is to develop a framework for implementing e-business. To achieve the research aim, six specific objectives are defined as follows:

1. Review the main issues that the construction industry faces in implementing e-business;
2. Establish the level of penetration of e-business in the sector;
3. Assess how much understanding industry members have about implementing e-business strategically;
4. Explore the units of measurement that the sector members use for evaluating e-business implementation and strategies;
5. Determine the required elements of a Strategic e-Business Framework; and
6. Develop a Strategic e-Business Framework for organisations in the sector.

1.5 Research Scope

This research focuses on e-business implementation in the construction industry, specifically the strategic implications of e-business in the UK construction industry. Implementation is considered at the organisational level because: 1) implementation refers to the realisation of an application or execution of a plan, idea, or policy; 2) its

effectiveness is measured through whether or not it is consistent with the organisation's goals; and 3) the decision to implement is ultimately based on the results of a cost-versus-benefit comparison at business level (Rankin and Luther, 2006). The investigation of e-business implementation in this research mainly concentrates on various construction organisations including consultants, contractors, suppliers and manufacturers. This research attempts to determine the current strategic practices of different construction organisations and create a holistic approach to enable them to improve their e-business implementation continuously. The holistic approach can help organisations to consider e-business implementation in long-term, measure the effectiveness of the implementation through determining its alignment with organisations' goals, and make the decision to implement based on careful situation analysis that includes a cost-versus-benefit comparison.

1.6 Research Methodology

In order to achieve the prime aim of the current research as identified in Section 1.4, a multi-methodological research design was adopted to take account of the industry context and investigate e-business implementation by construction organisations both in breadth and depth. A pragmatic mixed-methods approach, combining both quantitative and qualitative approaches for data collection and analysis, was identified and applied as the most suitable strategy for the current research (for details see Chapter Three: Research Methodology).

The research design was conceived in accordance with the research aim and objectives and consists of four stages. The first stage is the exploratory study with the industry members from different construction disciplines (see Figure 1.1). Stage 1 reviewed e-business and its implementation in the construction industry. The brand review laid down a solid, theoretical foundation for determining the research questions and also provided the theoretical underpinning of the applied research approach and methodology in studying and analysing e-business implementation in the current study. Stage 2 explored the status of e-business implementation within the construction organisations and determined the construction-specific benefits, barriers, impact and drivers. Stage 3 is the in-depth examination of e-business practices with specific industry end-user companies. In Stage 3, the strategic practices of e-business within the studied organisations were defined, their e-business development stages were assessed,

impacts of e-business on their product, processes and people were identified, and units of measurement used for evaluating e-business strategies and implementation were discovered. Stage 4 is the development of a Strategic e-Business Framework based on the outputs generalised from Stages 1, 2 and 3. In Stage 4, a holistic approach was developed for organisations in the construction industry to consistently plan, execute and review their e-business strategies. Stage 5 is to evaluate the effectiveness of the Strategic e-Business Framework with selected industry practitioners. In Stage 5, the benefits and limits of the Strategic e-Business Framework were summarised for future development, and the results contributed to the recommendations and conclusions of the current research. Figure 1.1 outlines the research design in terms of the adopted research stages, the conducted research programme and the delivered research outcome.

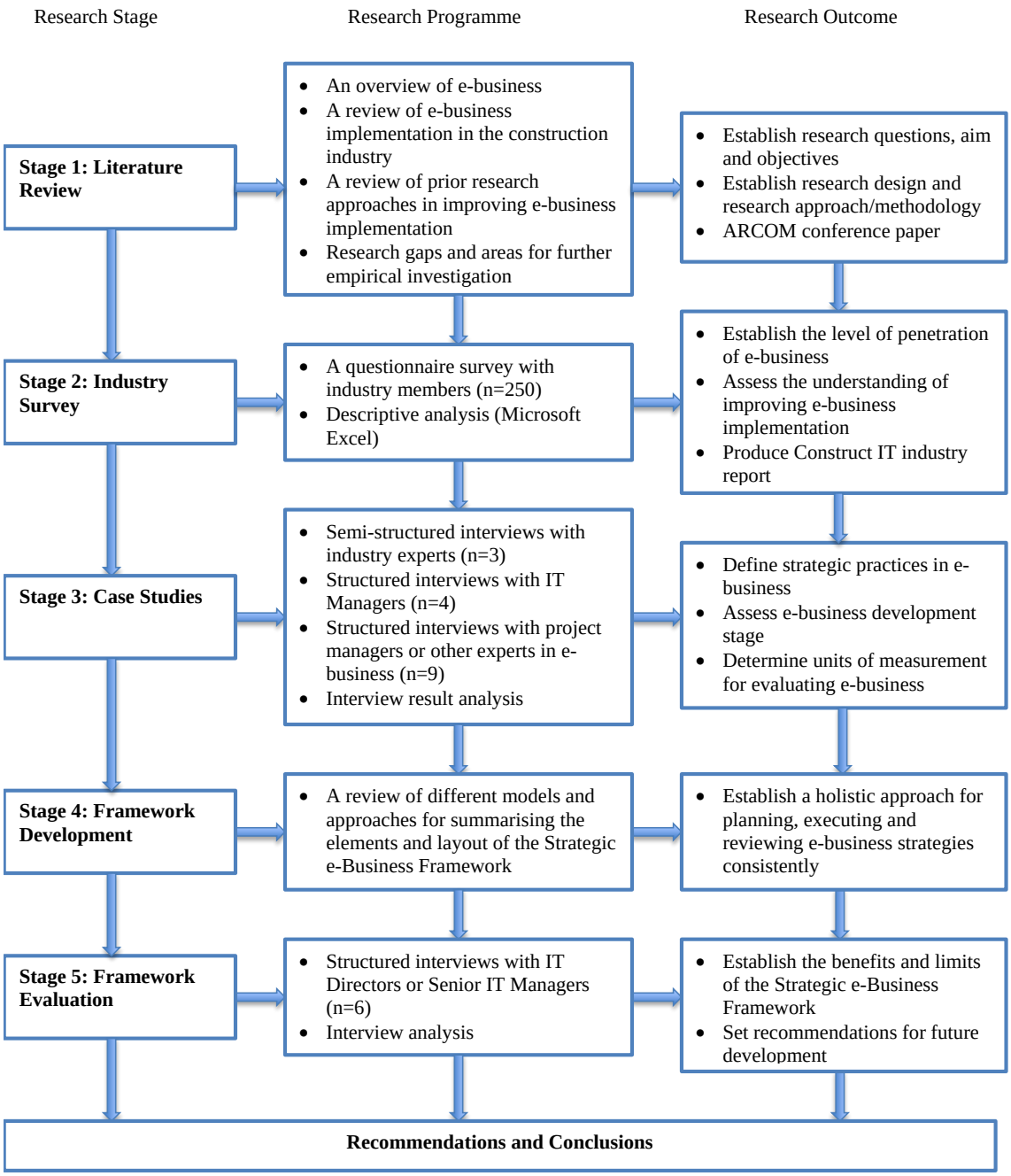

Figure 1.1 Research Design

1.7 Contribution to Knowledge

The core of this thesis is the development of a framework for organisations in the construction industry to guide their e-business implementation. The main contributions to knowledge of this research are detailed below:

- This research identified the research approaches that have employed in an attempt to help construction organisations to improve their e-business implementation.
- This research established the level of penetration of e-business among the surveyed members of the construction industry.
- The research identified how aware industry members were of the added value of e-business with regard to business process operations, e-business capabilities and resources.
- The research identified the mixed e-business development stage among the specific end-user companies involving in the case studies and defined gaps and problems existing in their e-business practices.
- The research identified the issues that organisations in the industry must address in order to develop a complete and robust e-business strategy.
- The research developed a Strategic e-Business Framework to help industry practitioners (e.g. IT Directors or Senior IT Managers) to define, execute and review their e-business strategies.
- The research identified potential targets for future research work, and gave recommendations for other researchers to execute further research work.

1.8 Guide to Thesis

This thesis includes eight chapters. Figure 1.2 describes the structure of the thesis and the inter-relationship between the various chapters.

The main contents of each chapter are as follows:

Chapter One provides an introduction to the current thesis research. It provides the research background and context, and describes the essential steps required to conduct a study on strategic implementation in the e-business domain. It establishes the research aim and objectives, and briefly describes how the aim and objectives are achieved through four stages of investigation. The main contributions of the current study to knowledge are then summarised. Finally, the chapter gives a guide to the readers about how the thesis is organised and broken into eight chapters.

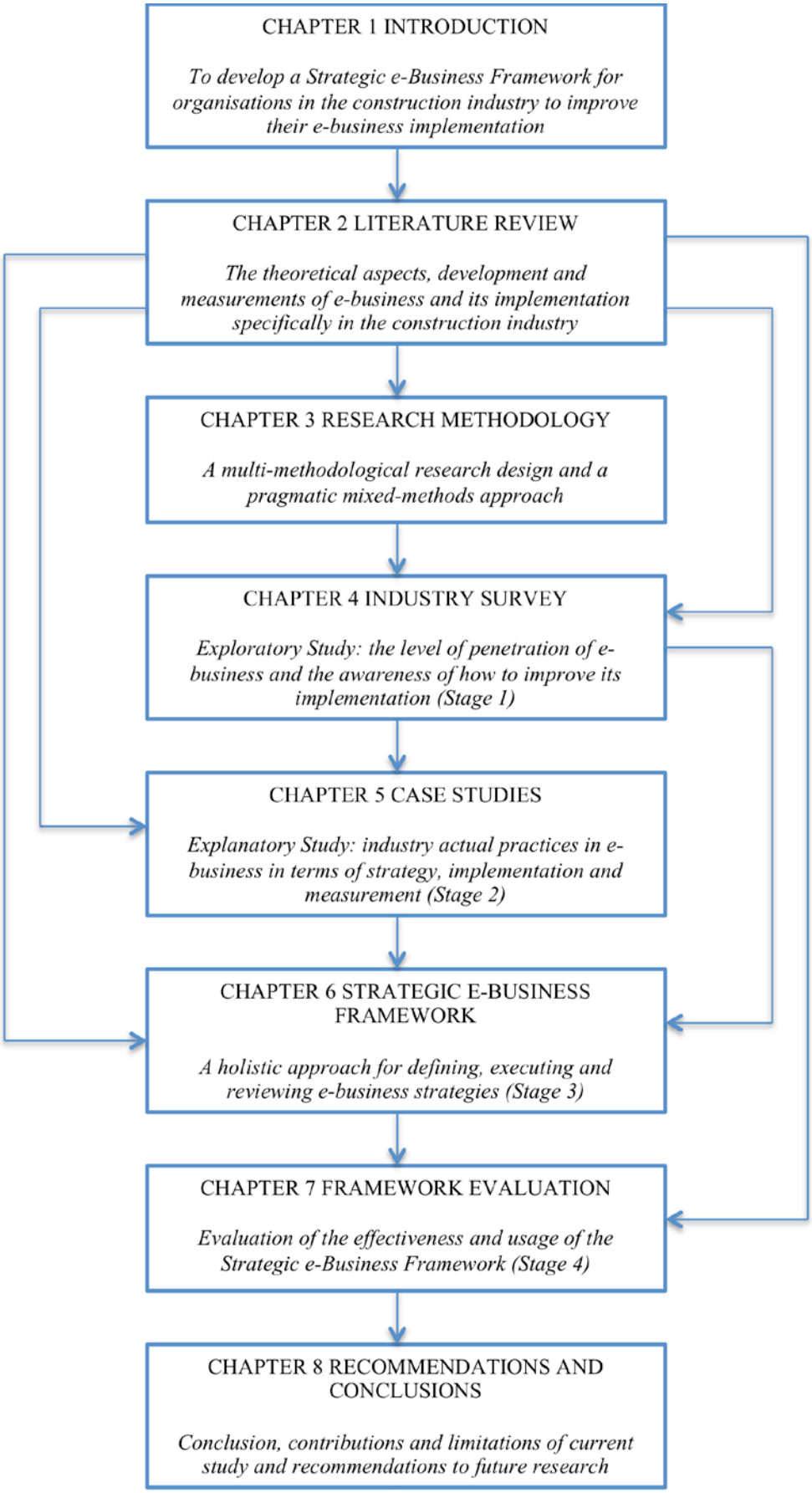

Figure 1.2 Structure of the Thesis

Chapter Two presents a review of the relevant literature and provides a theoretical foundation for the current study. It explores how e-business initiatives have transformed the industry and the potential for construction organisations to achieve the promised benefits. It highlights how different e-business tools and applications were introduced to the construction industry and the current status of their usage. It also discusses the approaches for improving e-business implementation. It describes the importance of considering a new way for construction organisations to implement e-business, and indicates the need of improving e-business implementation continuously and planning it in a strategic way.

Chapter Three introduces the methodological consideration of the current research. It justifies the philosophical stance, research strategies and the research design. The applied research methods are justified and described according to how they have helped to achieve the research objectives defined in Section 1.4.

Chapter Four introduces the background of the questionnaire survey that was conducted with members in the different construction disciplines, including the aim and objectives, the questionnaire design and justification, and the scope of the survey. The chapter also presents the findings of the survey. It analyses the survey findings to establish the level of penetration of e-business in the survey organisations. It discusses the survey outputs and addresses the comments of survey respondents to assess the understanding of industry members in improving e-business implementation with regard to internal resources, business processes and organisational culture.

Chapter Five presents the findings of the case studies with four end-user industry companies. The chapter reviews the background of 13 interviewees and the companies they represent. It describes the actual practices of these companies in e-business at both the organisational level and the project level. It discusses the outputs and comments of interviewees used to determine the main issues in implementing e-business strategically.

Chapter Six presents a Strategic e-Business Framework that organisations in the construction industry can use to define, execute and review their e-business strategies. The chapter justifies the need for a Strategic e-Business Framework. It introduces the aim and objectives of the Strategic e-Business Framework. It outlines how the PDSA (Plan-Do-Study-Act) model assisted the development of the Framework and how five other approaches contributed to determining the main contents and layout of the

Framework. It summarises the main elements of the Framework including the six phases, five factors and 23 key activities.

Chapter Seven describes the evaluation of the Strategic e-Business Framework by industry practitioners. The chapter introduces the aim and objectives of performing the evaluation, justifies the evaluation questionnaire and presents the evaluation results. It discusses the findings of evaluation to assess the understanding and acceptability of the industry practitioners. It explores the comments of the evaluators in order to determine the benefits and limits of the Strategic e-Business Framework and suggest opportunities for further development.

Chapter Eight summarises the conclusions, contributions and recommendations of the current study. The chapter draws conclusions to how the research aim and each objective were addressed and achieved. It provides recommendations on how industry practitioners can implement e-business. It outlines the contributions of current research as well as the limitations. It also foresees the future research based on the current study.

The following chapter presents the results of review of literature based on the established research aim and objectives. The research questions and areas for further empirical investigation are described.

CHAPER TWO REVIEW OF E-BUSINESS IN CONSTRUCTION

2.1 Introduction

This chapter discusses the implementation of electronic business (e-business) in the construction industry. The primary focus of the chapter is to provide a review of literature and the related work in improving e-business implementation in the construction industry in order to establish the research context. The literature review serves three purposes: 1) to identify the limitations and gaps in prior research, 2) to determine research questions and set them in a theoretical context, and 3) to develop the theoretical underpinnings of current research design and describe the methodological consideration. To meet these purposes, the chapter is broken into a number of sections. Section 2.2 presents an overview of the fundamentals of e-business in four aspects: the definition of e-business, information transaction tools, the taxonomy of e-business, and the four faces of e-business. Section 2.3 discusses the implementation of e-business in the construction industry, including its drivers, benefits, requirements, barriers and impact. Section 2.4 summarises the prior research that has attempted to help organisations in the construction industry to improve e-business implementation. The topics discussed include: 1) the different approaches to identify the benefits and created value resulting from e-business implementation; 2) the benchmarking studies aimed at identifying e-business potential and measuring e-business performance; 3) the readiness tools to assess firms' capabilities and ability to benefit from e-business applications; and 4) the strategic consideration for e-business implementation and the approaches (e.g. models or frameworks) for e-business strategy and its development. Section 2.5 outlines the research areas and research questions required for further empirical investigation. Section 2.6 concludes the chapter with a general summary.

2.2 e-Business Overview	2.3 e-Business Implementation in the Construction Industry	2.4 Improve e-Business Implementation	2.5 Research Areas for Further Investigation
2.6 Summary			

2.2 e-Business Overview

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2.2.1 e-Business Definitions

Electronic business (e-business) can be defined in several ways. It can be simply defined as doing business electronically, primarily using the Internet (Ruikar and Anumba, 2008). This definition outlines the opportunities for organisations to carry out a new way of working, mainly operating online and having no physical presence in reality and seeking to minimise customer service and support through enabling 'web self-service' (Chaffey, 2009). To clarify the scope of business activities involved in e-business, Damanpour (2001) described e-business as "any 'net' business activity that transforms internal and external relationships to create value and exploit market opportunities". Similarly, Chaffey (2009) identified such business activities as "all electronically mediated information exchanges, both within an organisation and with external stakeholders supporting the range of business processes". Hence, e-business involves all the business activities associated with the electronic exchange of information, including the exchanges that support internal activities operating within organisations and their functional units, and also the exchanges that support external activities conducted to interact with the business partners (e.g. customers and suppliers).

On the other hand, e-business can also be defined according to the technologies used for facilitating business activities. IBM, one of the first suppliers to use the term "e-business" (Gerstner, 2002), defined e-business as "a business process transformed to leverage the World Wide Web (Web) (Internet, intranet, and extranet) technology for business benefit" (IBM, 2001). Amor (2002) detailed the role of Web in e-business as one of combining the resources of traditional information systems, Web-based core business systems and the core business constituents (e.g. customers, employees and suppliers) via intranets, extranets and the Internet. Additionally, the subsequent emergence of new technologies has extended the revolution of business done on the Web. Other digital technologies, such as wireless and mobile connections, were added as supporting technologies for e-business. Therefore, Beynon-Davies (2004) updated the definition of e-business as "the utilisation of information and communication

technologies (ICTs) in support of all the activities of business". Comparably, the Department of Trade and Industry (DTI, 2004) also emphasised the application of ICTs in the full range of business activities. Chaffey (2009) described the supportive ICTs as "the software applications, computer hardware and networks used to create e-business systems." Therefore, e-business is currently supported with a variety of information and communication technologies, including the Web and the other digital technologies.

Moreover, e-business can also be identified based on the transformation of business processes. The Organisation for Economic Cooperation and Development (OECD) defined e-business as "automated business processes over computer mediated networks" (OECD, 1999). Amor (2002) argued that the term e-business was introduced to distinguish between the simple one-dimensional electronic applications for automation and the more richly integrated e-business applications for integration. The European Commission (2005a) suggested that e-business was found in both business process automation and integration, and also in the impact thereof. Furthermore, DTI (2004) stated that e-business should include process automation, reengineering and integration. DTI described e-business as follows:

When a business has fully integrated information and communication technologies (ICT) into its operations, potentially redesigning its business processes around ICT or completely reinventing its business model... e-business is understood to be the integration of all these activities with the internal processes of a business through ICT (DTI, 2004).

In the DTI definition, process automation, reengineering and integration are each involved while an organisation attempts to fully integrate ICTs into its operations and its internal processes.

In summary, e-business has evolved from a very specific business operation tool to a very comprehensive business field (European Commission, 2006). The definition of e-business is not static. It can be defined from different perspectives. From the business activities perspective, e-business involves both internal and external electronic interactivities and exchange. From the technologies perspective, e-business is supported with a range of information and communications technologies, mainly Web-based technologies. From the process perspective, e-business transforms the business processes through automation, reengineering and integration. This thesis adopts this wider definition of e-business.

2.2.2 Information Transaction Tools

Through its growth and development e-business has transformed many industrial sectors and become a key component of their business operations (Schneider, 2010). It also has changed the way in which people and businesses communicate and interact, and revolutionised the ways in which information is stored, exchanged and viewed (Ruikar, 2004). In e-business, information transactions have progressed from EDI, electronic mail (email) to web technologies. A transaction is "an exchange of value, such as a purchase, a sale, or the conversion of raw material into a finished product" (Schneider, 2010, Page 6). The sections that follow describe three prominent tools for information transactions.

2.2.2.1 Electronic Data Interchange (EDI)

Electronic data interchange (EDI) over secure private networks started in 1960s. Originally EDI referred to the computer-to-computer transfers of business information between organisations in a standardised electronic format (Clarke, 1998). EDI required the support of private lines or value-added networks (VANs) and relied on software that could incorporate varying formats (DTI, 2000). EDI also required significant investment to facilitate trading among business partners (Li, 2003). Usage of EDI was therefore limited due to system incompatibility problems and the high cost of entry, specifically for the SMEs (O'Brien and Al-Soufi, 1994; Akintoye and Mckellar, 1997; Hulme, 1997; DTI, 2000; Low and Sloan, 2000).

In recent years, EDI has become integrated with Internet technologies to achieve Internet-enabled EDI (EDI Insider, 1996; IDC, 1999; Fu, et al., 1999). This transition has enabled EDI to be implemented at lower costs through virtual private networks or the public Internet. Chaffey (2009) described the advantage of the new generation of EDI as one of increased access, specifically to SMEs.

2.2.2.2 Email

Electronic mail (email) is a natural use of networked communication technologies that developed alongside the evolution of the Internet (Crocker, 2000). It acts as a great tool for human communication and has become widely regarded as business-critical, specifically with the increasing use of mobile devices (Chaffey, 2009). The percentage of email usage within a firm or a sector is used as a prime parameter to measure the connectivity of organisations in e-business (DTI, 2004; Industry Canada, 2007).

Currently most communications, both within and outside the organisations take place by exchanging emails. However, the use of email ha been criticised for overloading employees due to the need to read and respond to this information (Wilkinson, 2005; Wilkinson, 2006a; Wilkinson 2006b; Chaffey, 2009; Hagan, 2012).

2.2.2.3 Web Technologies

The World Wide Web (WWW) is the most common technique for publishing information on the Internet. "The Web" (also known as Web 1.0) was developed in the early 1990s and was a software tool that, along with hypertext, allows computers to connect to the Internet (Berners-Lee, et al., 1992; Berners-Lee, 1999). Since 2004, the Web 2.0 concept has increased in prominence amongst Web site owners and developers (O'Reilly, 2004). This new generation of Web technologies approaches a vision that the Internet is used as a platform for interconnectivity and interactivity (Chaffey, 2009). The data on the Web is defined as common formats, which allows a person, or a machine to use the data across various applications (W3C, 2011). The concepts of Web 2.0 exploit the interactivity and extensibility of the Web, on which many new communication tools were built, such as the blogs, feeds and social networks (Chaffey, 2009). Nowadays, Web technologies are not only applied to communication, but also are utilised to support marketing and information transactions, providing emerging ways of doing business that could not even be imagined a few decades ago (Khosrow-Pour and Herman, 2001; Chaffey, 2009; Schneider, 2010).

2.2.3 Taxonomy of e-Business

The taxonomy of e-business is based on the concepts of how end-users undertake communications. In 1999, the European Commission cited four categories of e-business, which included business-to-business (B2B), business-to-consumer (B2C), business-to-administration (B2A), and consumer-to administration (C2A) (European Commission, 1999). Since then, additional categories such as consumer-to–consumer or C2C have emerged. Currently e-business can be broadly divided into the following categories (Ruikar and Anumba, 2008; Schneider, 2010) (see Figure 2.1):

- *Business to Business (B2B)*: B2B refers to electronic methods of carrying out business transactions between two or more businesses, e.g. electronic data interchange (EDI) through the Internet between two companies.

- *Consumer to Consumer (C2C)*: C2C refers to the online exchange of value or economic activities between consumers, for example include consumer e-auction and personal blogs.
- *Administration to Administration (A2A)*: A2A refers mainly to activities between government departments that communicate and exchange classified information through Internet, such as the national DNA database.
- *Business to Consumer (B2C) or Consumer to Business (C2B)*: B2C is similar in concept to traditional retailing methods, except that the medium used to carry out business is the Internet. Notable examples include Amazon and eBay. C2B is the reversal of traditional business model in that consumers offer products and services to companies, such as SurveyMonkey, and Zoomerang.
- *Business to Administration (B2A) or Administration to Business (A2B)*: B2A covers all transactions that are carried out between businesses and governments through the Internet. A2B includes government-to-public e-solutions that provide business-specific information.
- *Consumer to Administration (C2A) or Administration to Consumer (A2C)*: C2A refers to electronic applications that connect consumers to the government to express concerns, and provide feedback or information, such as electronic voting. Examples of A2C include local or civic service Websites. For example, the www.cic.gc.ca (2012) Website provides services supporting immigration and citizenship applications.

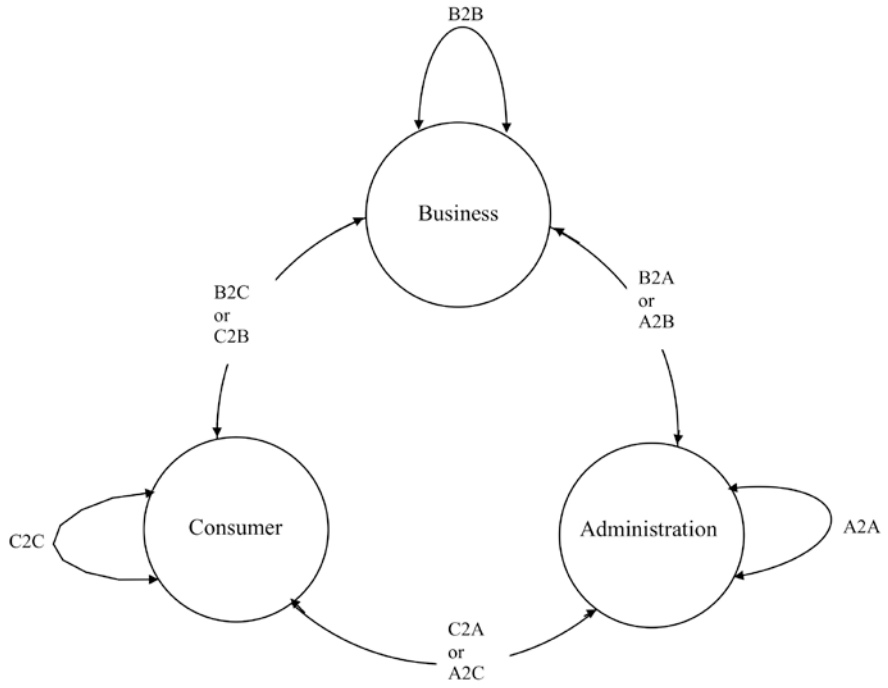

Figure 2.1 e-Business Taxonomy (Source: Ruikar and Anumba, 2008)

2.2.4 The Faces of e-Business

The four faces of e-business were originally identified by the research and advisory firm Gartner Advisory Group (1999), to consider e-business from different perspectives and determine the e-business associated opportunities and risks. According to Damanpour (2001), the faces include the following (see Figure 2.2):

(1) *Face 1: Business/Financial Models Perspective*. This face emphasises the opportunities e-business provides for organisations including: the financial opportunities to reduce cost and improve efficiency in operations; and the business opportunities to use new business models, which enable a business to operate as an electronic entity rather than a physical one. Technology is used as an enabler of these opportunities.

(2) *Face 2: Relationships Perspective*. This face refers to the new relationships and collaborations that e-business provides to an organisation through entering new business markets or enhancing customer, supplier and business interactions. Notable examples include customer relationship management (CRM), supply chain management (SCM), and technology infrastructure management created by e-business changes.

(3) *Face 3: Commerce Perspective*. This face is about electronic buying and selling. The commerce face overlaps the other three faces. It emphasises the importance of technology to business success and meeting customer demands.

(4) *Face 4: Responsiveness Perspective*. This face deals with the efficiency and timing of business transactions. Responsiveness means reducing the time between a business request and its fulfilment. This will help a company to complete business transactions electronically without resorting to hand-carried or faxed information.

The four faces of e-business suggest opportunities in adopting new business or financial models, improving relationships with business partners, buying and selling online, and improving information transactions and process responsiveness. All of them can help an organisation to determine the focus of its business. However, they are not all applicable to every organisation (Damanpour, 2001). For traditional businesses such as organisations in the construction industry, it is crucial to determine the potentials of e-business to improve their competitive advantages (Chaffey, 2009).

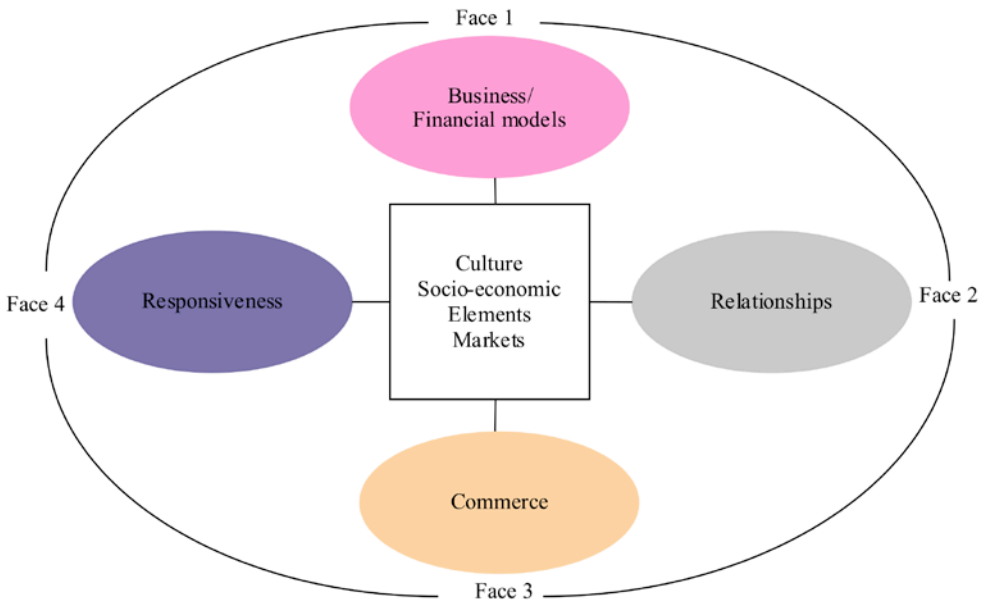

Figure 2.2 Four Faces of e-Business (Adapted from Gartner Advisory Group, 1999)

2.3 e-Business Implementation in the Construction Industry

2.2 e-Business Overview	2.3 e-Business Implementation in the Construction Industry	2.4 Improve e-Business Implementation	2.5 Research Areas for Further Investigation
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2.3.1 e-Business Benefits for the Construction Industry

The benefits of implementing e-business in the construction industry have been known for a decade. The main benefits of using e-business in the construction industry include improved quality of work, better financial control, faster communications, and simpler and faster access to common information (Industry Canada, 2000; Rivard, 2000; DTI, 2003; Issa et al., 2003; Europe Commission, 2005a; Kalapesi, et al., 2010). Chaffey (2009) reviewed the potential advantages of e-business as both tangible and intangible. The tangible benefits refer to benefits for which monetary savings can be identified. The intangible benefits refer to benefits for which it is more difficult to calculate cost savings. On the other hand, Zou and Seo (2006) generalised the benefits of e-business to construction organisations according to different disciplines. For example, the benefits to clients/owners/developers include improving project efficiency, reducing construction costs, reducing the chance of errors and the need for rework, compressing the length of the construction programme and improving transparency. Ruikar and Anumba (2008) suggested that e-business could benefit construction organisations in many areas including transaction, transparency, procurement, management, collaboration and communication.

Practitioners in the industry have started to recognise that e-business technologies that are currently available would bring substantial benefits to their organisations (Issa et al. 2003; DTI, 2004; Alshawi et al., 2008). However, supposed benefits and gains resulting from new technologies are only anecdotal until their value has been proven in actual practice, so organisations in the industry can benefit from the implementation of e-business only when they recognise its potential benefits and the subsequent value for their own businesses (Industry Canada, 2004; Chen, 2006; Chaffey, 2009). Therefore, organisations that are currently using e-business and those that have yet to use it, both need to assess their business practises, and take strategic measures to ensure a productive and beneficial implementation (Chen, 2006; Ruikar et al., 2006; Chaffey, 2009). However, few organisations in the construction industry so far have developed

adequate performance metrics related to e-business benefits (Weischedel, 2003; Love et al., 2004; Ruikar and Anumba, 2008).

2.3.2 Drivers for the Construction Industry to Implement e-Business

Motivation for businesses to implement e-business was simple and obvious in the early 1990s (Wilkinson, 2005; Chaffey, 2009; Schneider, 2010). The adoption of e-business was driven by the benefits of profitability or the generated value to an organisation (Chaffey, 2009). Organisations that started or launched e-business believed that it would lead to higher revenue, increased profitability and dramatic business success (Chaffey, 2009; Schneider, 2010).

However, after the burst of the dotcom bubble in the late 1990s, organisations started to reconsider the promised benefits and added value of e-business. DTI (2000) identified two main categories of drivers: cost/efficiency and competitiveness. Perrott (2005) identified the drivers of e-business more comprehensively in four key areas: cost-benefit, competitive pressure, market advantage and value-added. Chaffey (2009) suggested that the drivers of e-business centred on the competitive advantages that an organisation could achieve, such as higher customer satisfaction, establishing new branding, more mobility in the workforce, and a sustainable business/financial model.

Many organisations in the construction industry took a wait-and-see approach in applying further investment in e-business (DTI, 2004). It was argued that the driving forces were not positive enough to lead many members of the sector, specifically for the SMEs, to take further steps in e-business implementation unless there was a superior strategic solution that combined with a sustainable business model and the resources the organisation could leverage (Albers and Clement, 2007). Innovators in the industry implemented e-business to match their business needs. Their implementation of e-business was mainly management driven (Ruikar et al., 2005). Organisational readiness tools, such as VERDICT (an acronym for Verify End-user e-Readiness using a Diagnostic Tool), has been developed to help industry end-users to gauge their e-readiness for using e-business technologies and make them more ready for adopt, use and benefit from e-business (Ruikar, 2004). To encourage wider adoption of e-business initiatives in the sector, the industry specific needs and requirements must first be addressed (European Commission, 2006).

2.3.3 Needs and Requirements for the Construction Industry to Implement e-Business

The needs and requirements for organisations in the construction industry to implement e-business are associated with the nature of the sector (or characteristics of the sector), which include being fragmented, information-intensive and underperforming (Egan, 1998; Ruikar et al., 2004; Wilkinson, 2005; European Commission, 2006). The sub-sections will discuss this in more detail.

2.3.3.1 Fragmentation

It is widely acknowledged that the construction industry is fragmented in structure (Paulson, 1995; Egan, 1998; Wilkinson, 2005; Morton, 2008). The structure of the industry has been described as fragmented with a small number of large businesses on top and a much larger number of SMEs at bottom (Wilkinson, 2005; Morton, 2008). The capabilities and interests of the organisations are related to their size. The large companies tend to look for the true inventory trends and are better able to coordinate their production based on accurate market predictions (Heyes, 2000); while many SMEs merely struggle to survive and have limited resources for investment in new technologies (European Commission, 2005a). Therefore, there is a need for narrowing the competitive gaps between large organisations and the SMEs, which suggests a specific call for changing the pattern of winning in the marketplace through newly emerging e-business technologies, such as Web-based technologies.

2.3.3.2 Information-intensive

The construction process consists of different stages, such as design, procurement, construction and operation (DETR, 2000). The final product of construction can incorporated various specialised systems of components, such as structural, electrical, mechanical and others (Construction Statistics Annual, 2007). Also, the participants involved in projects are multi-disciplinary, multi-company and multi-location (Wilkinson, 2005). Due to the complexity of both the construction processes and the final product, and the number of participants involved, the volume of information flowing through the construction processes is extensive and complex (Ruikar, 2004; Wilkinson, 2005). Managing this large volume of information efficiently will improve the productivity of the whole industry significantly (Harris and McCaffer, 2006). More advanced methods for information management are required and hence there is a great

need for e-business initiatives in this area.

2.3.3.3 Being Underperforming

The construction industry is generally regarded as relatively inefficient when compared to other sectors such as manufacturing and electronics (Paulson 1995; Egan, 1998; Egan, 2002; Wolstenholme, 2009; GCS, 2011). Inefficiencies arise in the construction industry because the fragmented groups, which characterise the organisational structure of the industry, have difficulty coordinating their efforts and combining their individual contributions (Howard et al., 1989; Howard et al., 2002). Moreover, construction projects are carried out by multi-disciplinary, multi-company and multi-location groups of people (Wilkinson, 2005). Those groups involved in the projects usually communicate with one another individually (Alexander, et al., 1998; Hibberd, 2000; Wilkinson, 2005; European Commission, 2006). This traditional way of one-to-one correspondence makes the communication complex and repetitive. Inefficiencies also arise because of poor communication processes and little or no collaboration (Egan, 1998; Wilkinson, 2005). Therefore, to improve the efficiency of interdisciplinary communications and encourage collaboration, there has been an increased demand in the industry to develop a new and more efficient way of communicating, specifically via e-business-enabled tools and applications.

2.3.4 Available Construction-Specific e-Business Solutions and Their Implementation Status in the Construction Industry

Aiming to fill the industry-specific gaps (e.g. competitive gap, information management gap and communication gap) and push wider adoption of e-business initiatives, industry associations/ institutions and IT service providers have worked diligently and produced a number of documents (e.g. reports, guides and case studies) offering guidance on e-business solutions (Construct IT, 2000; Construction Industry Computing Association, 2003; Construct IT, 2003; Institution of Royal Charted Surveyors, 2005; Wilkinson, 2005; International Alliance for Interoperability, 2008; Causeway, 2009; Asite, 2010; Institution of Civil Engineers, 2010a; Institution of Civil Engineers, 2010b, International Alliance for Interoperability, 2011; Conject.com, 2012; 4Projects, 2012). This section reviews several e-business solutions designed for the construction industry to address the industry's specific needs and requirements. The review is based on the popularity of the e-business solutions (Getapp.Com, 2012;

ITshowcase, 2012). The reviewed solutions include Enterprise Resource Planning (ERP), electronic procurement (e-procurement), collaboration technologies and Building Information Modelling (BIM). The e-business solutions are reviewed based on the following concepts: 1) what they are; 2) when they started to emerge; 3) why they were developed or introduced to the construction organisations; 4) how they were implemented in the industry; and 5) their future potential.

2.3.4.1 Enterprise Resource Planning

ERP represents the development of methods and software tools for the planning and controlling of resources for organisations (Akkermans and Helden, 2002). ERP systems were developed in the 1990s and regarded as one of the most innovative development in the information technology (Chung and Snyder, 2000; Al-Mashari, 2002). ERP systems were introduced to the construction industry in the early 2000s (Lee and Kim, 2001; Voordijk, et al., 2003; Chung and Skibniewski, 2007; Chung et al., 2009). ERP systems were introduced to integrate the key business processes of an entire organisation into a single software system that allows information to flow seamlessly throughout the organisation (Koch, 2002). The main benefits of ERP systems to organisations in the construction industry include coordinating process and information, reducing carrying costs, decreasing cycle time and improving responsiveness to customer needs (Davenport, 2000).

ERP systems can help organisations redesign, integrate and manage e-business processes. ERP systems are used to facilitate the flow of information through business processes and integrate various types of information, such as finances, accounting, human resources, supply chain, and customer information (Davenport, 1998). Based on case studies of large construction companies, researchers have identified the conditions necessary for successful ERP implementation: the primary business processes are inter-organisationally standardised, business and IT strategies are matched, and the ability to use ERP for information management is high (Voordijk, et al., 2003; Bergstrom and Stehn, 2005).

Despite the advantages they offer, ERP systems remain a challenging e-business initiative to implement in the construction industry (Ahmed et al., 2003). Several end-user companies, mainly the large enterprises in the industry, have stated that attempts to implement ERP systems have so far yielded more failures than successes (Voordijk, et al., 2003). One main reason for the failures is due to the fact that until recently there has

been no ERP systems specifically designed for the construction industry (Yang, et al., 2007).

In recent years construction-specific ERP systems have become available, such as project-based ERP. The project-based ERP systems are more amenable to the construction industry than general ERP systems because: 1) the project-based ERP systems were designed to address the nature of construction industry; 2) the systems have the potential to motivate and support changes in the industry, such as consolidation, cross-functional collaboration and off-site construction; and 3) the systems can integrate with other e-business solutions, such as BIM (IFS, 2010; Epicor, 2012; IFS, 2012). Examples of available project-based ERP systems include the IFS project-based ERP solutions for construction, civil engineering and contracting, and the Epicor project-based ERP for construction and engineering. The wider adoption of ERP systems in the construction industry should come in near future, because the newer, currently available solutions are better to meet the industry-specific needs (IFS, 2010).

2.3.4.2 Electronic Procurement (e-Procurement)

Electronic procurement (e-procurement) can be simply defined as business-to-business purchase and sale of products and services by electronic means (Schneider, 2010). E-procurement is the electronic integration and management of all procurement activities including purchase requests, authorisation, ordering, delivery, and payments between a purchaser and a supplier (Kalatota and Robinson, 2001). In the construction industry, e-procurement primarily refers to the electronic bidding and tendering processes that deliver projects (Chen and Rankin, 2006). Moreover, e-procurement can also be applied to suppliers or specialist subcontractors (e.g. procurement of bulk material and equipment purchases) (Chen, 2006; European Commission, 2006).

During the late 1990s, the construction industry started to enthusiastically establish electronic commerce (e-commerce) portals to carry out procurement activities, and e-procurement applications were also introduced to the construction industry (Wilkinson 2005). The main advantages of e-procurement for organisations in the construction industry include improving communication, reducing administration costs, price reduction in tendering and achieving competitive advantages (NePP, 2004; European Commission, 2005a; European Commission, 2006; Eadie et al., 2007; Construction Industry Council, 2008). European Commission (2005a) has listed five types of ICT tools for e-procurement: 1) standard software package; 2) customised,

company-specific IT solutions; 3) software services provided by Application Service Providers (ASPs); 4) functionality offered via sales solutions of suppliers; and 5) functionality offered on e-marketplaces.

E-procurement has traditionally been a subset of e-business (Schneider, 2010) and primarily was implemented by large enterprises due to the extensive initial investment cost, which limited the ability of smaller firms to participate (European Commission, 2006). In the 2008, less than 20% of the UK construction organisations used e-procurement in the UK (Martin, 2009).

E-procurement adoption is beginning to gain momentum within the construction industry (Martin, 2009). Two elements have contributed to this: 1) the maturity of available technologies; and 2) the intention of government to carry out procurement electronically (European Commission, 2006; GCS, 2011). Carefully designed features of the technological infrastructure provide the basis for implementing e-procurement efficiently (Chaffey, 2009). As large construction companies began to implement e-procurement solutions, the SMEs operating as subcontractors or suppliers, could also deliver product information online (Chen, 2006). Also, the SMEs can use open source software to mitigate the cost barrier (Kauffman and Mohtadi, 2004). An e-procurement capability maturity model in relation to the production of new systems and their location and pricing in the construction marketplace would increase e-procurement adoption across the construction industry (Eadie et al., 2010). The Government Construction Strategy (2011) has set the objective of performing all public projects electronically including procurement by 2016. In the Government Construction Strategy (GCS), it was also suggested that procurement should be considered as " part of broader asset life-cycle, rather than as a stand-alone process", with opportunities to integrate e-procurement solutions with other e-business solutions, such as ERP, collaboration technologies and BIM (Department for Business and Innovation & Skills, 2011; Wilkinson, 2011).

2.3.4.3 Construction Collaboration Technologies (Extranet)

The term 'collaboration technology' is often used to describe various combinations of software and/or hardware employed to help people collaborate, which include enterprise portals and intranet applications, generic workspace or project team applications, web and video conferencing and online meeting applications, peer-to-peer file-sharing, and real-time instant messaging (Wilkinson, 2005). Construction

collaboration technology, also called project extranet, is defined as " a combination of technologies that together create a single shared interface between two or more interested individuals (people), enabling them to participate in a creative process in which they share their collective skills, expertise, understanding and knowledge (information) in an atmosphere of openness, honesty, trust and mutual respect, and thereby jointly deliver the best solution that meets their common goal(s), while simultaneously creating an auditable electronic record of the people, processes and information employed in the delivery of the solutions(s)" (Wilkinson, 2005). Construction collaboration technologies are used to establish a single shared environment accessible to all authorised team members and offer a more efficient and less complex way to manage communication instead of linear communications and separate 'islands' of information (NCCTP, 2010).

The idea of an integrated project team dates back from as early as the 1960s (Banwell, 1964). Businesses in the construction industry have started to promote more collaborative working style since the late 1990s following the Latham report (1994) and Egan report (2002). Construction collaboration technologies began to emerge during 1999 to 2001 (Wilkinson, 2005). These technologies were introduced to construction organisations because collaboration services were thought to have the potential to encourage the wider uptake of e-business initiatives (Fuscaldo, 2002; Athanasios et al., 2006). Strategic collaboration can provide a more integrative approach to the design process and eliminate problems associated with the competitive tendering process, and encourage the sharing of risks and rewards (Bayramoglu, 2001). Both tangible and intangible savings are found from the implementation of collaboration technologies (Wilkinson, 2008; NCCTP, 2011).

Collaboration technologies are continuously being tailored to suit the specific needs of construction industry (European Commission, 2006). Technologies readily available today for construction collaboration are mature (Wilkinson, 2005). However, collaborative design processes are rarely used (European Commission, 2006), and collaborative project management processes are mainly applied in large construction firms (Wilkinson, 2008).

The implementation of construction collaboration technologies will be more common in future because of the emergence of a new strategic solution, Software-as-a-Service (SaaS). SaaS has made the collaboration technology applications affordable to more construction organisations, even the SMEs (Wilkinson, 2012). For example, most

of the solutions of Conject.com (formerly BIW) and the collaborative solutions of Asite are Saas basis (Asite, 2012; Conject.com, 2012).

2.3.4.4 Building Information Modelling (BIM)

There is a wide range of definitions for Building Information Modelling (BIM) (Associated General Contractors of America, 2006; International Alliance for Interoperability, 2007; General Services Administration, 2007). Eastman et al. (2008) defined BIM as "a modelling technology and associated set of processes to produce, communicate, and analyse building models and interfaces, methods, and applications that are pertinent to BIM technology, including but not limited to the following: sustainable practices, management and organisational issues around technology, and assisting technologies and methods". BIM provides dynamic decision-making information throughout a project lifecycle. Meanwhile its encapsulated information synchronizes with construction practices ranging from design, execution, operation, maintenance, through to renovation (Lu and Li, 2010).

BIM was introduced to the construction industry in the early 2000s because of its potential to change the traditional construction practices in a broader sense of people, process, working culture, communication and business models (International Alliance for Interoperability, 2007). Some even advocated that the traditional construction practices would face a paradigm shift with the wider application of BIM (Ruikar et al., 2006; Price, 2010; Becerik-Gerber and Kensek, 2010; Baker, 2010; Department for Business and Innovation & Skills, 2011). The main benefits of implementing BIM include: 1) providing virtual design, construction and operation; 2) enabling life-cycle analysis and integrated project delivery; 3) improving collaboration; 4) increasing information reuse; 5) improving sustainability; and 6) better business outcomes (Eastman et al., 2008; Price, 2010).

The implementation of BIM in the construction industry was limited in the early 2000s (Howell and Batcheler, 2007). More recently there has been an expanding adoption of BIM in the construction industry (Department for Business and Innovation & Skills, 2011). Nonetheless, various intriguing questions have yet to be fully explored before it is likely that the tipping point of using BIM in the construction industry will be reached (Lu and Li, 2010). Moreover, the GCS (2011) announced the Government's intention to require collaborative 3D BIM (with all project and asset information, documentation and data being electronic) on its projects by 2016. In the near future,

BIM will be considered more seriously among the organisations in the industry because BIM, together with other e-business solutions, could enable them improve productivity and process efficiency so as to meet the goal set by the Government, which was that the construction industry needed to realise a "cost reduction of 20% during the term of the current Parliament" (Bew, 2011).

2.3.5 Barriers for the Construction Industry to Implement e-Business

The technologies and e-business solutions available currently are mature enough to meet construction-specific needs and requirements (Wilkinson, 2005; IFS, 2010). Furthermore, they enable construction organisations to do many advanced business activities in addition to basic connectivity (DTI, 2004; European Commission, 2006; Ruikar and Anumba, 2008). However, there are also barriers associated with the adoption of those e-business solutions. According to Ruikar and Anumba (2008), the barriers or challenges associated with e-business need to be recognised, identified and addressed in order to improve public confidence and encourage its adoption.

Thorbjornsen and Descamps (1997) suggested that the general barriers to e-business fell into three categories: 1) infrastructure, 2) trust and reliability, and 3) regulatory issues. OCED (2004) summarised four common barriers of e-business for sectors that were characterised by having a large number of SMEs, such as the construction industry. The four types of barriers include 1) unsuitability for the type of business; 2) lack of enablers (e.g. availability of ICT skills, qualified personnel and network infrastructure); 3) cost issues (e.g. costs of ICT infrastructure, software and on-going costs); and 4) security and trust issues (e.g. security and reliability of systems and legal frameworks). Chen (2006) stated that the barriers to e-business in the construction industry stem from four sources: technological, human, financial and environmental.

In the early 2000s, infrastructure and security issues were the major challenges that limited the uptake of e-business in the construction industry (Ugwu et al., 2000). Examples included the required frequency of system upgrades, concerns about security and problems of reliability of data in online transactions, integration with legacy systems, and interoperability of distributed software applications over the Internet. Additionally, the large size of the initial investment was also crucial for most organisations in the industry, specially the SMEs (Elliman and Orange, 2000; Anumba and Ruikar, 2002).

The technological barriers to e-business can be overcome if the infrastructure for e-business use was properly created, and security issues can be addressed through firewalls and secure encryption technologies (Ruikar and Anumba, 2008). Also, with the emergence of new technologies (e.g. collaboration technologies) and new e-business service models (e.g. SaaS), the financial barriers can also be overcome. Indeed the currently available e-business solutions are affordable to most organisations in the industry, even the SMEs.

More recently, industry experts believe that the barriers to the effective use of e-business in the industry are related to organisational policies and management, as well as human resources and culture (Aranda-Mena, and Stewart, 2005; Hjelt and Bjork, 2006; Ruikar et al., 2006; Zou and Soe, 2006). The uptake of e-business affects business operations of organisations, and this impact will cause changes in organisational goals, technology, vision, training, policies, culture, mission and business strategy (Ruikar and Anumba, 2008). Moreover, the implementation of e-business can also affect organisational structure and culture (Chaffey, 2009). Organisational culture plays a significant role in the implementation of innovation (Rankin and Luther, 2006), and furthermore, contribution by staff in task execution and management is crucial and their performance can greatly affect the success and failure of organisations (Cheng at el., 2001). The successful implementation of e-business requires buy-in and commitment on the top management (Ruikar et al., 2006). Building trust and confidence in staff to commit to e-business is also crucial (Industry Canada, 2007). Therefore, to improve their e-business implementation, it is important for organisations in the industry to create a positive organisational culture that informs, equips and encourage staff members to learn and adopt e-business initiatives in future (Ruikar and Anumba, 2008).

2.4 Research Work to Improve e-Business Implementation

2.2 e-Business Overview	2.3 e-Business Implementation in the Construction Industry	2.4 Improve e-Business Implementation	2.5 Research Areas for Further Investigation
2.6 Summary			

The implementation of e-business in the construction industry has provided many opportunities for organisations in the sector to improve business performance and achieve competitive advantages. On the other hand, it has brought about a number of challenges that organisations in the construction sector must overcome in order to

achieve effective use of e-business. Compared to other industrial sectors, the construction industry was slow in embracing e-business (DTI, 2004; European Commission, 2006). To encourage the wider adoption of e-business, several research initiatives have been completed or are on-going. The section provides a review of prior research work in four areas: 1) the different approaches to identifying the benefits and created value resulting from e-business implementation; 2) benchmarking studies aiming at identifying e-business potential and measuring e-business performance; 3) tools to assess firms' capabilities and readiness to benefit from e-business applications; and 4) the strategic consideration for e-business implementation and the various approaches (models or frameworks) for developing and applying e-business strategy.

2.4.1 Research in Identifying the Benefits and Created Value of e-Business

The adoption of e-business is driven by the benefits that would have impact on profitability or the generated value to an organisation (Chaffey, 2009). Usually the benefits of e-business are evaluated by comparing the cost of performing certain business operations and the net benefit that e-business will provide (Mogollon and Raisinghani, 2003). However, technologies involved in e-business operations introduce an additional complexity, which must be weighed against expected benefits (Robeiro and Love, 2003). The created value of e-business is not easy to evaluate because the impacts of e-business extend beyond organisational boundaries, so the evaluation requires cooperation from business partners and even competitors in the industry (Subramaniam and Shaw, 2002). Three main research approaches that focus on identifying the benefits and created value of e-business are introduced in this section: 1) calculating the return-on-investment (ROI), 2) performing value decomposition, and 3) identifying the benefits and created value of e-business through a resource-based view.

2.4.1.1 Identifying the Benefits and Created Value of e-Business through Calculating ROI

Return-On-Investment (ROI) is "a measure of the net income a firm is able to earn with its total assets" (Resource Management Systems, 2012). ROI is calculated by dividing net profits after taxes by total assets. The more simple explanation of ROI is what you get back (return) for the money you are being asked to spend (investment).

In e-business, ROI has been applied as an important evaluation criterion for IT departments (Ferengul, 2001; Chaffey, 2009). IT managers use ROI to: 1) convince the

corporation management of the value of a project, 2) compare projects to determine which offers the best return, and 3) justify the implementation of an e-business application (Mogollon and Raisinghani, 2003). Moreover, calculating the ROI on an e-business project was one means of measuring the benefit to the organisation (Wu, 2000). The returns flowing from the investment of e-business applications were referred to as benefits and included in a cost benefit analysis (Mogollon and Raisinghani, 2003). Benefits could relatively easily be quantified in monetary terms since e-business produced tangible benefits mainly in the form of cost reduction and better utilisation of working capital (Fink, 2006). Mogollon and Raisinghani (2003) reviewed the benefits (both tangible and intangible) generated by e-business projects and suggested a ROI Calculator Tool. Organisations could use the ROI Calculator Tool to measure and quantify the costs versus the benefits of undertaking an e-business project.

However, there are challenges in calculating the complete ROI of e-business within organisations. To calculate the ROI of e-business, an organisation needs to identify its investment in e-business applications and the payoffs that it receives after adopting e-business. To determine what constitutes the total cost of a certain e-business application and what constitutes the total return of the application is usually difficult (Mogollon and Raisinghani, 2003). On one hand, the investment justification is difficult because of the complicated combination of direct cost and related indirect cost of an e-business application (Love and Irani, 2004). On the other hand, the economic returns of e-business are not easy to evaluate because e-business has impacts across business boundaries (Subramaniam and Shaw 2002).

Furthermore, the challenges in calculating ROI of e-business raise many other concerns. Mogollon and Raisinghani (2003) stated that ROI was an imperfect calculation because it was not able to measure intangible benefits of e-business. Love et al. (2004) questioned past studies on methodological grounds such as use of inappropriate measures of technology intensity, and failure to control for other factors that drive a firm’s profits. Strassman (1997) even argued that there was no discernible relationship between IT investments (including e-business applications) and any measure of firm profitability including ROI. All of these concerns emphasise the need for a better theoretical framework with which to trace the path from e-business investments to business value.

In the construction industry, a survey by DTI (2004) showed that companies in the sector have started to recognise and evaluate the benefits of e-business to their own

organisations. Robeiro and Love (2003) suggested three categories of e-business benefits and created value in the context of the ROI: business value, market value and technical value. However, they did not discuss how to use ROI to evaluate those benefits and created values. More research work is required in order to investigate the implementation of ROI or any other financial measures within or among organisations in the construction industry.

2.4.1.2 Identifying the Benefits and Created Value of e-Business through Doing Value Decomposition

The technique of decomposition is from the information systems and computer science disciplines (Fink, 2006). It is a top-down approach to solving a complex problem by segmenting and decomposing the problem into smaller, functionally self-contained sub-problems (Davis, 1994). The sub-problems are simpler than the original problem, and when spliced together, the sub-problems can solve the original problem (Gillettt and Pollack, 1982; Trefethen and Bau, 1997; GSL Team, 2007).

Fink (2006) applied the decomposition technique to e-business to examine the intangible benefits of e-business; he called his method “value decomposition”. In adopting the technique to recognise the benefits and created value of e-business, e-business values were decomposed into lower levels until a particular benefit could be singled out and quantified. Therefore, the value of e-business was defined as different hierarchical levels. Fink (2006) suggested three levels of value hierarchies, including value construct, value variables and value metrics.

The significance of the research is that the intangible benefits of e-business become quantifiable through value decomposition. Also, the lowest level of the hierarchies, such as the value metrics defined by Fink, succinctly indicated the created value of different e-business initiatives and can be used by IT managers to justify the investment and performance. One drawback is that the value metrics within a given organisation may undergo changes over time as its e-business implementation becomes more complete or more advanced (Weischedel et al., 2003).

In the construction industry, Chen (2006) applied a similar approach to evaluate the benefits and created value of e-procurement (a subset of e-business). Chen defined three hierarchical levels for evaluating e-procurement including parameters, values for quantification and value examples. Value decomposition was used to make the intangible benefits and created value of e-procurement measurable and this enabled a

comparison between the construction industry and manufacture industry, which in turn led to the identification of the potential opportunities for construction organisations to improve their e-procurement implementation.

Value decomposition has made the complicated usage of e-business initiatives measurable. The different levels of hierarchies built upon the value decomposition principle enabled more granular and accurate understanding of ICT use and e-business implementation (DTI, 2004; Chen, 2006; Fink, 2006). Value decomposition is an effective way to identify metrics for operationalizing e-business performances that are non-monetary in nature but which nevertheless contribute to the overall profitability of the organisation. However, value generation and value metric establishment would be very difficult and complicated if there were a variety of technological solutions involving in e-business implementation within a given organisations (Subramaniam and Shaw 2002; Jelassi and Enders, 2009).

2.4.1.3 Identifying the Benefits and Created Value of e-Business through Resource-based View

In the resource-based view, a firm is viewed as a bundle of resources and capabilities (Amit and Zott, 2001). Resources are a set of assets and capabilities available for a firm that is useful in detecting and responding to market opportunities or threats (Hoopes, et al., 2003). Capabilities are higher-order resources that involve the ability of a firm to deploy resources in combination with organisational processes to obtain desired outcomes (Amit and Schoemaker, 1993; Grant, 1991; Helfat, et al., 2009). Resources and capabilities are organisation-specific, rare and difficult to imitate or substitute (Barney, 1991; Eisenhardt and Martin, 2000; Amit and Zott, 2001; Johnson, et al., 2009). A firm's resources and capabilities "are valuable if, and only if, they reduce a firm's cost or increase its revenues compared to what have been the case if the firm did not possess those resources" (Barney, 1997).

The implementation of e-business transforms the way organisations do business and conduct communication, which opens up new sources of value creation in the area of resources and capabilities (Amit and Zott, 2001; Chen, 2006; Johnson, et al., 2009). In an electronic environment enabled by the Internet, resources can be combined and integrated into unique functionalities that enable distinctive capabilities within a firm, which cannot be substituted for or easily imitated (e.g. shared information) (Teece et al., 1997; Zhao, et al., 2008). So a firm could benefit from the distinctive capabilities when

the firm embeds e-business capabilities into its organisational fabric in a way that produces resource complementarity (Zhu, 2004). Therefore, the value of e-business is created during the transformation of e-business investment into e-business capabilities of an organisation.

Barua et al. (2004) studied a firm's ability to deploy three resources, IT infrastructure, business processes and readiness of customers and suppliers, to create business value. This empirical study indicated that leveraging online information capabilities (OIC) had a positive impact on operational and financial performance. Raymond and Bergeron (2008) categorised e-business capabilities into four types: e-communication, e-intelligence, e-commerce, and e-collaboration. Zhao et al. (2008) indicated that e-business capabilities included information sharing capabilities and collaborative process capabilities. All these research studies have substantially contributed to the understanding of the role of resources and capabilities in the process of e-business value creation from resource-based view, but none of them suggested any metrics applicable for quantifying those predicted e-business benefits and created value.

In the construction industry, the European Commission (2006) suggested that instead of more investment in e-business, organisations in the industry should leverage their IT resources so as to create unique e-business resources and capabilities. Organisations in the industry range in size, capabilities and level of e-business implementation (Wilkinson, 2005; European Commission, 2006). Many of them are aware that the implementation of e-business can be improved through leveraging their IT resources (Alshawi, et al., 2008; Chen et al., 2011). However, few of them have focused on leveraging their IT resources to create the distinctive e-business capabilities of their own (Wolstenholme, 2009; Underwood and Khosrowshahi, 2012).

2.4.2 e-Business Benchmarking Studies

Benchmarking is widely accepted as a continuous improvement tool for organisations to establish achievable goals or enhance their performance based on a comparison of the organisation's processes, products or services with those identified as best practice (Kozak, 2004). Benchmarking was first applied as a tool to investigate a competitor's operating capabilities and the features of competing products (Yasin, et al., 2002). Today benchmarking is broadly used in various business-related fields. In addition, benchmarking emerged as a reaction to growing competitive pressures in international markets and has become a common technique applied at the organisational

level and even at national/international levels (Sisson et al., 2003; Global Benchmarking Network, 2012). In this broadest sense, benchmarking also acts as a discovery process and a learning experience, which motivates decision makers to identify practices that can be adapted to build a winning economic policy or strategy (Ahmed et al., 2006).

In the construction industry, benchmarking was first applied as a total quality management tool (Fisher et al., 1995). In the early 2000s, the high frequency of business failures, low productivity, and movements towards innovation in the construction industry motivated financial benchmarking and benchmarking applications in management practices (Chen, 2006). Moreover, benchmarking was also used in evaluating the performance and impact of ICT and e-business on the economics of construction industry (European Commission, 2008).

Several benchmarking studies have been undertaken to evaluate the implementation of e-business in the construction industry in several developed countries. Notable examples relevant to the UK construction industry include *Business in the Information Age* (DTI, 2003~2004), and *e-Watch* (European Commission, 2005~2006). The benchmarking studies were undertaken to: 1) assess the level of penetration of e-business in the industry by mid-2000, 2) identify the strengths and weaknesses of industry members in their attempt to implement e-business, 3) provide quantitative performance metrics to evaluate e-business implementation, and 4) recommend policy or identify strategy implications for future e-business development. The next a few sections will review these two studies briefly. The e-business benchmarking tools derived from these two studies include Sophistication Index (DTI, 2003; DTI, 2004) and e-Business Watch Policy Implications (European Commission, 2005b; European Commission, 2006).

2.4.2.1 Business in the Information Age (DTI, 2003~2004)

Business in the Information Age was an international benchmarking study (IBS), which was conducted by Department of Trade and Industry (DTI) to measure the use of ICT to conduct business electronically in the UK, and other developed countries.

The benchmarking study assessed the level of penetration of e-business through reviewing facts in the following areas: 1) technology, 2) external usage (interacting with customers and suppliers), 3) internal functions and processes, 4) business strategy, 5) drivers and barriers, and 6) sources of advice (DTI, 2003). Also, the study measured the UK's e-business performance against other benchmarked countries, highlighted the

areas of relative strength and weakness of e-business across all sizes of businesses, provided a basis for the e-business policy-making, and tracked the impact of recent government initiatives.

The results of the study were presented in the annual reports (DTI, 2003; DTI, 2004). The study indicated that businesses in the UK have realised a wide range of benefits from the deployment of e-business, but the adoption of e-business were strongly influenced by their environment (e.g. government and competitors). The sector analysis has identified significant variations in the level of technology adoption and deployment across sectors: financial services businesses had the highest levels of adoption and connectivity, whilst businesses in construction sectors had the lowest. For example, 96% UK financial services businesses had a website, versus 80% of UK construction businesses. Therefore, it is crucial for construction industry to develop the business policies or strategies to support effective take up and use of e-business technologies and deliver productivity improvements.

2.4.2.2 e-Watch (European Commission, 2005~2006)

E-watch refers to the e-Business Watch Study launched by the European Commission to measure the growing maturity of e-business across different industrial sectors in the enlarged European Union.

The study assessed the level of penetration of e-business through reviewing the following factors: 1) ICT infrastructure, 2) e-skill development and outsourcing, 3) ICT expenditures and investments, 4) internal and external e-collaboration, 5) online sourcing and procurement, 6) online marketing and sales, 7) e-standards and interoperability issues, 8) ICT impacts, drivers and inhibiters, and 9) innovation activities. Additionally, the study measured the usage of e-business in the construction industry, and recommended possible policies or strategies to assist the industry to conduct e-business. Furthermore, the study conducted the strengths-weaknesses-opportunities-threats (SWOT) analysis specifically for the SMEs, in the area of better and further implementation of e-business.

The results of the study were presented in the annual reports (European Commission, 2005a; European Commission, 2005b; European Commission, 2006). Similar to the results of IBS, the e-Watch study also indicated that the construction sector as a whole lagged behind other sectors. This study revealed that the construction industry was a reactive sector in relation to e- business that primarily acted on external

pressures for ICT usage rather than internal managerial decisions based on pro-active ICT strategies. Moreover, the study also indicated that e-business was not a major way that enterprises operated in the construction sector at this point. For example, enterprises representing only 11% of the sector's employees considered e-business to be a significant part of the way the enterprises operated. Furthermore, the study recommended four areas that were potentially important for the future development of e-business in the construction industry: 1) applications to enhance productivity, 2) increasing internal integration, 3) promoting external collaboration, and 4) creating a single European market in the construction sector.

Through benchmarking practices, the implementation of e-business in the construction industry has been measured and potential opportunities for future e-business development have been indicated. It's more effective than value decomposition method in evaluating the e-business values (Jaques and Povey, 2007). However, since the benchmarking studies were concentrating on the industry level and comparisons were carried out between sectors and even nations, further investigating is required into how individual organisations can apply the established metrics to measure their performance and benefit from the policy or strategy recommendations.

2.4.3 Organisational Readiness for e-Business

As presented in Section 2.4.1.3, the implementation of e-business opened up new sources of value creation in the area of resources and capabilities (Amit and Zott, 2001; Chen, 2006; Johnson, et al., 2009). Organisations in the construction industry should leverage their IT resources so as to create unique e-business resources and capabilities (European Commission, 2006). Several studies have been undertaken to develop a suitable approach for construction organisations to define the capabilities that reflected their e-business implementation level and enabled future improvement. Pena-Mora et al. (1999) developed an information technology planning framework for large-scale construction projects to evaluate the returns from IT investment. Sarshar et al. (2000) developed SPICE (Standardised Process Improvement for Construction Enterprises), a business process diagnostic tool for construction projects, to assess process capability and prioritise process improvement. Keraminiyage et al. (2008) recommended an approach that connected the IT adoptability with construction process improvement. Jocobsson and Linderoth (2010, 2012) suggested to consider contextual elements

(mainly referred to characteristics) of organisations' to evaluate ICT adoption at project level.

All the above studies were focused on the implementation of e-business at project level. However, the one-off nature of construction projects would lead to short-term consideration of e-business implementation (Ruikar et al., 2008). To address the organisational issues and consider e-business implementation at longer-term, organisational readiness tools were introduced to the construction industry.

Readiness assessment tools have been developed to gauge how ready an economy, an industrial sector or an organisation is to benefit from ICT and e-business (Peters, 2001). In the construction industry, organisational readiness for e-business or e-readiness has been defined as 'the ability of an organisation, department or workgroup to successfully adopt, use and benefit from ICTs such as e-business' (Ruikar et al., 2008). To assess the e-readiness of organisations in the industry, Ruikar et al. (2006) defined the capabilities of construction organisations that were ready for implementing e-business in terms of management, people, process and technology. According to Ruikar et al. (2006), an organisation is ready for e-business only when:

- Management believes in the technology and takes strategic measures to drive its adoption, implementation and usage in order to derive business benefits from the technology;
- Processes are available and support the successful adoption of the technology;
- People have adequate skills, understanding of, and belief in, the technology; and finally
- Technology tools and infrastructure necessary to support the business functions are achievable (e.g. processes and people).

Figure 2.3 displays the four elements for an e-ready organisation. Based on the four elements, an assessment tool named VERDICT (an acronym for Verify End-user e-Readiness using a Diagnostic Tool) has been developed to aid construction industry end-users to gauge their e-readiness for using e-business technologies (Ruikar et al., 2006). Besides assessing the organisational readiness for e-business, the VERDICT tool could also help in highlighting areas that must be addressed to achieve e-readiness. By addressing these areas, organisations can make themselves more ready for adopt, use and benefit from e-business. For example, an initial implementation of the tool among

some industry practitioners indicated that organisations in the construction industry were strongest in technology e-readiness and weakest in management e-readiness. However, the specific measures that organisations could use to address these issues and the necessary procedures for them to go through have not been addressed in the e-readiness tools. For example, in an initial study, the VERDICT tool defined management buy-in as an area needing attention, but the tool could not help organisations to improve the buy-in. An alternative approach is required to guide organisation in addressing the issues identified by e-readiness tools.

Figure 2.3 Four Elements for an e-Ready Organisation (Source: Ruikar et al., 2006)

2.4.4 e-Business Strategy and Different Approaches for e-Business Strategy Development

This section briefly introduces the concept and meaning of strategy and how it was introduced to the e-business domain. The section then discusses different views on what e-business strategy should focus on and includes a discussion of the issues that have been addressed in prior research. Several approaches for e-business strategy and its development are presented and discussed in the section, which aims to determine the potential elements for an e-business strategy development process.

2.4.4.1 The Concept and Meaning of Strategy

The concept of strategy has been borrowed from the military and adapted for use in business (Niklos, 2000). Broadly, strategy is a generic framework that provides guidance for actions to be taken and, at the same time, is shaped by the actions taken (Ruikar et al., 2006). Therefore, by choosing strategy, a firm decides to pursue one course of action over others. Hoskisson et al. (2008) emphasised the importance of achieving competitive advantage in a strategy and identified strategy as "an integrated and coordinated set of commitment and actions designed to exploit core competencies and gain a competitive advantage". Similarly, Dobson et al. (2004) agreed that strategy was about achieving competitive advantage through being different, delivering unique value added service to the customer, and having a clear view of the position of an organisation in its industry.

Moreover, Johnson et al. (2008) stated that strategy was "the direction and scope of an organisation over the long-term, which achieves advantage for the organisation through its configuration of resources within a challenging environment, to meet the needs of markets and to fulfil stakeholder expectations". Chaffey (2009) concluded that the following statements summarised the essence of strategy and could equally apply to each type of strategy. According to Chaffey (2009), strategy should:

- Provide a long-term plan for the development of an organisation (Vision);
- Determine how an organisation will meet its objectives (Objectives);
- Set allocation of resources to meet goals (Resources);
- Select preferred strategic options to compete within a market (Market and scope); and
- Identify competitive advantage through developing an appropriate positioning and defining a value proposition delivered to customer segment (Competitive advantage).

Thus in summary, it can be said that strategy is about defining the future direction (both long-term vision and short-term objectives) and actions (all associated actions such as allocating resources, meeting market needs and requirements, and determining value proposition) of an organisation.

2.4.4.2 The Levels of Strategy

According to Johnson and Scholes (2003), organisations, particularly larger or global ones, have different levels of strategy. They summarised the different levels as follows:

- *Corporate strategy*: is concerned with the overall purpose and scope of an organisation.
- *Business level strategy*: defines how to compete successfully in a particular market.
- *Operation strategy*: is concentrated on the main operations of an organisation, and how to achieve corporate and business strategies through operations.

Corporate strategy, business strategy and operational strategy are formulated and managed differently within organisations, ranging from the overall business (or group of businesses) through to individuals working within it (Ruikar et al., 2006). Additionally, Chaffey (2009) added another level of strategy called functional or process strategy. A functional or process strategy describes how the corporate and business unit strategies will be operationalized in different functional areas or business processes, such as marketing, supply chain management, human resources, finance and information systems strategies. Based on this definition, functional strategy could be considered as part of an operation strategy within an organisation.

2.4.4.3 The Need for an e-Business Strategy

The concept of strategy was introduced to the e-business domain after the dot-com bubble burst, and organisations realised that technology alone was not adequate for the success of e-business implementation. There was a growing realisation that it must be accompanied with appropriate managerial and organisational practices (Jelassi and Enders, 2009; Chaffey, 2009; Laudon and Laudon, 2009). Currently there is a tendency for e-business strategy to be incorporated within the functional strategies, for example within a marketing plan or logistics plan, or as part of information systems (IS) strategy (Chaffey, 2009). However, the leaders in e-business have typically defined e-business as an element of their corporate strategy development and the importance of e-business strategy has been recognised by the senior management board (Deise et al., 2000; Norton, 2002; Jelassi and Enders, 2009; Chaffey, 2009).

The goal of e-business strategy is to define the future direction and actions of an organisation by which the applications of internal and external electronic communications can support and influence corporate strategy (Chaffey, 2009). Beal and Mosse (2008) stated that e-business strategy enabled organisations to promote the alignment of business and IT infrastructure in order to derive the maximum benefit from their investments in technology. The misalignment occurs when business and IT decisions are made independently, which leads to the failure of technological investment to deliver the expected benefits within organisations (Hoque, 2002; Alshawi et al., 2008). Daghfous and Al-Nahas (2006) emphasised the role of e-business strategy in reducing the uncertainty associated with moving business operations to the Internet. Moreover, Chaffey (2009) stated that IT strategy was designed to support the e-business strategy. Zeng and Li (2008) suggested that IT was the internal driver of e-business implementation. They argued that IT strategy identified the robust IT infrastructure necessary to support business functions while e-business strategy defined how organisations connected with external partners as well as how organisations operated within management activities, processes and systems. Pursultani and Akhgar (2010) added that e-business strategy established a clear vision, gained full commitment from the top management, and harnessed new capabilities and skills of people so as to support the overall business goal. Furthermore, Chaffey (2009) suggested that without a clearly defined e-business strategy, the following problems might result:

- *Missed opportunities*: because of a lack of evaluation of opportunities or insufficient resourcing of e-business initiatives;
- *Inappropriate direction in e-business development:* having no long-term consideration of e-business development and without clearly defined objectives;
- *Limited integration:* at only a technical level potentially resulting in “silos” (e.g. separate organisational team with distinct responsibilities that do not work in an integrated manner with other teams) of information in different systems; and
- *Resource wastage:* due to duplication of e-business development in different functions and limited sharing of best practice.

Therefore, it is important for organisations to define an appropriate e-business strategy to guide its implementation and support the overall corporate strategy. Poorly defined e-business strategy would result financial wastage even IT investment fail.

2.4.4.4 e-Business Strategy and What It Should Cover

E-business strategy was first considered only with regard to technological aspects, such as infrastructure, applications, and integration (Anice et al., 2001). New business models were established based on the newly emerging technologies (Schneider, 2010). There have been many start-ups such as eBay™, Amazon™, Lastminute.com and Zopa.com that have succeeded through these innovative business models (Chaffey, 2009). It is worthy of note that those models have not considered the managerial and organisational aspects of e-business.

On the other hand, some researchers have regarded e-business strategy as only relevant to managerial and marketing because they considered e-business to be fundamentally the same as traditional business except e-business operates using Internet-enabled tools (Charelsworth, 2011). Norton (2002) put forward eight Cs for e-business strategy formulation: Customers, Creation of value, Cooperation, Commitment, Charging, Competition, Culture and Cost. Norton (2002) noted that the eight Cs were all business issues rather than technological issues, because an e-business strategy should be a vital concern for senior management, not just for the IT department or teams.

Additionally, there have been many other different views of the contents of e-business strategy, such as focusing on human factors (Daghfous and AI-Nahas, 2006), environment (Pai and Yeh, 2008), inter-organisational relationships (Julta et al., 2001), networks (Sultan and Hussain, 2001), financial considerations (Levenburg and Magal, 2004), and markets (Jarvenpaa and Tiller, 2001).

However, as more research work was undertaken in e-business strategy concepts and solutions, researchers started to realise that e-business strategies should not be limited to simply one aspect but also should include multiple elements (Pursultani and Akhgar, 2010). For example, Alhawamdeh (2007) suggested that an e-business strategy should be derived from the business objectives, organisational culture, policy, and current knowledge resources. Chaffey (2009) pointed out that an e-business strategy should share the common essences of a strategy, such as vision, objectives, competitive advantage, resources, market and environment. Jelassi and Enders (2009) argued that

besides all the common essences of a strategy, there should also be specific contents in an e-business strategy due to the complexity and newness of involved technologies, fast changes in the domain, and uncertainty and risks associated with implementation. Pursultani and Akhgar (2010) suggested that an e-business strategy should include multiple elements and collaboration of partners should lie at the heart of the e-business strategy.

Furthermore, to clearly define an appropriate e-business strategy, different models are developed to support strategy formulation. Roberts and Toleman (2007) worked out a conceptual model to assist in e-business strategy formulation. Four elements were included in the conceptual model: 1) regulatory environment, 2) firm characteristics, 3) stakeholder power, and 4) market and technological uncertainty. Marshall and McKay (2000) established a maturity model for formulating e-business strategy. Five issues were considered in the maturity model: 1) investment in suitable information systems and technology, 2) appropriate reengineering and redesign of business processes, 3) effective marketing and customer relationship management, 4) efficient and effective acquisition and management of resources and relationships, and 5) development and management of an efficient and effective logistics or distribution capability. Other examples include the Roadmap for e-Business (Kalakota and Robinson, 2004) and the Generic e-Business Process Model (Chaffey, 2009).

Some researchers have argued that a model alone is not sufficient for traditional organisations to formulate e-business strategy, because of the fragmented needs and requirements within organisations (Jelassi and Enders, 2009; Pursultani and Akhgar, 2010). Wassenaar and Gregor (2001) proposed a toolbox-based framework to formulate e-business strategy, and six segments were included: 1) the single organisation, 2) the industry network, 3) the supply chain network, 4) the information and communication platform, 5) the customer/community network, and 6) the institutional (regulatory) network segments. Li and Chang (2004) suggested a holistic framework for e-business strategy, which included strategy contents and strategy process. Jelassi and Enders (2009) also proposed an e-Business Strategy Framework.

Based on the above information, an e-business strategy should include multiple elements rather than one element, and collaboration of partners should lie at the heart of the e-business strategy (Alhawamdeh, 2007; Chaffey, 2009; Pursultani and Akhgar, 2010). Also, models or frameworks can help an organisation to define an appropriate e-business strategy (Marshall and McKay, 2000; Roberts and Toleman, 2007; Chaffey,

2009). Compared to models, frameworks are sufficient for traditional organisations to formulate their e-business strategies because frameworks can address the fragmented needs and requirements within organisations ((Jelassi and Enders, 2009; Pursultani and Akhgar, 2010).

2.4.4.5 Different Approaches for e-Business Strategy and Its Development

This section reviews three different approaches for e-business strategy and its development, and attempts to generate the key elements for the e-business development process. The three approaches are the *Roadmap for e-Business* defined by Kalakota and Robinson (2004), *e-Business Strategy Framework* defined by Jelassi and Enders (2009), and *Generic e-Business Process Model* defined by Chaffey (2009).

A) The Roadmap for e-Business (Kalakola and Robinson, 2004)

Kalakola and Robinson (2004) recommended a dynamic model designed specifically for e-business and its development, called a *Roadmap for e-Business*. The model was established for e-business strategy planning and implementation and had a focus on continuous review and prioritisation of investment in new e-business applications. The model suggested four stages of planning for an organisation to formulate an appropriate e-business strategy: 1) considering knowledge building and evaluating its e-business capabilities; 2) carrying out e-business design based on the overall business goal and determining the key strategic objectives; 3) developing a high-level action plan (called blueprint of action in the model), and deciding priorities for investment and planning for technological e-business applications; and 4) developing and deploying the e-business applications for implementation. The four stages were sequential for the purpose of continuous planning and feedback. Figure 2.4 summarises the model of *Roadmap for e-Business*.

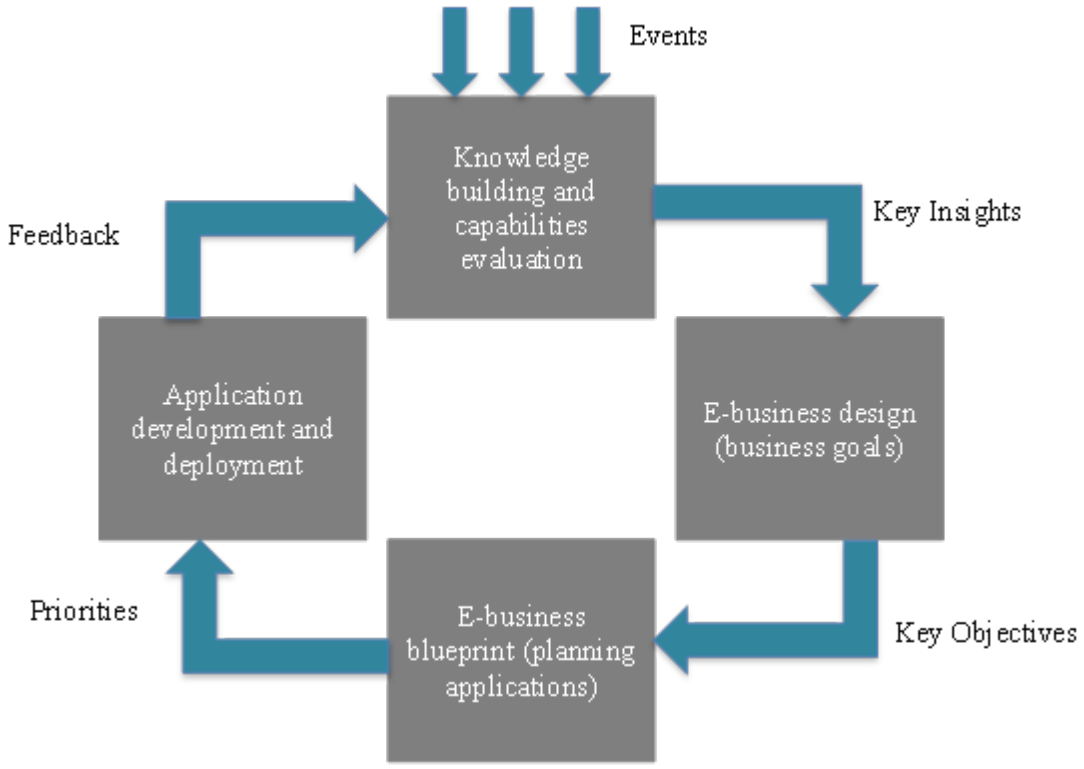


Figure 2.4 Roadmap for e-Business (Source: Kalakota and Robinson, 2004)

The *Roadmap for e-Business* model suggested that organisations in the traditional business sectors should carry out a situation analysis (mainly based on customer demands and technological trend) before considering any e-business design and strategy planning. The model also emphasised the importance of change management and communications within organisations during the implementation of e-business applications. Moreover, the model also recommended procedures for collecting feedback, and units of measurement for learning and improvement. The *Roadmap for e-Business* model has an emphasis on the continuous review and prioritisation of investment in new applications. The model is good in defining an emergent e-business strategy and developing executable projects based on the emergent e-business strategy. Organisations naturally also need a process to enable strategic agility and the ability to rapidly respond to marketplace dynamics. However, this model is not suitable for organisations wishing to leverage their resources to improve e-business capabilities and provide an integrated approach for long-term e-business implementation.

B) E-business Strategy Framework

Jelassi and Enders (2009) suggested that there were three key dimensions for defining e-business strategy:

- *Where the organisation will compete:* to determine the external micro-environment in which an organisation will be competing;
- *What type of value will e-business create:* to consider strategy options in order to generate value through increased revenue or reduced costs; and
- *How the organisation should be designed to deliver value:* to plan actions including the leverage of internal structure and resources and interfaces with external business partners.

Based on the three key areas of consideration, Jelassi and Enders (2009) developed a framework for e-business strategy formulation and implementation (see Figure 2.5).

The Framework suggested that in order for organisations to plan and implement their e-business strategies, they should pass-through three phases. The first phase was to implement situation analysis or scanning. The situation analysis included both an external analysis and an internal analysis. The purpose of the external analysis was to determine the impact of new technologies (e.g. Internet) on the macro-environment and on the industry structure. The macro-environment was defined as the wider environment in which a company operates, which includes economic, social, legal and ethical factors (Johnson and Scholes, 2003). The external analysis was undertaken using Porter's (1985) five forces model: the threat of entry of new competitors (barrier to entry), the threat of substitutes, the bargaining power of supplier, the bargaining power of buyer, and the degree of rivalry between existing competitors. The purpose of the internal analysis was to determine e-business competences as sources of strengths and weaknesses.

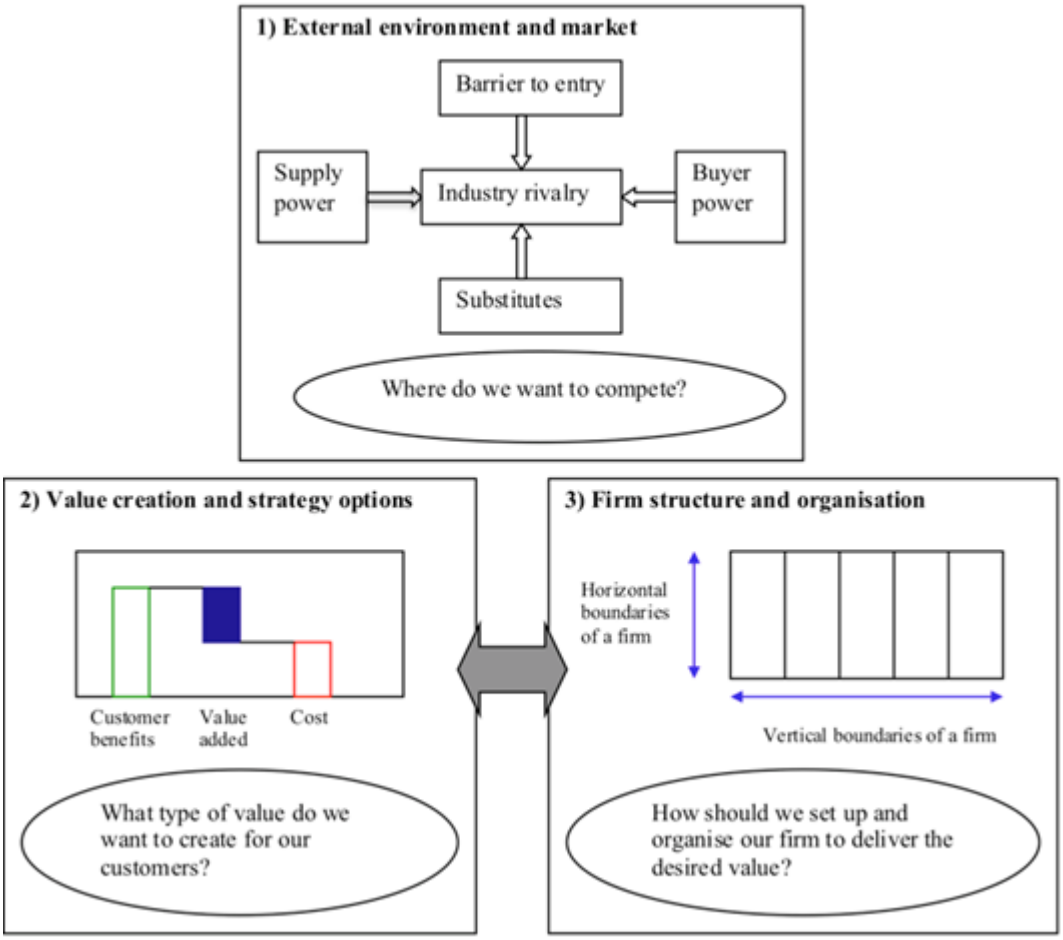


Figure 2.5 e-Business Strategy Framework (Source: Jelassi and Enders, 2009)

The second phase was to consider strategy options. E-business strategy options were analysed based on whether or not their implementation would generate created value for organisations, mainly referring to increased revenue or reduced costs. The value generation process was similar to the calculating ROI approach: calculating the benefits to customers when implementing the selected e-business application and summarising the total cost of investing such an application. The difference between the costs and benefits was the created value of e-business.

The third phase included strategy implementation. According to this framework, the implementation of e-business strategy would affect the structure of the firm as well as its relationship with external organisations, such as suppliers and customers. Managing changes in structure and relationships would ensure the success of the selected e-business strategy. Jelassi and Enders (2009) defined the structure of an

organisation as horizontal boundaries and relationships with outsiders as vertical boundaries.

The *e-Business Strategy Framework* suggests that developing a complete e-business strategy should include strategy analysis, strategy formulation and strategy implementation. The core of the Framework is the idea that organisations should undertake e-business strategy options based on the created value of implementing such options (Jelassi and Enders, 2009). However, as discussed in Section 2.4.1 (Identifying the Created Value of e-Business), the created value of e-business includes both tangible and intangible. The method used in the second phase of the *e-Business Strategy Framework* can only work out the tangible value (see Figure 2.5). This is because that the intangible benefits are difficult to be quantified in monetary terms (Al-Mashari, 2002; Mogollon and Raisinghani, 2003; Fink, 206; Chaffey, 2009). Therefore, it would more persuasive to show the role of e-business strategy in improving the overall performance of the organisations and supporting the corporate goal (Chaffey, 2009).

C) Generic e-Business Strategy Process Model

Based on the Roadmap for e-Business (Kalakota and Robinson, 2004) and e-Business Strategy Framework (Jelassi and Enders, 2009), Chaffey (2009) stated that an approach for developing e-business strategy should include four phases: strategic analysis, strategic objectives, strategic definition and strategy implementation. The four phases were defined as follows:

- *Strategic Analysis:* collection and review of information about an organisation's internal processes and resources and external marketplace factors in order to inform strategy definition;
- *Strategic Objectives:* statement and communication of an organisation's mission, vision and objectives;
- *Strategy Definition:* formulation, review and selection of strategies to achieve strategic objectives; and
- *Strategy Implementation:* planning, actions and controls needed to achieve strategic goals.

Based on the descriptions of the four phases, Chaffey (2009) recommended a *Generic e-Business Strategy Process Model* (see Figure 2.6). The model attempted to capture all the elements of an e-business strategy. Also, the model tried to incorporate a

dynamic approach through using of two-way arrows to indicate that each phase was not discrete, but rather it involved referring backwards or forwards to other strategy elements.

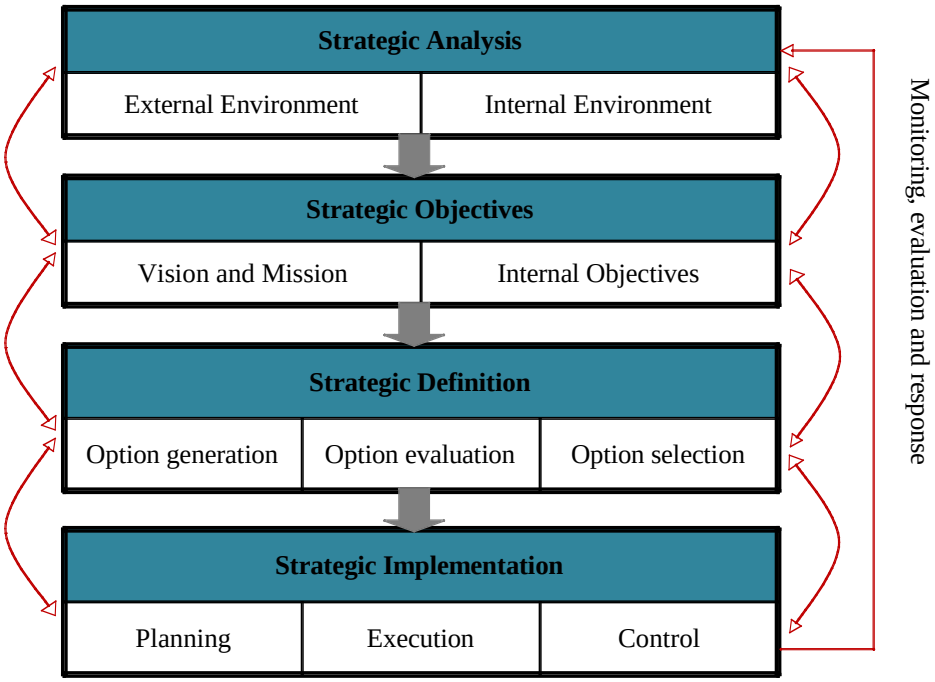


Figure 2.6 Generic e-Business Strategy Process Model (Source: Chaffey, 2009)

Chaffey's Generic e-Business Strategy Process Model suggested that the development of an e-business strategy should include strategic analysis, strategic objectives, strategic definition and strategic implementation. The Model emphasised the importance of controlling, monitoring, evaluating and responding to changes required for strategy implementation. Therefore, the Model allows organisations to be more responsive to changes in strategies (Chaffey, 2009). However, since it is a generic model, it only provided the phases that need to be followed in order to define an e-business strategy at high level. Organisational-specific issues (e.g. achieving commitment of senior management, possessing IT capabilities, and achieving necessary e-skills) and how to address them have not been included in the Model. These organisational-specific issues and how they can be addressed are critical for a successful e-business strategy (Anice et al., 2001; Pursultani and Akhgar, 2010). An alternative approach is required to address these issues.

Based on the review of the three approaches, it can conclude that an approach for developing an e-business strategy should include phases such as strategic analysis,

strategic objective and strategic implementation. Strategic analysis, or situation analysis, is a way of understanding the strategic position of an organisation implementing e-business. It helps organisations to scan their internal strategic drivers including capabilities, resources and culture, and also helped them to seek external, attractive opportunities in the marketplace. Strategic objective is concerned with the most fundamental decision in e-business strategy development, which is, determining the purpose of the strategy. Strategy implementation is about the practices and execution of the defined e-business strategy. Successful implementation was assured by appointing the right people to take the right actions in the right way. Currently available approaches can guide organisations to position them in the micro- and macro-environment. However, there are some areas still missing: 1) assisting organisations to leverage their resources to improve e-business capabilities; 2) revealing the role of an e-business strategy in improving the overall performance of organisations and supporting the corporate goal; 3) including the organisational-specific issues and how these issues can be addressed; and 4) reviewing an e-business strategy to gauge its effectiveness after implementation.

2.4.4.6 Strategic Consideration of e-Business Implementation in the Construction Industry

In the late half of the 1990s, strategic thinking became increasingly important for construction organisations as a result of the industry dramatically changing business environment (e.g. prefabrication, subcontracting, newly emerged technologies and innovation) (Jonnonen, 1998). Strategic thinking was also introduced to the construction industry for the management of IT and the determination of IT best practices (Betts, 1999). However, strategic practices, including strategic consideration of IT, in the industry was quite limited (Price et al., 2003). In 2008, Construct IT undertook the first strategic study to assess the attitude of key decision makers (Executives and Information Technology/Innovation Directors) within the industry towards IT investment aimed at continuous improvement and achieving a competitive advantage (Alshawi et al., 2008).

The strategic consideration of e-business implementation in the construction industry was also very limited. Ruikar et al. (2008) recommended a strategy development based on the e-readiness measurement and evaluation. Other experts stated that it was important to consider a holistic approach for e-business implementation in

the construction industry since the approaches available were mainly 'reactive' and lacked a long-term vision or strategy (Ruikar, 2004; European Commission, 2006; Ruikar et al., 2006; Alshawi et al., 2008). However, the issue of the content of an e-business strategy and how it should be developed have not been discussed. This research is the first step towards bringing the current gap.

2.5 Research Areas that Require Further Empirical Investigation

2.2 e-Business Overview	2.3 e-Business Implementation in the Construction Industry	2.4 Improve e-Business Implementation	2.5 Research Areas for Further Investigation
2.6 Summary			

This section discusses the areas required for further empirical investigation and forms the research questions that guide the current research. The following paragraphs will demonstrate these in detail.

Based on the information presented in Section 2.4, it can be concluded that the implementation of e-business has provided many opportunities for organisations in the construction industry. Organisations in the industry need to consider the industry-specific needs and requirements when implementing e-business. The specific needs and requirements have been associated with the characteristics of the sector, which include being fragmented, information-intensive and underperforming (Egan, 1998; Ruikar et al., 2004; Wilkinson, 2005; European Commission, 2006). The currently available technologies and e-business solutions can address the industry-specific needs and requirements and have the potential to overcome the main problems faced by industry participants and improve their performance and productivity (Wilkinson, 2005; IFS, 2010).

There are also barriers and challenges associated with the implementation of those solutions. These challenges have led many concerns in the industry (DTI, 2004; European Commission, 2006). The concerns mainly fall into four areas as described below.

Firstly, participants in the industry have already set up basic connectivity (mainly emails and Websites) by the early 2000s, and currently are starting to deploy more advanced and complicated technologies (DTI, 2003). Several new construction-specific e-business solutions were subsequently introduced to the industry in the early to mid-2000s, such as construction collaboration technology and BIM (Wilkinson, 2005; IAI,

2007). The adoption of those solutions among innovators was mainly management driven (Ruikar et al., 2006). Now that construction collaboration tools have been used for over a decade, their use in the industry needs to be assessed for more clarity on: 1) how the e-business applications assist organisations to improve their productivity and performance; 2) how they transform (or impact on) organisations; and 3) what the current drivers and barriers for their adoption are? All these inquiries (level of usage, impact, drivers and barriers) lead to the first research question: **What is the current level of penetration of e-business in the industry**?

After having invested in e-business solutions, several construction industry organisations began automating their business processes to realise the value from their e-business adoption (DTI, 2004). Several approaches were available for identifying the benefits and created value of e-business, such as calculating the ROI, carrying out value decomposition and performing resource-based value determination. However, in practice, the created value of e-business is not easy to recognise and measure because the impact of e-business extends beyond organisational boundaries. An investigation of these values therefore required cooperation from business partners (Subramaniam and Shaw 2002). In the construction industry, the way that organisations in the sector recognise the created value of e-business is unknown. Moreover, benchmarking studies have been undertaken to measure e-business performance in the industry as a whole. The units of measurement were not conducted at the level of individual organisation, and lessons learnt weren't always known. This needs to be investigated (second research question): **How do industry members measure their level of e-business implementation?**

Thirdly, organisations in the industry have realised that technologies alone are not sufficient to ensure the success of e-business implementation. E-business solutions must be accompanied by business processes reengineering, change management, and interaction with business collaborators (Chaffey, 2009; Laudon and Laudon, 2009). Organisations were aware of the need to be e-ready in order to adopt, use and benefit from e-business (Ruikar et al., 2006). There were also calls for them to leverage their resource and capability to improve their e-business implementation and to consider e-business implementation strategically (Elliman and Orange, 2000; Egan, 2001; Wolstenholme, 2009). However, the research conducted to date has not revealed how organisations can improve their e-business implementation with regard to business process operations, e-business capabilities and resources and alignment with overall

business goal. This leads to the third research question: **What is the (current) understanding of industry members about the strategic issues associated with implementation of e-business?**

Fourthly, organisations in the industry have recognised that they must have realistic expectations about their online business and consider it as part of their overall business goals (Alshawi et al., 2008). Many of them failed to make the best use of their available resources by buying smartly and matching the size of their demand for e-business solutions to the supply market in which they were competing (Salah, 2003; Wolstenholme, 2009). The cost of funding such ill-planned projects and the missed opportunities of not benefiting from the intended capabilities constituted a great loss to organisations (Alshawi et al., 2008; Chaffey, 2009). There was thus, a need for organisations in the industry to consider a holistic approach for e-business adoption. Several logic-approaches were introduced to consider e-business strategy and its development. It was recognised that organisation-specific issues had to be added when considering an e-business strategy for an individual organisation. Nevertheless, the identity of these organisation-specific issues has not been discovered. This brings about the fourth research question: **What do industry members think are the key elements that must be considered as part of an e-business strategy development process?**

Table 2.1 summarises the research areas required for further empirical investigation and the resultant research questions.

Table 2.1 Research Areas for Further Investigation and Research Questions

Formed Research Questions	**Areas for Further Empirical Investigation**
Q1: What is the current level of penetration of e-business in the industry?	Level of usage, drivers, barriers, impact, sources of IT investment advice
Q2: How do industry members measure their level of e-business implementation?	Recognition of e-business benefits and created value, and units of measurement of e-business performance
Q3: What is the (current) understanding of industry members about the strategic issues associated with implementation of e-business?	Opinions of industry practitioners in improve e-business implementation with regard to business processes, e-business capability and resources, and alignment with the overall business goal
Q4: What do industry members think are the key elements that must be considered as part of an e-business strategy development process?	Basic essence of e-business strategy and elements included in the e-business strategy development process

2.6 Summary

2.2 e-Business Overview	2.3 e-Business Implementation in the Construction Industry	2.4 Improve e-Business Implementation	2.5 Research Areas for Further Investigation
2.6 Summary			

This chapter reviewed the implementation of e-business in the construction industry. Section 2.2 gave an overview of the fundamentals of e-business by defining e-business and identifying the potential and opportunities that e-business has provided to businesses in all sectors. Section 2.3 reviewed the implementation of e-business in the construction industry and presented a background scenario for the current research. Section 2.4 discussed the prior research approaches that attempted to help organisations improve their e-business implementation, described the limitations of each research approach and identified the gaps existing in prior research. Based on the discussion in Sections 2.3 and 2.4, Section 2.5 summarised the main concerns of industry members in implementing e-business, generalised the areas required for further empirical investigation, and formed four research questions for the current research. The thought flow and debate involved in the entire chapter presents a solid theoretical underpinning for the research design and research methodological considerations. Using a broadly scoped review of literature, the main issues of e-business implementation in the construction industry have been identified, and the first research objective (introduced in Chapter One) has been accomplished. The next chapter will discuss the research design and methodological considerations of current research and describe how each of the remaining five objectives will be achieved.

CHAPTER THREE RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the research design and methodology adopted to meet the research aim and objectives set out in Chapter One. This chapter divides into three parts. Section 3.1 gives a brief review of different research philosophies, approaches, strategies and methods based on the research process 'onion' (Saunders et al, 2007). The discussion focuses on the main concepts of research philosophies, approaches, strategies and methods and how they should be applied to actual research. This review is necessary to facilitate the selection of the most appropriate techniques and methods to accomplish this research. Section 3.2 introduces the methodological considerations and research design of the current study. The methodological consideration is justified and described also based on the research process 'onion', including the philosophical concerns of the current research, the research approach consideration, and the research strategy consideration. The research design is to guide the conduction of the current research to achieve the research aim and objectives. Section 3.3 presents and justifies the adopted research methods as the research progresses from stage to stage. The chapter concludes with a summary of the contents and the next stage of the research.

3.2 Review of Research Philosophies/Approaches/Strategies/Methods	3.3 Methodological Considerations and Research Design of the Current Study	3.4 Research Methods Applied in the Current Study
3.5 Summary		

3.2 Review of Research Philosophies/Approaches/Strategies/Methods

3.2 Review of Research Philosophies/Approaches/Strategies/Methods	3.3 Methodological Considerations and Research Design of the Current Study	3.4 Research Methods Applied in the Current Study
3.5 Summary		

3.2.1 Introduction to Research Process 'Onion'

Research methodology refers to the principles, procedures and logical thought processes that are applied to a scientific investigation (Fellows and Liu, 2008). Methodological considerations help researchers to establish a theoretical foundation for

the flow of thought in which the research objectives are formulated and research questions are answered. In the business and management disciplines, Saunders et al. (2007) defined the so-called research process 'onion', consisting of several layers (see Figure 3.1). The main concept of the research onion is to consider the methodology and research design from top down, beginning from the outside layers (identifying the research philosophy) and thereafter peeling away every layer until the last inside layer is reached (defining data collection methods). In the current research, this process has been adopted to guide the review of different research elements (such as philosophy, approaches, strategies, methods and etc.) and define the methodological approach.

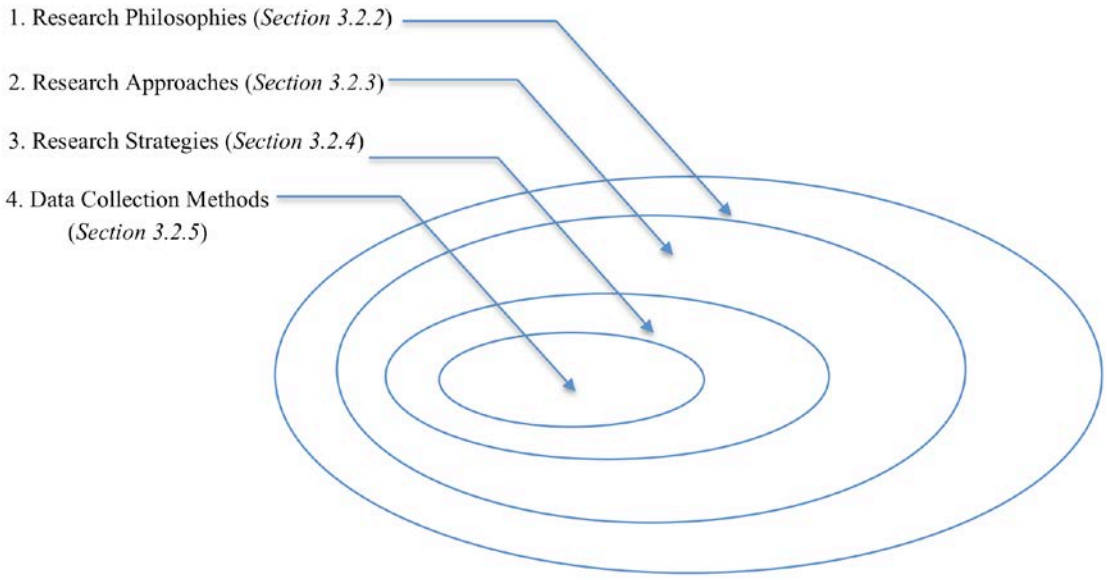


Figure 3.1 Research Process 'Onion' (Adapted from Saunders et al., 2007)

3.2.2 Research Philosophies

Creswell (2003) and Saunders et al. (2007) stated that researchers could identify the research methodological approach to be followed by assessing the knowledge claims brought to study. For example, quantitative research is associated to positivism (Creswell, 2003; Saunders et al., 2007). However, Knox (2004) questioned this suggested connection between methodological approaches and philosophical stances, and suggested using a logic thought of principles to address the research needs at different levels. Crotty (2006) supported this view by arguing that bending and adopting appropriate research methods for each individual piece of research to achieve its

research aims/objectives was more important than aligning the methodological approach with philosophical stances.

Since the relationship between methodological approaches and philosophical stances is not straightforward, how can philosophical considerations help in defining research approaches and methodology? Slife and Williams (1995) stated that philosophical ideas still influence the practice of research and therefore should be identified, although most of the time, they remained "hidden" in the research. Easterby-Smith (2002) argued that it is unwise to conduct research without an awareness of the philosophical issues that lie in the background. The research philosophy adopted by researchers indicates the way in which they view the world, and contains assumptions that will underpin the research strategy and research methods. Saunders et al. (2007) stated that there are practical benefits for researchers if they understand the philosophical assumptions and developed the research questions based on the philosophical standpoint. Johnson and Clark (2006) commented that it was important for researchers to reflect upon the philosophical choices and defend them in relation to the alternatives that they could have adopted.

Creswell (2003) simplified philosophical concerns as the nature of that knowledge (what it is, ontology) and the development of knowledge (how we know it, epistemology). Saunders et al. (2007) also stated that ontology and epistemology were two major ways of thinking about research philosophies. Other researchers also emphasised the importance of ontological and epistemological considerations in research. For example, Remenyi et al. (1998) suggested that researchers must think of the ontological and epistemological assumptions of their research before considering the appropriate research design; Bryman (2004) and Crotty (2007) stated that the ontological and epistemological statement would shape the research approaches and impact the whole research process.

As this point it is necessary to better define ontology and epistemology. Ontology is about the theory of entities and concerned with the assumptions in conceptual reality and the question of existence apart from specific objects and events (Fellows and Liu, 2008). Traditionally, ontology deals with question such as "what is the nature of being" (Saunders et al., 2007). Epistemology is concerned with the question of what is (or should be) regarded as acceptable knowledge in a discipline (Walliman, 2006). The particular central issue in this context is the question of whether the social world can and should be studied (Bryman, 2004). All philosophical positions hold a view about

social reality and that view, in turn, will determine what can be regarded as legitimate knowledge. Thus, the ontological shapes the epistemological (Williams and May, 1996).

Bryman (2004) suggested two main ontological considerations: objectivism and constructionism in social science. Objectivism is an ontological position that asserts that social phenomena and their meanings have an existence that is independent of social actors. Constructionism is an ontological position that asserts that social phenomena and their meanings are not only produced through social interaction but that they are in a constant state of revision that is being continually accomplished by social actors.

Saunders et al. (2007) suggested four research epistemological positions in management research: positivism, realism, interpretivism and pragmatism. Positivism is a position that adopts the philosophical stance of natural sciences to the study of social reality (Bryman and Bell, 2003). Researchers applying positivism work with an observable social reality and the end product of their research can be law-like generalisations similar to those produced by the physical and natural scientists (Remenyi et al., 1998). Realism is another epistemological position that relates to natural scientific enquiry. The underlying philosophy of realism is that there is a reality quite independent of the mind (Saunders et al., 2007). Researchers adopting realism assume a scientific approach to develop knowledge. Interpretivism is a term contrasting epistemology to positivism and it subsumes the views of writers who have been critical of the application of the scientific model to the study of the social world and who have been influenced by different intellectual traditions (Bryman, 2004). It emphasises the differences between people and the objects of study in natural and physical sciences and therefore requires the social scientist to grasp the subjective meaning of the observed social action (Bryman and Bell, 2003; Saunders et al., 2007). Researchers using interpretivisam endeavour to describe, interpret, and understand a situation from the perspective of the scientist (Creswell, 2007). Pragmatism is a belief that claims of knowledge arise out of actions, situations, and consequences rather than antecedents (Creswell, 2003) and it is concerned with applications (what works) and solutions to problems (Patton, 2002; Saunders et al., 2007). Researchers applying a pragmatism epistemology into their research have a freedom to choose the methods, techniques, and procedures of research that best meet their needs and purpose (Creswell, 2003).

3.2.3 Research Approaches

Broadly speaking, a research approach can be classified as quantitative, qualitative, or a combination of the two, which is called triangulation (Fellows and Liu, 2008; Creswell, 2009; Silverman, 2010; Neuman, 2011). Quantitative research refers to explaining a phenomenon by collecting numerical data that is analysed using mathematical methods, in particular statistics (Aliaga and Gunderson, 2002). Qualitative research is designed to explore the human elements of a given topic, where specific methods are used to examine how individuals see and experience the world (Given, 2008). Triangulation is a combination of the two research approaches.

Quantitative research is a scientific approach and is useful for research that demands a quantitative answer (e.g. How many construction companies use Microsoft Project for project programming?) or concentrates on numerical changes (e.g. Is the use of Blackberry™ Mobile phones increasing or decreasing among construction project managers since the iPhone has come onto the market?) (Fellows and Liu, 2008). The quantitative approach is also applied to test hypotheses. A hypothesis is a tentative explanation that accounts for a set of facts and can be tested by further investigation (Muijs, 2011). Quantitative research is often used to test a hypothesis through the collection of the relevant quantitative data and the use of statistical analysis techniques.

In the contrast to the above, the qualitative approach is more concerned with the beliefs, understandings, opinions and views of people than with numbers and facts (Fellows and Liu, 2008). It is a situated activity that locates the observer in the world and consists of a set of interpretive, material practices that make the world visible. The qualitative approach is useful for complex, in-depth investigation of a particular issue (e.g. How can Apple Macintosh™ products be successful in the wireless device market?). Unlike the quantitative approach, the qualitative approach can be applied to the development of a hypothesis.

Table 3.1 (below) displays the main characteristics of the quantitative and qualitative approaches.

Table 3.1: Characteristics of Different Research Approaches (Adapted from Creswell, 2007 and Muijs, 2011)

	Quantitative Approach	**Qualitative Approach**
Focus of Research	Scientific and quantity	Native setting (field focused) and quality
Role of Investigator	Researcher as a subjective observer	Researcher as a key instrument of data collection
Research Design	Predetermined, structured	Flexible, emergent
Sample	Large, representative	Small, theoretical
Data Collection	Inanimate instruments (tests, questionnaires, surveys, computers)	Researcher as primary instrument, interviews, observations
Mode of Analysis	Deductive data analysis	Inductive data analysis
Findings	Precise, but narrow	Comprehensive and holistic

Triangulated studies employ both the qualitative and quantitative approaches to reduce or eliminate the disadvantages of each individual approach while gaining the advantages of both. This approach has become more common, and much research practice lies somewhere on a continuum between the quantitative and qualitative (Fellows and Liu, 2008; Creswell, 2009). It is the nature and objectives of a research project as well as the employed data collection and analysis techniques which determine whether the research can be classified as qualitative, quantitative or both.

3.2.4 Research Strategy

Research strategy comprises an all-encompassing method with the logic of design incorporating specific approaches to data collection and to data analysis (Yin, 2009). Bell and Opie (2002) suggested five types of research strategies: 1) action, 2) ethnographic, 3) surveys, 4) case study, and 5) experimental. Saunders et al. (2007) added one more research strategy: grounded theory. Every strategy can be used for exploratory, descriptive and explanatory research (Yin, 2009). For example, there may be exploratory case studies, descriptive case studies, or explanatory case studies; there may be exploratory experiments, descriptive experiments, or explanatory experiments.

Furthermore, even though each strategy has its distinctive characteristics, there are large areas of overlap among them (Sieber, 1973). Yin (2009) suggested three conditions to distinguish the different strategies: 1) the type of research question posed, 2) the extent of control an investigator has over actual behavioural events, and 3) the

degree of focus on contemporary as opposed to historical events. Saunders et al. (2007) reviewed the different research strategies and stated that the choice of research strategy is guided by the research question(s) and objectives, the extent of existing knowledge, the amount of time and other resources the researchers have available, and the philosophical underpinnings. The next a few paragraphs give the definition of each research strategy and briefly highlight the elements of each strategy.

Action research refers to "a particular process concerned with developing practical knowing in the pursuit of worthwhile human purposes, and seeks to bring together action and reflection, theory and practice" (Reason and Bradbury, 2008). The action approach is characterised by "insider" involvement and usually includes collaborative reflection on existing thinking and practice relevant to it (Cameron and Price, 2009). Action research concentrates on a specific context with a clear purpose, and requires the involvement of the researcher. Therefore, the researcher needs to be devoted to all the actions throughout the process (Saunders et al., 2007). This could be time consuming and draining and the researcher has to be capable of handling such situations.

Ethnographic research has its roots in anthropology, and the approach suggests that the researcher must become part of the group under study and observes the subjective behaviours of the groups to gain insights into what, how and why their patterns of behaviour occur (Fellows and Liu, 2008). Ethnographic research is particularly indicated when one is seeking insight into a new research domain and can provide valuable understanding which can guide later research using different approaches, therefore, depth rather than breadth of coverage is the norm, with a moderately small number of cases being studied (Robson, 2011). One of the key and yet most difficult steps in ethnographical research is gaining access to a social setting that is relevant to the research problem in which the researcher is interested (Bryman, 2004). The role of researcher can be participant, observer, or both. In each circumstance and role, the researcher needs to have control over the time consumed (Saunders et al., 2007). However, the research process needs to be flexible because the researcher needs to be prepared for tests of either competence or credibility (Claire, 2003), and prepared for changes in circumstances (Giulianotti, 1993; Armstrong, 1993).

The **survey approach** is a group of research methods commonly used to determine the present status of a given phenomenon (Connaway and Powell, 2010). The basic assumption of most survey research is that, by carefully following certain

scientific procedures, one can make inferences about a large group of elements by studying a relatively small number selected from the larger group (Forza, 2002). Therefore, surveys operate on the basis of statistical sampling, and the information gathered from a sample of individuals is used to describe the characteristics of a defined population (Thomas, 1996). The survey approach is used to gather contemporary data, and is suited for studying a large number of cases, including those that are geographically dispersed (Gray, 2009). Also, survey research is generally considered to be more appropriate for studying personal factors and for exploratory analysis of relationships (Yin, 2009). Survey research can be exploratory, analytical and descriptive (Connaway and Powell, 2010). The most crucial part in survey research is sampling (Thomas, 1996; Bryman, 2004; Gray, 2009; Connaway and Powell, 2010; Robson, 2011). The mode of data collection and validity of the data are also critical for the completion of survey research (Birley and Moreland, 1998; Bryman, 2004).

The **case study approach** encourages in-depth investigation of particular instances within a research subject (Flyvbjerj, 2006; Fellows and Liu, 2008). This approach concentrates on the examination of a single instance or event (Birely and Moreland, 1998). Instead of using large samples, case studies focus on observing an individual case (or a small number of multiple cases) to analyse the variables relevant to the subject under study. The case study approach is of greatest relevance when the focus of a study is on extensively exploring and understanding rather than confirming and quantifying (Kumar, 2011). When doing case studies, the researcher has the ability to access a range and a depth of information using multiple sources of data or multiple means of data collection, such as documentation, archival records, interviews, direct observations, participant-observations, and physical artifacts (Yin, 2009). However, the use of multiple sources of data and multiple methods of data gathering make the whole process very time-consuming. In case studies, it is critical for the researcher to decide what should be included and excluded when selecting the information and data (Cameron and Price, 2009).

Experimental research makes observations or obtains measures using instruments at a pre- or post-test stage of the procedures (Creswell, 2003). In experimental research the researcher manipulates at least one independent variable, controls other relevant variables, and observes the effect on one or more dependent variables (Connaway and Powell, 2010). Experimental research is considered to be good for testing causal relationships and suited to bounded problems or issues in which

the variables involved are known, or hypothesised with some confidence (Fellows and Liu, 2008). In experimental research, the independent variable can be observed, introduced, controlled and manipulated by the researcher (Kumar, 2011). This approach aims to produce results that are objective, valid and capable of replication by other researchers or by the initial researcher (Gray, 2009). The required resources are limited, but the time consumed is not predicable (Saunders et al., 2007).

Grounded theory is a systematic approach for gathering, synthesising, analysing and conceptualising qualitative data to construct theory (Chiara, 2011). This approach aims to formulate hypotheses based on conceptual ideas and to discover the participants' main concern and how they continually try to resolve it (Saunders et al., 2007). The grounded theory approach develops models, hypotheses, and theory directly and primarily from the data without reference to pre-existing concepts or theories (Connaway and Powell, 2010). Grounded theory research values the process of continuously developing, refining, and enhancing theory in recognition of the contributions that other studies, perspectives, and minds can make to the original effort (Mann and Stewart, 2000). The explanations of these theories are "grounded" in the "details, evidence, and examples" of the data (Melon, 1986). Originated by Glaser and Strauss (Glaser and Strauss, 1967; Strauss, 1987; Glaser, 1992), grounded theory is currently viewed as both a strategy of developing theory and a category of theory, namely that which develops from this strategy (Covey, 2002). Coding and categories are used in grounded theory research, and the theoretical categories are critical for theory development (Strauss and Corbin, 1994). The required resources are limited, but the researcher has the control to the time consumed (Saunders et al., 2007).

Table 3.2 summarises the points discussed in the previous paragraphs and highlights the main elements of each research strategy.

Table 3.2: Main Elements of Different Research Strategies (Adapted from Saunders et al., 2007; Yin, 2009)

Name of Strategy	**Main Concerns**	**Required Time and Resources**	**Research Questions Applicable**
Action Research	• A specific context and with a clear purpose	Requiring the involvement of the researcher, and the researcher needs to be devoted to all the actions throughout the process	How

Ethnographic Research	• Research process needs to be flexible and responsive to change	Requiring limited resources, the researcher has control of the time consumed	What, how, why
Survey	• Sampling • Mode of data collection • Validity	Requiring limited resources, the researcher has control of the time consumed	Who, what, where, how many, how much
Case Study	• Case selection • Reliability	In-depth investigation of research, requiring multiple kinds of resources, and it is time-consuming	How, why
Experimental Research	• Sampling • Validity	Requiring limited resources, the time consumed is not predicable	How, why
Grounded Theory	• Category and coding • Theoretical sampling	Requiring limited resources, the researcher has control of the time consumed	How, why

3.2.5 Review of Research Methods

Kumar (2011) summarised the basic research methods currently available as: observations, questionnaires and interviews. The next a few sections will describe each of them in brief.

3.2.5.1 Observation

Observation is a purposeful, systematic and selective way of watching and listening to an interaction or phenomenon as it takes place (Kumar, 2011). Observation is useful in the study of social behaviour. Participants sometimes are observed for a predetermined period of time using a common set of rules. These rules are referred as observation schedules.

Based on the use of an observation schedule, Bryman (2004) classified observation as either structured or unstructured. Structured observation is a technique in which the researcher employs explicitly formulated rules for the observation and recording of behaviour. In contrast to this, unstructured observation records the

behaviour as long as possible to develop a narrative account of that behaviour, and does not entail the use of an observation schedule for the recording of behaviour.

The choice of a particular observation method is dependent upon the purpose of the observation, the complexity of the interaction and the type of population being observed (Kumar, 2011). Structured observation is an alternative to interviewing or a questionnaire, and tends to be employed in certain specific research environments, such as the behaviour of teachers and pupils and interaction between them (Bryman, 2004). Unstructured observation is more common in research of general human behaviour.

3.2.5.2 Interviewing

"An interview is a verbal interchange, often face to face, though the telephone or other instrument may be used, in which an interviewer tries to elicit information, beliefs or opinions from another person" (Burns, 1997). Interviewing is a widely employed method of data collection. Interviewing allows a researcher to investigate and prompt information that cannot be directly observed, such as thoughts, values, prejudices, perceptions, views, feelings and perspectives (Wellington, 2000).

Interviews are classified into different categories according to the degree of flexibility and specificity. Categories include unstructured interviews, semi-structured interviews and structured interviews. In an unstructured interview, the interviewer typically only has a list of topics or issues (called an interview guide), and furthermore, the style of questioning is usually informal, and the phrasing and sequencing of questions vary from interview to interview. In other words, the interview structure, contents and questions are all flexible. Semi-structured interviews cover a wide range of instances, and typically refer to a context in which the interviewer has a series of questions that are in general form of an interview schedule but is able to very the sequence of questions or has some latitude to ask further questions in response to what are seen as significant relies (Bryman, 2004). In a structured interview, the interviewer asks a predetermined set of questions, using the same wording and order of questions as specified in the interview schedule (a written question list prepared for use by an interviewer in a person-to-person interaction).

The choice of interviewing style is associated with the researcher's main concern and the focus of the research objective. Unstructured interviews offer flexibility in structure, contents and questions, but require a high level of interviewer expertise and an in-depth understanding of the research objectives (Parsons, 1984). Structured

interviews maximise the reliability and validity of measurement of key concepts, but are little more than a face-to-face questionnaire (Bryman, 2004). The semi-structured interview is more valuable because it avoids the inflexibility of structured interview and overcomes the problems inherent in the unstructured interview (Wellington, 2000).

Table 3.3 compares the three styles of interviewing.

Table 3.3 Styles of Interviews (Adapted from Wellington, 2000)

Unstructured Interview	**Semi-structured Interview**	**Structured Interview**
Some control on both	More control by interviewer	More control by interviewer
Very flexible	Flexible	Less flexible
Guided by the interviewee	Not completely pre-determined	Guided by interviewer's pre-determined agenda
Direction unpredictable		More predictable
May be difficult to analysis		May provide easier framework for analysis

3.2.5.3 Questionnaire

A questionnaire is a written list of questions, the answers to which are recorded by respondents (Kumar, 2011). A questionnaire works best with standardised questions that are interpreted the same way by all respondents (Robson, 2011). Questionnaires can be classified as self-administered or interview-administered. Internet mediated questionnaires, postal questionnaires, and delivery and collection questionnaires are all self-administered and usually completed by the respondents. Interview-administered questionnaires are completed or recorded by the interviewers based on the respondents' answer. Examples include interview by telephone and face-to-face interview. Figure 3.2 shows the different types of questionnaires.

Each type of the questionnaire has its advantage and disadvantages. For example, the benefits of Internet mediated questionnaires are low cost, high speed, high confidence to reach the right target respondent, automated data for future analysis and a potentially large sample size, but the response rate is typically lower than the other types of questionnaires (Witmer et al., 1999: Dillman, 2000; Hewson et al., 2003; Saunders et al., 2007). Face-to-face interview questionnaires afford interviewers the opportunity to solicit clarification, or use follow-up or branched questions, and tend to result in high rates of response, however, the data collection process usually requires travel, clerical support and large amount of time (Forza, 2002).

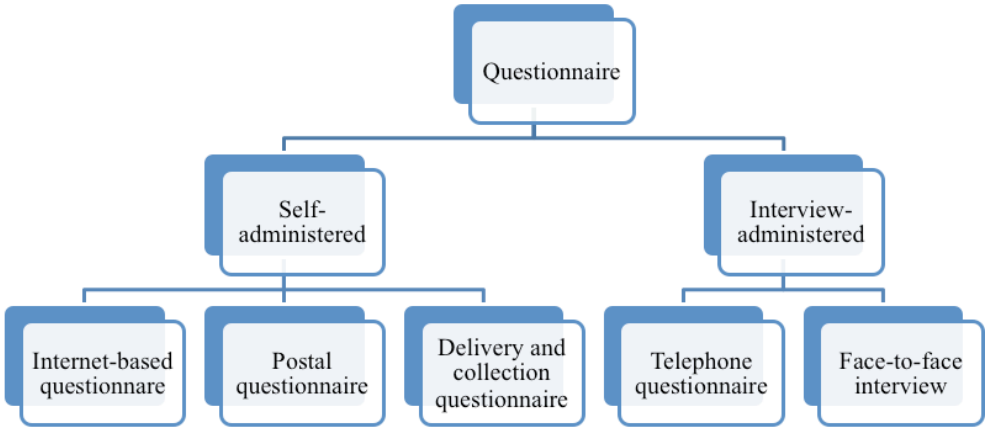


Figure 3.2 Types of Questionnaires (Source: Saunders et al., 2007)

Decisions about which type of questionnaire is best are based on the needs of the specific survey as well as time, cost and human resource constraints. According to Saunders et al. (2007), the factors that should be considered in choosing the appropriate type of questionnaire include: 1) characteristics of the respondents; 2) importance of reaching a particular person as respondent; 3) importance of respondents' answers not being contaminated or distorted; 4) size of sample required for the analysis, taking into account the likely response rate; 5) type of question that must to be asked in order to collect the required data; and 6) the number of required questions.

3.2.5.4 Mono-method, Multiple-methods and Mixed-methods

The choices of research methods in a research study include mono-method, multiple-methods, and mixed-methods. Mono-method refers to using a single data collection technique and corresponding analysis procedure. Multiple-methods refer to using more than one data collection technique with associated analysis technique, but all the adopted methods are restricted within either the quantitative or qualitative category. Mixed-methods refer to using both quantitative and qualitative data collection techniques and data analysis procedures in a research design (Saunders et al., 2007).

In the mono-method design, only one analytic interest is pursued, while in the multiple-method or mixed-method design, two or more analytic interests are investigated. Multi-method designs are generally intended to supplement one information source with another, or 'triangulate' on an issue by using different data

sources to approach a research problem from different points of view (PREST, 2004). In other words, multiple-methods can add insight and meaning that might be missing in a singular method (mono-method) design, and uses the strengths of one research method to overcome weaknesses of another. However, the mixed-method designs are conceptually more complex. Mixed-method designs may provide a basis for triangulation but, more often, become the source of different ways of conceptualising the problem, such as different instrument design for data collection (qualitatively and quantitatively), and various methods of data analysis and inference (statistically and qualitatively) (Tashakkori and Teddlie, 2003; Creswell, 2009). Therefore, besides the strengths of complementarity and triangulation, the mixed-method designs have other advantages, such as providing both narrative and numeric data, interpreting a broader and more complete range of questions, increasing generalisability of results, and producing more complete knowledge to inform practice (Traynor, 2004). The weaknesses of mixed-methods are mainly in relation to the complexity of data collection and analysis (Saunders et al., 2007).

3.3 Methodological Considerations and Research Design of the Current Study

3.2 Review of Research Philosophies/Approaches/Strategies/Methods	3.3 Methodological Considerations and Research Design of the Current Study	3.4 Research Methods Applied in the Current Study
3.5 Summary		

3.3.1 Adopting Research Process ‘Onion’ Concept to the Current Study

As discussed in Section 3.2.1, the main concept of the research ‘onion’ is to consider the methodology and research design from top down, beginning from the outside layers (identifying the research philosophy) and thereafter peeling away every layer until the last inside layer is reached (defining data collection methods). In the current research, this process was also adopted to define the methodological approach (e.g. philosophical concerns, approach considerations, and strategy considerations). Figure 3.3 presents how the concept of the research process ‘onion’ was adapted to the current research context. The next few sections describe it in detail.

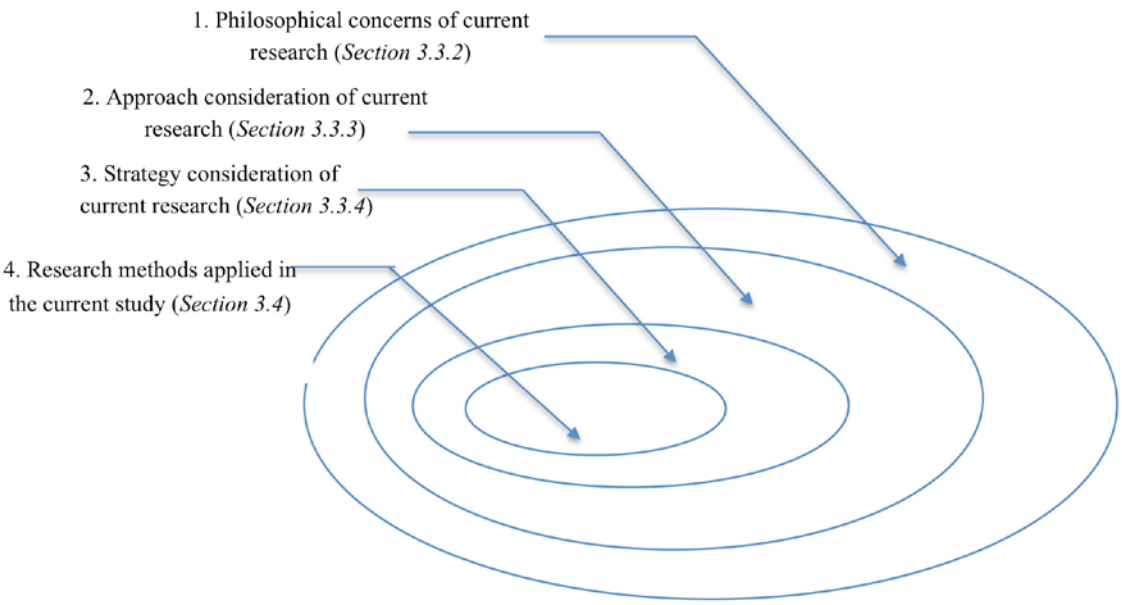


Figure 3.3 Methodological Consideration Based on the Research Process 'Onion'

3.3.2 Philosophical Concerns of Current Research

3.3.2.1 Ontological Consideration

As discussed in Section 3.2.2, ontology is concerned with the assumptions in conceptual reality and the question of existence apart from specific objects and events (Fellows and Liu, 2008). Ontology deals with questions such as "what is the nature of being" (Saunders et al., 2007). Looking at e-business from an ontological perspective means that the question to consider is "what is the nature of e-business?" As discussed in Section 2.2.1 of Chapter Two, the meaning of e-business varies from person to person. Researchers have defined e-business differently according to their research aims and objectives, and in turn, the different perspectives of investigating e-business have yielded substantially different research findings (Colecchia, 1999; Atrostic, et al., 2000; Atrostic, et al., 2001; OCED, 2004). The current study considers the meaning of e-business as not static, but as evolving with time in response to newly emerged technologies, new business models and new communication approaches (European Commission, 2006; Chaffey, 2009). Moreover, the current study assumes that e-business can be defined from different perspectives, such as the business activities perspective, technology perspective and process perspective. Therefore, the nature of e-business is changing constantly due to social factors involved (e.g. business activity, technologies and process) and the interaction between e-business and those factors. This belief is consistent with the philosophy of constructionism. So the ontological position

of the current research is constructionism. In fact, the current study is attempting to discover how e-business interacts with different factors and how the implementation of e-business can be improved through managing and changing those factors. For example, one goals of the literature review is to determine how e-business could affect the internal business activities and processes of organisations and created added value, and at the same time, to explore how to improve the implementation of e-business continuously through changing and managing business activities and processes.

3.3.2.2 Epistemological Position

As discussed in Section 3.2.2, epistemology concerns what constitutes acceptable knowledge in a field of study (Saunders, et al., 2007). The epistemological position of research refers to the relationship between researchers and their research. In the other words, the epistemological position clarifies the researchers' philosophical assumptions about how they will learn and what they will learn during their inquiry (Crewell, 2003). The epistemology deals with questions such as "how knowledge is acquired" (Crewell, 2009). To determine the epistemological position of the current research means that the question to deal with is "how knowledge of e-business described in the current research is acquired?"

The nature of e-business presents obstacles to academic study because of its recent emergence and the rapid changes within the domain (Clarke, 2000). Those changes mean that the implementation of e-business is highly dependent on actions, situations and consequences. The primary aim of the current research is to develop a framework for implementing e-business. This research aim is proposed based on the problem statement presented in Chapter One. The problem statement has generalised the existing problems with e-business implementation in the construction industry, and assumes that the proposed strategic e-business framework would be an appropriate solution. The completed framework will have to provide a holistic approach to guide organisations in the construction industry to identify current limitations of e-business implementation and determine necessary actions to allow effective utilisation of e-business in the future. In other words, the main purpose of the current research study is to resolve a real-world problem (e.g. providing a holistic approach for e-business implementation because current available approaches were mainly 'reactive' and lacking of long-term vision or strategy).

A comprehensive literature review was conducted to have thorough understanding of the problem proposed in the main research aim (details see Chapter Two). Four research questions have been derived on the basis of literature review. The four research questions are: 1) What is the current level of penetration of e-business in the industry; 2) How do industry members measure their level of e-business implementation; 3) What is the (current) understanding of industry members about the strategic issues associated with implementation of e-business; and 4) What do industry members think are the key elements that must be considered as part of an e-business strategy development process? These four research questions interpret the research aim broadly and completely. Thus, all these research questions must be investigated in depth and with generalisability in order to produce complete knowledge to inform practice – developing the strategic e-business framework.

To establish the level of penetration of e-business in the construction industry (Research Question One), various types of 'facts' (i.e. level of document computerisation, network usage, and e-business-enabled activities usage) were investigated, collected and analysed. The 'facts' were observed and generalised objectively like studying objects or entities in physics or natural science. To determine the measures used for evaluating e-business implementation (Research Question Two), more 'facts' (i.e. tools for evaluating e-business benefits, and tools for evaluating the effectiveness of different e-business applications) were also studied, collected and analysed.

Moreover, to determine the understanding of industry members about the strategic issues associated with implementation of e-business (Research Question Three), an investigation was conducted to examine their beliefs to improvements of e-business practices. For example, investigation was carried out on how change of internal resources related to improvement of e-business practices.

Furthermore, to identify the opinions of industry members on the key elements of a strategic e-business framework (Research Question Four), the researcher investigated the industry organisations' daily practices in e-business and tried to interpret their awareness, attitude, understanding and opinions on the subjects. To capture the industry practitioners' opinions precisely, the researcher interacted with the informants during the data collection processes.

Therefore, it is not realistic just to choose between one epistemological position and the other for the current research. This situation is consistent with the philosophy of

pragmatism. Therefore, the epistemological position in the current research is pragmatist.

In fact, the current research is attempting to employ both exploratory and explanatory studies to investigate the research questions, observe the industry organisations' strategic practices in e-business with depth and width, analyse the collected data either quantitatively or qualitatively. Moreover, the solution of the real-world problem (the Strategic e-Business Framework) was developed based on the results from literature review, an industry survey and four case studies. Furthermore, the Strategic e-Business Framework was evaluated based on the reviews of industry practitioners. The comments and suggestions of industry practitioners helped with the improvement of the Strategic e-Business Framework as well as the recommendations of future research work. The epistemological position (pragmatism) enabled the researcher to have a freedom to choose the methods, techniques, and procedures of research that best met research needs and purposes.

3.3.3 Approach Consideration of Current Research

Research methods focus on the techniques that are available and those that are actually employed for data collection and analysis in a research project (Fellows and Liu, 2008). As discussed in Section 3.3.2.2, the current research employed approaches that demanded a quantitative answer (i.e. with number and facts). For example, the approaches used to investigate Research Question One (What is the current level of penetration of e-business in the industry?) and Research Question Two (How do industry members measure their level of e-business implementation?). Additionally, the current research also employed approaches that were mainly concerned with the beliefs, understandings, opinions and views of people. For example, the approaches used to investigate Research Question Three (What is the (current) understanding of industry members about the strategic issues associated with implementation of e-business?) and Research Question Four (What do industry members think are the key elements that must be considered as part of an e-business strategy development process?). Triangulated approaches were applied to the current study to acquire the richness of knowledge of e-business. A qualitative approach was applied to review the main issues that the construction industry faced in implementing e-business. Quantitative data collection methods and statistical analysis were used to establish the level of e-business development stage of industry organisations. Qualitative data collection methods and

documents analysis were employed to identify gaps and essential improvements for e-business implementation if industry organisations wished to use e-business as the mainstream of their daily business operations. Both qualitative and quantitative approaches were used to develop and evaluate the Strategic e-Business Framework.

3.3.4 Strategy Consideration of Current Research

In this research, in order to achieve the primary research aim (i.e. to develop a framework for implementing e-business), the researcher must explore the issues influencing e-business implementation in the industry and understands the context within which they occur, so that any strategies that are developed would take into account this context. One way of achieving this is by accessing the 'thinking' of various members of the construction sector as a way of understanding the strategic context of e-business in their organisations. For this purpose, the line of inquiry should include "what, how, why, and when", in order to develop a broad contextual understanding of issues surrounding e-business implementation in the industry as a whole. Furthermore, to strengthen this knowledge and develop a deeper understanding of specific business issues, it is equally important to investigate the actual practices in e-business implementation within a select few organisations. Here, the questions for investigation include "how and why". No single strategy will meet the requirements for both the breadth (the thinking of practitioners within the industry) and depth (actual practices within selected organisations) of the research. Two or more strategies must be applied to execute the research. Therefore, a multi-methodology research strategy is chosen for this research. The use of a survey is chosen to access the thoughts of industry sector members about implementing e-business strategically, and a case study approach is employed to investigate the actual practices of sector members in e-business implementation.

3.3.5 Research Design

Research design is the general plan that describes a researcher's attempt to answer research questions (Saunders et al., 2007). In the current study, a multi-methodological research strategy is applied to take account the industry context and investigate the implementation of e-business in the construction industry both in breadth and depth. A pragmatic mixed-methods design, combining both quantitative and qualitative

approaches for data collection and analysis, has been justified as the most suitable approach for the current research.

The research design is comprised of four stages and six objectives (see Figure 3.4).

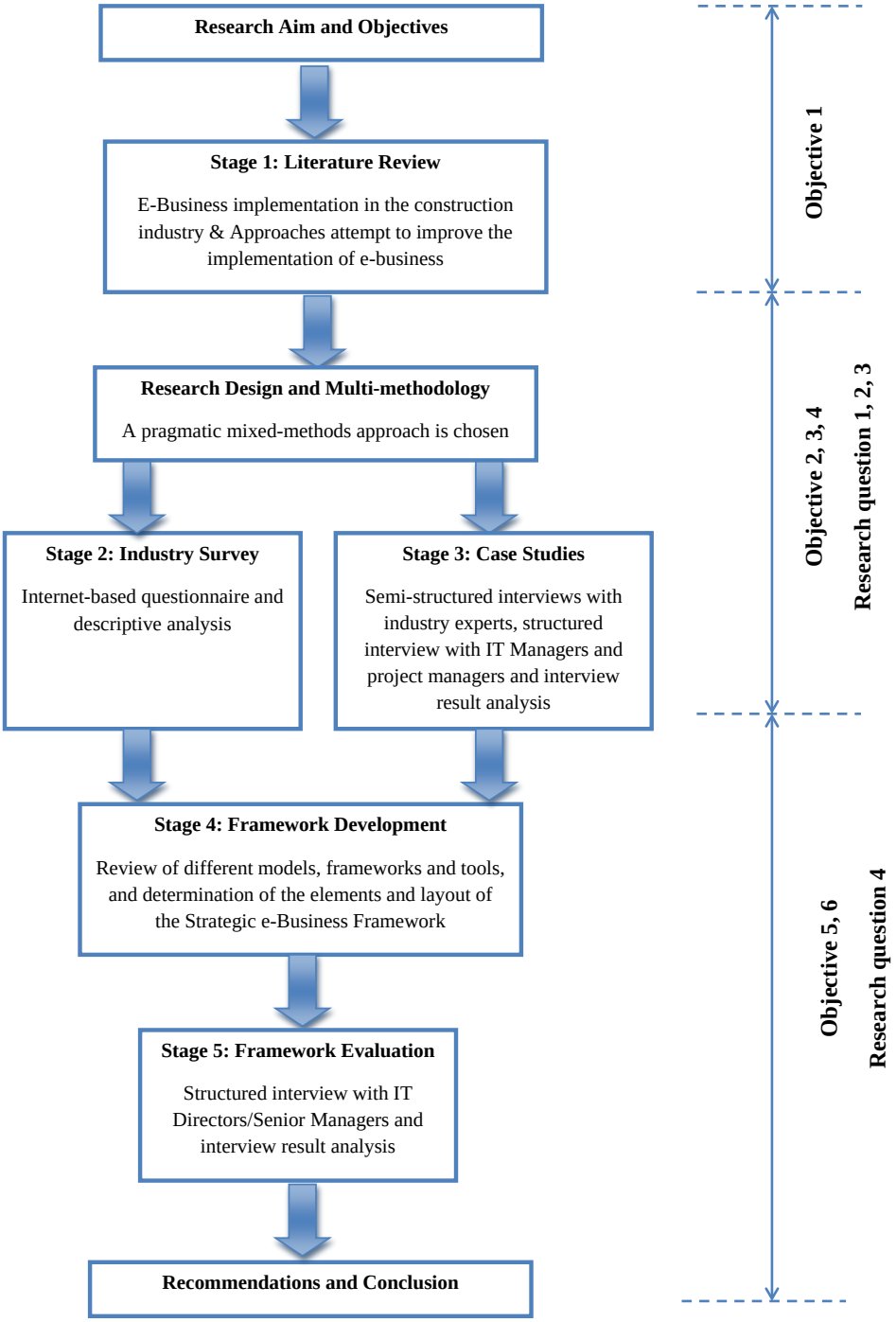


Figure 3.4 Overview of the Research Design

Stage 1 is the literature review of e-business and its implementation in the construction industry. It has laid a solid theoretical basis for determining the research questions and has also provided a theoretical underpinning for the applied research approach and methodology. The findings of this stage are presented in Chapter Two. Objective 1 (review the main issues that the construction industry faces in implementing e-business) is completed in this stage.

Stage 2 is the exploratory study involving practitioners from different construction disciplines. This stage is intended to establish the level of penetration of e-business in the construction industry, and assess the level of the understanding of industry members about implementing e-business strategically. The findings of this stage are presented in Chapter Four. Objective Two (establish the level of penetration of e-business in the sector) and Objective Three (assess how much understanding industry members have about implementing e-business strategically) are accomplished in this stage. Research Question One (What is the currently level of penetration of e-business in the industry?) and Research Question Three (What is the (current) understanding of industry members about the strategic issues associated with implementation of e-business?) are answered.

Stage 3 is the in-depth examination of e-business practices with specific industry practitioners. This stage is intended to investigate the actual e-business practices of the targeted organisation in terms of strategy, implementation and units of measurement. The findings of this stage are discussed in Chapter Five. Objective Four (explore the units of measurement that the sector members use for evaluating e-business implementation and strategies) is completed in this stage. Research Question Two (How do industry members measure their levelof e-business implementation?) is answered.

Stage 4 is the development of a Strategic e-Business Framework based on the results generalised from Stage One and Stage Two. This stage is intended to summarise the elements of a strategic e-business framework, and develop a holistic approach (the Strategic e-Business Framework) for organisations in the construction industry to plan, execute and review their e-business strategies. The findings of this stage are discussed in Chapter Six. Objective Five (determine the required elements of a Strategic e-Business Framework) and Objective Six (Develop a Strategic e-Business Framework for organisations in the sector) are achieved in this stage. Research Question Four (What do industry members think are the key elements that must be considered as part of an e-business strategy development process?) is answered.

Stage 5 is to evaluate the effectiveness of the Strategic e-Business Framework with the selected industry practitioners. This stage is intended to summarise the benefits and limitations of the Strategic e-Business Framework for future development. These contribute to the recommendations and conclusions of the current research. The findings of Stage Four are discussed in Chapter Seven.

3.4 Research Methods Applied in the Current Study

3.2 Review of Research Philosophies/Approaches/Strategies/Methods	3.3 Methodological Considerations and Research Design of the Current Study	3.4 Research Methods Applied in the Current Study
3.5 Summary		

3.4.1 Literature Review: Main Issues of e-Business Implementation

The first objective of this research is to review the main issues faced by organisations in the construction industry when implementing e-business. To satisfy Objective One, a comprehensive review of the relevant literature has been done to study the implementation of e-business and the approaches for its improvement. The review of the literature has been accomplished using information drawn from various sources including research and industry publications, the Internet, and information obtained from e-business seminars and conferences. Information obtained from these sources was critically analysed. Four research questions were derived from the literature review. The findings were presented in Chapter Two and a conference paper (Chen et al. 2008, see Appendix 1) was published.

3.4.2 Industry Survey: The Level of Penetration and Strategic Intent of e-Business Implementation

The second objective of this research is to establish the level of penetration of e-business in the construction industry. The third objective of this research is to assess how much understanding industry members have about implementing e-business strategically. To achieve the goals of Objective Two and Objective Three, an industry survey was selected as the appropriate research strategy. The survey was accomplished by going through seven steps (see Figure 3.5). The work carried out for each of these steps was done concurrently and iteratively as deemed necessary. The seven steps for conducting the survey include: 1) clearly identifying the objectives of the industry

survey; 2) defining the study population, sample and potential informants; 3) designing a structured questionnaire; 4) choosing the mode of administration for the questionnaire; 5) conducting a pilot study; 6) administering the questionnaire; and 7) analysing the survey findings and presenting the results.

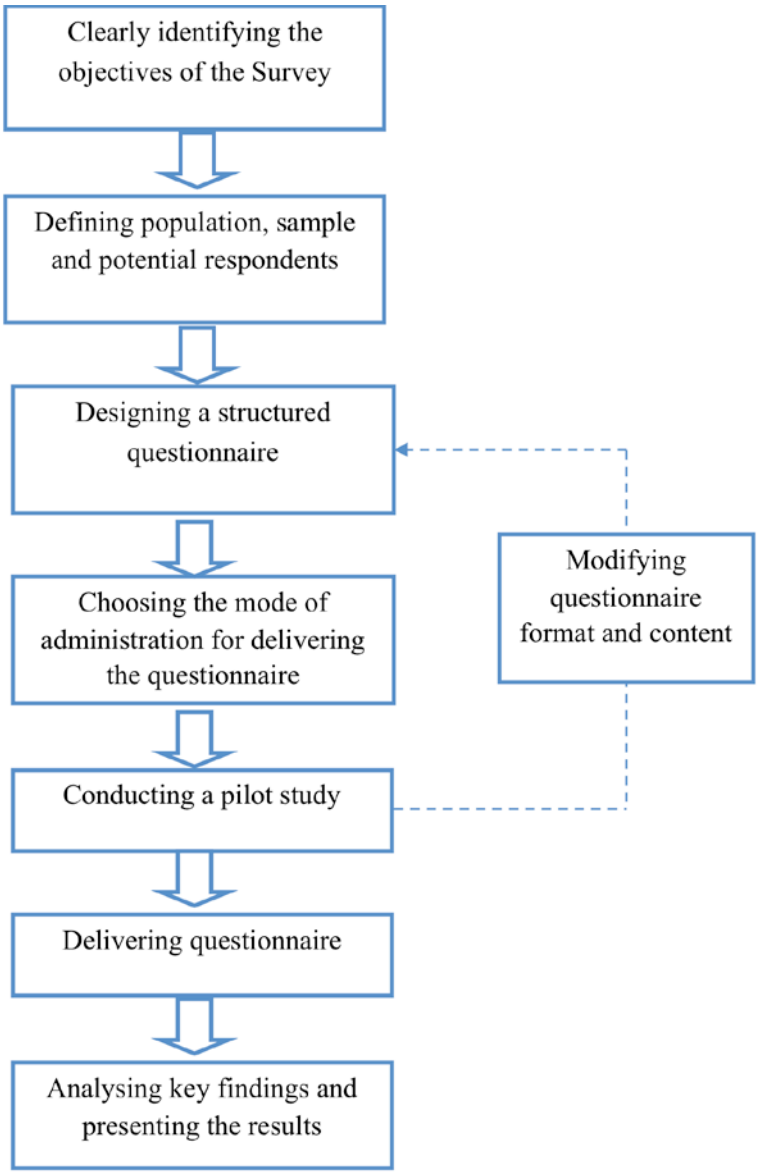


Figure 3.5 Steps Defined for Conducting the Industry Survey

Step One: Identifying the Objectives of the Industry Survey

The research questions derived from Chapter Two were reviewed, and two main areas were identified for investigation, which included: 1) establishing the level of penetration of e-business in the construction industry; and 2) assessing how much understanding industry members have in strategically implementing e-business. In

addition, the issues of how the two investigated areas might interact with each other and what their relationships should be was also reviewed. Seven specific objectives were identified for the survey (see Section 4.2.1 of Chapter Four).

Step Two: Defining the Study Population, Sample and Potential Respondents

The research scope discussed in Chapter One was reviewed to define the right study population. The investigation of e-business implementation in this research mainly concentrates on various construction organisations including consultants, contractors, suppliers and manufacturers. Based on the research scope, the population of the current study should be comprised of organisations in the different UK construction disciplines, which include consultants, contractors, suppliers and manufacturers.

In order to define an appropriate sample and its size, the previous studies on ICT and e-business in the construction industry were reviewed for referencing and benchmarking. General information was obtained about how the previous studies adopted different types of strategies to reach potential respondents was generalised, and this set a solid theoretical base and provided a practical guide for the current study. Generally, three strategies have been applied in several studies to reach out to potential respondents. The first strategy is to select the potential respondents through the national statistics agency, which is well suited for national level investigation and measuring the e-business economy. The second strategy is to select the top construction organisations that have been identified by authorised media or agencies as the potential respondents. This strategy is applicable for assessing the industry practitioners' attitudes and perceptions with respect to e-business. The third strategy is to target members of various construction industry associations. This strategy helps in reaching out to potential respondents from a variety of different construction disciplines.

The industry survey adopted the third strategy to reach out to potential respondents. The members of Construct IT were used as the target population because Construct IT is 'an industry-led non-profit making collaborative membership-based network' in the UK construction industry, and it comprises leading edge organisations representative of the industry supply chain in addition to professional institutes and R&D/academic institutions (Construct IT, 2011). Based on the time available and organisations that were reachable, 250 organisations were randomly selected from the target population, encompassing various construction disciplines including consultants, contractors, suppliers and manufacturers.

Step Three: Designing the Structured Questionnaire

A structured questionnaire was devised on the aim and objectives of the survey. Altogether, the questionnaire included 19 questions covering six sections (see Appendix 3). All the questions were designed as closed questions and some of them had the function for the respondents to leave comments and recommendations.

Section I considered the background information of the survey respondents. The background information was designed for analysing the survey results later, specifically for revealing the distribution of survey responses and identifying the trends or preferences of e-business practices based on different categories (i.e. organisation type, and organisation size). Section II considered the current status of industry members in implementing e- business. Section III determined the role of the IT department within organisations and how organisations provide IT training to their staff. Section IV determined the main issues of e-business implementation among industry practitioners. Section V assessed the understanding of industry practitioners about improvements to e-business practices within their organisations. Section VI considered the future trends of e-business in the construction industry.

Step Four: Choosing the Mode of Administration for the Questionnaire

Different modes for administering questionnaires were reviewed to choose the suitable one for the current study. An Internet-based questionnaire was chosen as the appropriate mode to administer the questionnaire, because all the members of Construct IT were reachable through Internet (Construct IT, 2011). Besides, an Internet-based questionnaire has advantages of low costs, high speeds, wide reach, and a reasonable response rate.

Step Five: Conducting a Pilot Study

A pilot study was conducted in order to finalise the contents and format of the questionnaire. The main investigated areas included: 1) required time for completing the questionnaire, 2) format of questionnaire, 3) wording of questionnaire, and 4) limitations of questionnaire.

Reviews from both industry practitioners and academics were collected for further enhancement of the questionnaire. Managerial staff of leading UK construction organisations conducted the industry reviews of the questionnaire. A total of ten industry practitioners in five construction companies were approached for reviewing the

questionnaire. These companies fall in a range of construction disciplines including contractors, consultants and designers. The industry practitioners were invited to complete the questionnaire and encouraged to give any comments or suggestions for enhancing the questionnaire. Six people completed the questionnaire and sent their comments back.

Researchers and academics of School of Civil and Building Engineering at Loughborough University conducted the academic reviews of the questionnaire. A total of eight researchers/academics were approached for reviewing the questionnaire. The researchers/academics were experts of construction management and knowledgeable in strategy management or ICT adoption. The researchers/academics were also invited to complete the questionnaire and encouraged to include any suggestions for further enhancing the questionnaire (e.g. format, wording and limitations of the questionnaire). Three researchers/academics completed questionnaire and had face-to-face discussion with the researcher about their comments on the questionnaire's format and contents.

Altogether, the pilot study included nine reviews. The recommendations from both the industry practitioners and academics were reviewed and used to modify the questionnaire. The modified areas included: 1) layout of the questionnaire, 2) wording of some questions, and 3) wording of some section titles (details see Appendix 2).

Step Six: Delivering the Questionnaire

The modified questionnaire was sent out via Internet. Email invitations were sent to the managerial staff of the 250 randomly selected Construct IT organisations inviting them to complete the modified questionnaire. The email invitations were marked as important messages to the receipts when sending out. Additionally, the email invitations were tracked to ensure messages were delivered to the recipients successfully and the recipients viewed the messages. Email reminders were sent out after two weeks. After another two weeks, another email reminder was sent. All these email reminders were sent out to reach to the potential respondents when they were convenient to complete the questionnaire and increase the survey responses.

Step Seven: Analysing the Survey Findings and Presenting the Results

Altogether, 49 complete responses were received by the closing date. The collected data (see Appendix 4) were analysed with descriptive statistical analysis using Microsoft Excel. The findings then were quantitatively illustrated in bar charts and pie

charts as appropriate. An industry report was produced for Construct IT based on the results and analysis (published in 2011, see Appendix 5). The details of the industry survey will be introduced in Chapter Four.

3.4.3 Case Studies: Industry Organisations' Strategic Practices in e-Business

The fourth objective of this research is to explore the units of measurement that the sector members used for evaluating e-business. To meet the goals of Objective Four, a case study strategy was applied. Multiple-case studies were accomplished by going through three steps (see Figure 3.6). The three steps for conducting the multiple-case studies include:

- *Defining and designing*: identifying the case study aim, the rationale for choosing the target organisations, and the methods for carrying out the case studies;
- *Preparing and collecting*: preparing for conducting the case studies, conducting the first case study and writing the individual case report, and then carrying on the same process on the next three cases; and
- *Analysing and concluding*: analysing the initial results, drawing cross-case conclusions, and writing cross-case report.

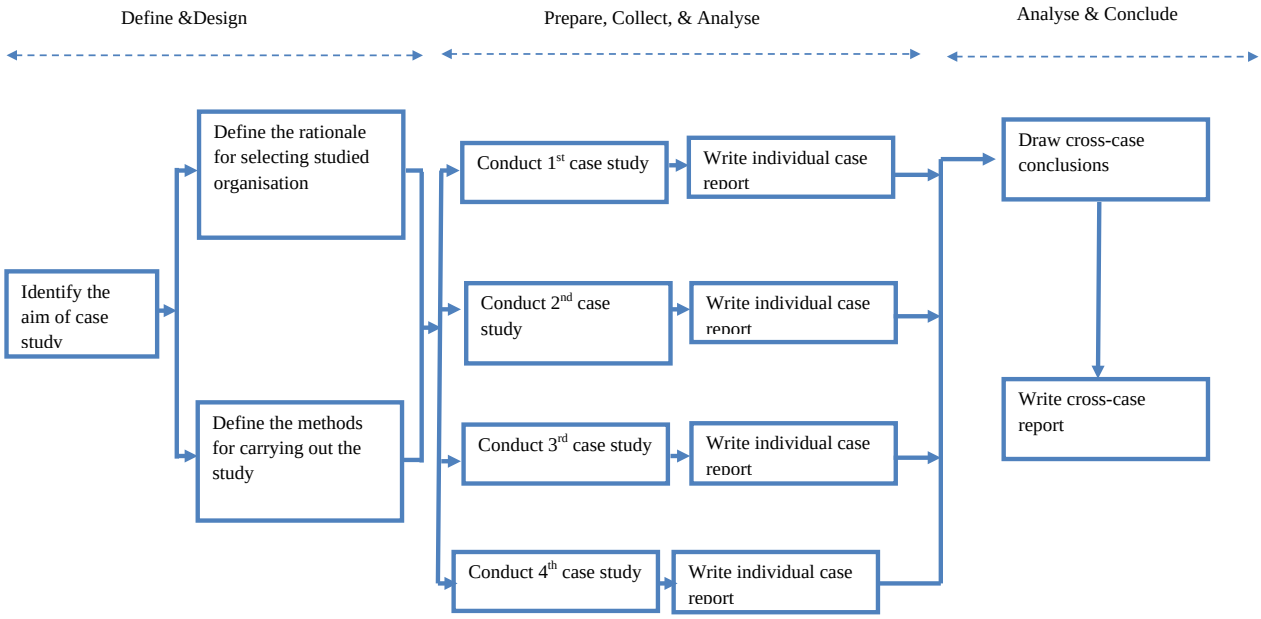


Figure 3.6 Steps Defined for the Multiple-case Studies

Step One: Defining and Designing of the Multiple-case Studies

The main purpose of the case studies was to investigate the actual practices of e-business implementation among the selected construction organisations. Three specific objectives associated with e-business strategy, implementation and units of measurement were established in order to achieve the main purpose of the case studies (see Section 5.2.1 of Chapter Five).

The rationale for selecting the case study organisations was also identified. This was done through a review of a variety of previous case studies in ICT and e-business and semi-structured interviews with industry experts. The previous case studies were reviewed for referencing and benchmarking. In the current research, semi-structured interviews were conducted with three industry experts. Two of them were experienced in strategy, innovation and e-business, and one of them was experienced in ICT consulting and providing e-business services for construction organisations. The list of questions used in the semi-structured interviews can be found in Appendix 6. Altogether, four organisations were selected for the case studies (details see Section 5.2.3 of Chapter Five).

The methods of carrying out the case studies were also defined. The case studies were carried out through investigating two levels of e-business implementation inside the selected organisations: 1) at the organisational level; and 2) at the project level.

At the organisational level, investigation was focused on exploring the strategic mission and vision of e-business implementation in the target organisations. At the project level, investigation was concentrated on exploring the strategic practices of various e-business tools/applications in the target organisations. Both types of investigation were accomplished via two main methods: 1) a review of documents, which were available from various sources (e.g. Webpages, company profile, company documentation, industry news and industry reports); and 2) structured interviews with the IT Directors or Senior IT Managers who were responsible for e-business strategy development, and structured interviews with project managers or other project experts who were familiar with the usage of different e-business tools/applications applied in projects.

Step Two: Preparing and Collecting of the Multiple-case Studies

This step involves preparing questionnaires and contact lists for the multiple-case studies, carrying out the case studies, and producing initial reports for each case. To

carry out the case studies at both the organisational and project levels, two questionnaires were prepared. One questionnaire was for the IT Directors or Senior IT Managers, and the other was for the project managers or other project experts.

Both questionnaires explored what the interviewees' understanding of e-business was. This question was asked in order to clarify the understanding of the different interviewees of the meaning of e-business. Moreover, both questionnaires consisted of five sections contained the three specific investigated areas of e-business: 1) strategy, 2) implementation, and 3) units of measurement.

Despite their similarities, the two questionnaires (see Appendices 7 and 8) each had a different focus. The questionnaire for the IT Directors or Senior IT Managers was focused on determining the e-business development stage of the target organisations and their overall e-business strategies. It was intended to 1) explore how organisations managed risks; 2) identify changes and gaps during e-business implementation in general; and 3) identify the measures and tools they used to measure e-business strategies and e-business implementation. The questionnaire for project managers or other project experts was centred on: 1) examining the usage of different e-business tools and applications in projects; 2) identifying the impact of using those tools and applications in terms of products, processes and people, discovering methods for measuring the efficiency of using those tools/applications; and 3) exploring the particular strategies for projects to implement the tools and applications.

When the questionnaires were ready, the potential informants were contacted to invite them to participate in the interviews. The IT Directors or Senior IT Managers were contacted first by phone. An interview schedule was worked out based on their time and availability. Face-to-face interviews were undertaken with the IT Directors or Senior IT Managers from the four target organisations. At the end of each interview, the IT Directors or Senior IT Managers were asked to recommend the right informants to contact in order to further investigate e-business at the project level. Another nine interviews were conducted by telephone. Documentation was collected during all the thirteen interviews, including copies of IT strategy documents, e-business standards, e-business execution plans, project details, and examples for measuring e-business benefits and efficiency.

All the interview conversations were transcribed. Initial reports were produced to describe the case and its context based on the collected data and documentation. The initial reports mainly concentrated on telling a complete story about how the target

organisations have implemented e-business and how they have engaged in strategic practices in e-business.

Step Three: Analysing and Concluding of the Multiple-case Studies

The four initial case study reports were analysed further with thematic analysis. In thematic analysis the task of the researcher is to identify a limited number of themes which adequately reflect their textual data (Howitt and Cramer, 2007). To reflect the required level of analysis adequately, the texts (transcribed from the interview conversations) and documentation (collected from the interviewees) were read through and attempted to generalise the main themes revealed in the texts and documentation about implementing e-business strategically (an example see Appendix 9). Here, themes were defined as units derived from patterns such as "conversation topics, vocabulary, recurring activities, meanings, feelings, or folk sayings and proverbs" (Taylor and Bogdan, 1989). Themes that emerge from the informants' stories are pieced together to form a comprehensive picture of their collective experience (Aronson, 1994; Guest, et al., 2012). The main themes were used as inputs for the development of the Strategic e-Business Framework in the next stage of the research. The results and findings of the multiple-case study are presented in Chapter Five.

3.4.4 Framework Development and Evaluation: A Holistic Approach for e-Business Implementation

The fifth objective of this research is to determine the elements of the Strategic e-Business Framework. To achieve the goals of Objective Five, information drawn together from Objectives One, Two, Three and Four, was critically analysed to generalise the main themes of an e-business strategy. The sixth objective of this research is to develop a Strategic e-Business Framework as a holistic approach to assist organisations in the construction industry to define, execute and review their e-business strategies. To meet the goals of Objective Six, a Strategic e-Business Framework was developed and evaluated systematically.

3.4.4.1 Generalising the Main Themes and Developing the Framework

As an initial step, an inclusive review of existing literature on the current available approaches (models, frameworks and tools) for e-business strategy and its development was carried out. Moreover, four construction-specific approaches (models, frameworks

or tools) relevant to the current study were also reviewed (details see Section 6.2.4 of Chapter Six).

The analysis of the industry survey and the multiple-case studies were also reviewed to generalise the shared themes. For example, the findings of the industry survey indicated that more involvement of senior management was very important to the improvement of e-business practices. The findings of the case studies indicated that the commitments of senior management were crucial for implementing an e-business strategy successfully within an organisation. The importance of management in e-business implementation and strategy was emphasised by both the survey respondents and the case study respondents. Therefore, management was one shared theme from the industry survey and case studies.

The review of the main themes suggested that six elements and five functional factors were crucial for e-business strategy and its development in organisations of the construction industry. The elements and functional factors collectively formed the basic content and layout of the Strategic e-Business Framework. Therefore, the findings from Objectives One, Two, Three, Four and Five were all used for developing the Strategic e-Business Framework (see Figure 3.7). The details of the Strategic e-Business Framework are presented in Chapter Six.

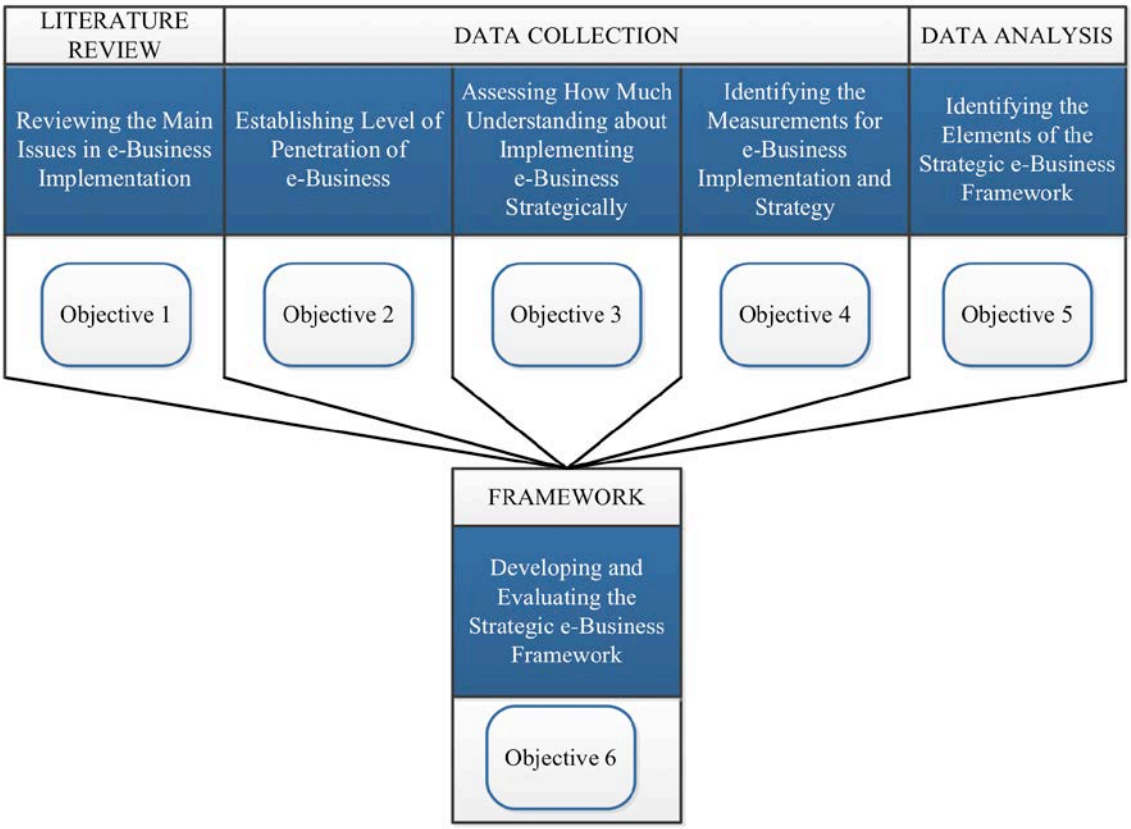


Figure 3.7 Inputs for Developing the Strategic e-Business Framework (Adapted From Ruikar et al., 2004)

3.4.4.2 Evaluating the Framework

The main purpose of the framework evaluation process was to gauge the appropriateness and effectiveness of the Strategic e-Business Framework from the industry perspective. The evaluation involved three steps: 1) preparing a questionnaire for conducting structured interviews; 2) carrying out the evaluation interviews with the industry practitioners; and 3) analysing the interview results and presenting the findings.

Step One: Preparing a Questionnaire for Conducting Evaluation Interviews

A questionnaire was prepared for the structured interviews with industry practitioners. The questionnaire included 32 questions consisting of five sections (see Appendix 10). Each section contained open-ended statements with a likert-scale of 1-5 on key criteria. Additionally, two open-ended questions were included at the end of the questionnaire to allow evaluators to make general comments and suggestions about the Strategic e-Business Framework.

Step Two: Carrying out the Evaluation Interviews with the Industry Practitioners

The evaluation was carried out based on structured interviews with the IT Directors or Senior IT Managers from the selected organisations. The interviews were conducted face-to-face or by phone, depending on the availability of the interviewees and location of the interviewees. The interviewees were invited to complete the evaluation questionnaire and explain their answers as necessary. Altogether, six evaluations were completed. Four evaluations were undertaken by the industry practitioners who took part in the multiple-case studies in Chapter Five, which aided in the development of the Framework. Industry practitioners who were new to the study carried out another two evaluations, which offered different perspectives and tested the applicability of the Framework in a wider scope.

Step Three: Analysing the Interview Results and Presenting the Findings

The evaluation results were illustrated quantitatively in tables and bar charts as appropriate. The comments and suggestions were reviewed carefully for further enhancing the Strategic e-Business Framework. The evaluation findings and results are presented in Chapter Seven.

3.5 Summary

3.2 Review of Research Philosophies/Approaches/Strategies/Methods	3.3 Methodological Considerations and Research Design of the Current Study	3.4 Research Methods Applied in the Current Study
3.5 Summary		

This chapter outlines the methodological considerations and research design of the current thesis research. The research ‘onion’ process was applied to guide the review of research philosophies, approaches, strategies and methods. The review set a solid theoretical foundation for the methodological considerations and research design. Research philosophical considerations of the current research were justified in order to guide the thought of logic flow, the selection of research approaches, strategies and data collection methods, and the overall research design. Constructionism was justified as the ontological position and pragmatism as the epistemological position of the current research. A multi-methodology research approach was identified as the most appropriated for the current thesis research, combining both a survey strategy and a case study strategy. The survey strategy was chosen to address the width of the investigation,

and the case study strategy was identified to deal with the depth of the investigation. Mixed-methods were adopted for the data collection and analysis in the actual research conduction. Altogether, the research comprised four stages and six objectives. As addressed in the end of Chapter Two, Objective One was completed through a comprehensive literature review. Objectives Two, Three, Four, Five and Six were accomplished through a four-stage research design. The next chapter will present the findings and analysis of the industry survey and will describe how Objective Two and Objective Three were achieved through the survey strategy.

CHAPTER FOUR INDUSTRY SURVEY

4.1 Introduction

This chapter introduces the industry survey conducted with members of the construction industry. The chapter first outlines the survey background, which includes the aim and objectives, the design and structure of the survey questionnaire, the strategy for reaching out to the respondents, and the scope of the survey. The main part of the chapter presents the findings and analysis of the survey. The findings and analysis are displayed based on six sections; these include 1) background information of the survey respondents; 2) e-business within the organisation; 3) IT investment advice and e-skill development; 4) drivers, impact and barriers; 5) improvement of e-business; and 6) future of e-business in the organisation. Finally, the chapter concludes with a summary of the entire contents.

4.2 Background of the Survey	4.3 Key Findings and Analysis of the Survey
4.4 Summary	

4.2 Background of the Industry Survey

4.2 Background of the Survey	4.3 Key Findings and Analysis of the Survey
4.4 Summary	

4.2.1 Aim and Objectives of the Survey

The aim of the industry survey was to establish the level of penetration of e-business in the construction industry, and to assess how much understanding industry members have in implementing e-business strategically. Seven specific objectives were defined to achieve the main purpose. The objectives were as follows:

- Determining the e-business activities and usage in the sector;
- Exploring how e-business has affected the sector in terms of product, process and organisational culture;

- Identifying the driving forces that encourage the industry practitioners to adopt various e-business initiatives;
- Identifying the main barriers for today's adopters to implement e-solutions;
- Determining how construction organisations become aware of the competitive advantage of e-business;
- Determining how construction organisations become aware of the strategic e-business implementation; and
- Predicting the future trends of e-business among construction organisations.

4.2.2 Design and Structure of the Survey Questionnaire

As discussed in Section 3.4.2 (Chapter Three), a questionnaire was designed for data collection. The questionnaire (see Appendix 3) was developed to investigate issues in two main areas: 1) providing a clear picture of the level of penetration of e-business; and 2) exploring how much understanding the industry members have in implementing e-business strategically.

Five steps were undertaken to establish the level of penetration of e-business in the sector: 1) determining the e-business practices were adopted in the industry (what they are doing); 2) investigating the level and degree of the industry practitioners in adopting different e-business applications (how they are doing); 3) identifying the driving forces that enabled the advancement of e-business implementation within the sector (why they are doing); 4) defining the barriers of e-business implementation and its impact on adopted organisations, and exploring the potentials of improvement (how they can improve); and 5) figuring out the future actions and possible trends of e-business in the sector (what they will do in the future).

The strategic analysis of the industry business practice can help to determine the strategic policy of e-business (Johnson et al., 2008; Chaffey, 2009; Jelassi and Enders, 2009). This analysis involved the reviews of: 1) the internal resources and processes of an organisation and its activities in the marketplace; 2) the immediate competitive environment (microenvironment) which an organisation facing; and 3) the wider environment (macro-environment) in which an organisation operates. The analysis of its internal resources and processes can help an organisation to determine its available IT or e-business resources and identify how its current internal processes work (Chaffey,

2009; Jelassi and Enders, 2009). The analysis of its microenvironment and macro-environment can enable an organisation to determine what kind of external environment they compete in, and then decide when and how to respond to environment and the competitors (Smith and Taylor, 2004; McDonald, 2008; Jelassi and Enders, 2009; Chaffey, 2009). The relationship between the establishment of the level of penetration of e-business and the strategic analysis of e-business can be presented as follows (Figure 4.1):

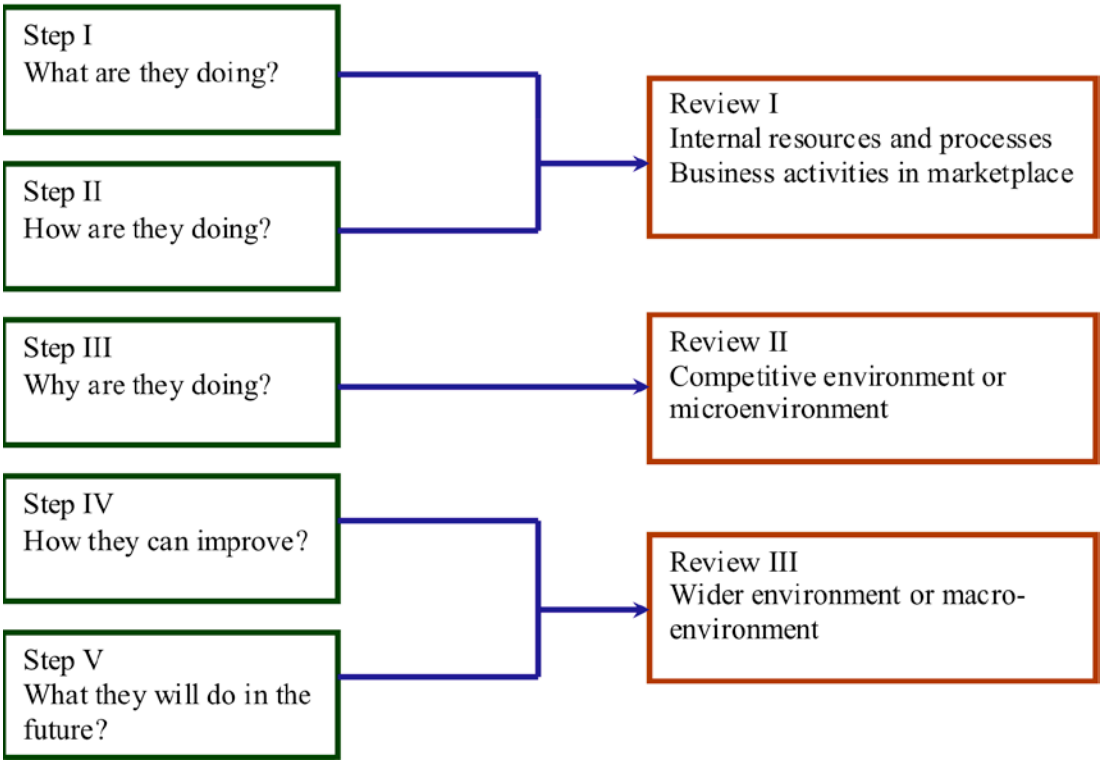


Figure 4.1 The Relationship Between Two Areas (Establishing Level of Penetration and Conducting Strategic Analysis) of Investigation

Based on the two areas of investigation, a questionnaire was completed. Altogether, the questionnaire (see Appendix 3) included 19 questions covering six sections as described below:

1) Background Information
    - Type of Organisation
    - Area of Work
    - Job Title
    - Size of Organisation
2) e-Business in Your Organisation

- e-Business Activities
- Communication Networks
- Level of e-Business Usage

3) IT Investment Advice and e-Skill Development
    - IT Investment Advice
    - IT Expenditure
    - e-Skill Development
4) Drivers, Impact and Barriers of e-Business
    - Drivers
    - Impact
    - Barriers
5) Improvement of e-Business
    - Internal Resources
    - Business Processes
    - Organisational Culture
    - Business Goal
6) Future of e-Business in Your Organisation
    - Future Investment in e-Business
    - Launch of e-Business Policy

4.2.3 The Strategy for Reaching out to Respondents

Section 3.4.2 (Chapter Three) reviewed three strategies that have been applied in previous studies to reach out to potential respondents. The Section also noted that the industry survey, conducted as a part of this research, was carried out in association with Construct IT. The members of the association are leaders in the applications of ICT in innovation and the development of best practice. A total of 250 organisations, encompassing various construction disciplines including consultants, contractors, suppliers and manufacturers, were randomly selected from the list of Construct IT members.

4.2.4 The Scope of the Survey

The modified questionnaire was sent out electronically to 250 randomly selected Construct IT members. Altogether, 49 completed responses were received. The

collected data (see Appendix 4) was analysed with descriptive statistical analysis. The analysis included initial analysis to determine the general trends and further analysis to determine the specific trends based on different categories (organisation type, organisation size and respondents based on job title). However, the further analysis by categories did not show any interesting trends.

4.3 The Key Findings and Analysis of the Survey

4.2 Background of the Survey	4.3 Key Findings and Analysis of the Survey
4.4 Summary	

4.3.1 Background Information of the Survey Respondents

This section considered the background information of the survey respondents. The respondents were asked to identify the type of their organisation, the areas of their work, their job titles, and the size of their organisation. Figure 4.2 shows the distribution of survey respondents based on organisation type. The breakdown of the responses was contractors (48%), consultant (22%), developer (10%), and other (20%). Here contractors include main contractors, M&E contractors and trade contractors. Consultants include designers and engineers.

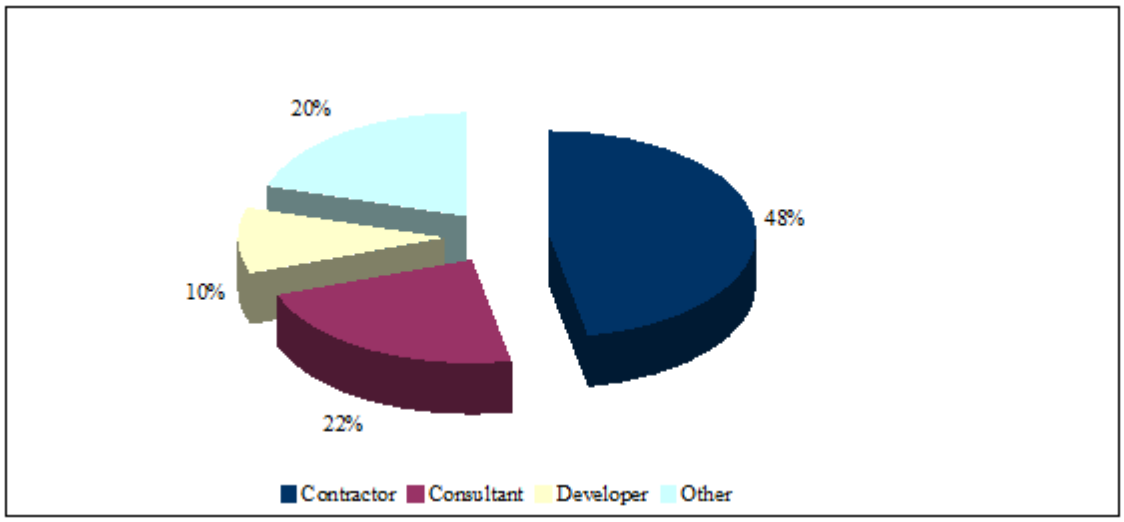


Figure 4.2 The Distribution of Respondents by Organisation Type

The distribution of respondents based on organisation size is shown in Figure 4.3. Forty-eight per cent of the survey respondents were from organisations that had the

annual turnover over £100 million, which was the largest response group based on organisation size.

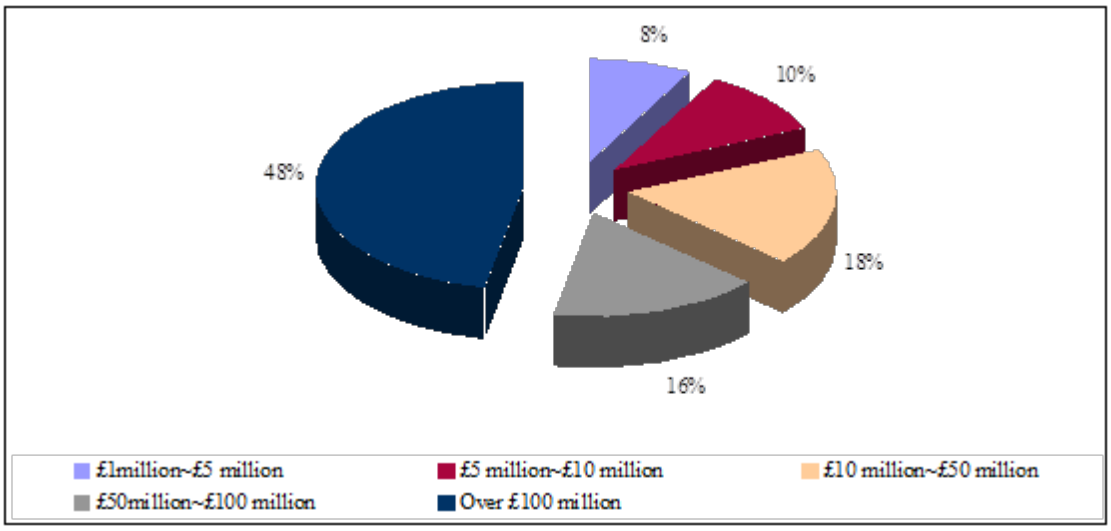


Figure 4.3 The Distribution of Respondents by Organisation Size

The distribution of respondents based on job title is shown in Figure 4.4. The breakdown of responses to their roles within organisations included senior management staff (52%), middle management staff (18%), IT staff (10%), and other (20%). The great number of senior management staff (52%) responding to the survey indicates that senior management is more involved in organisations' e-business strategic practices than the other members of organisations, such as middle management staff and IT staff.

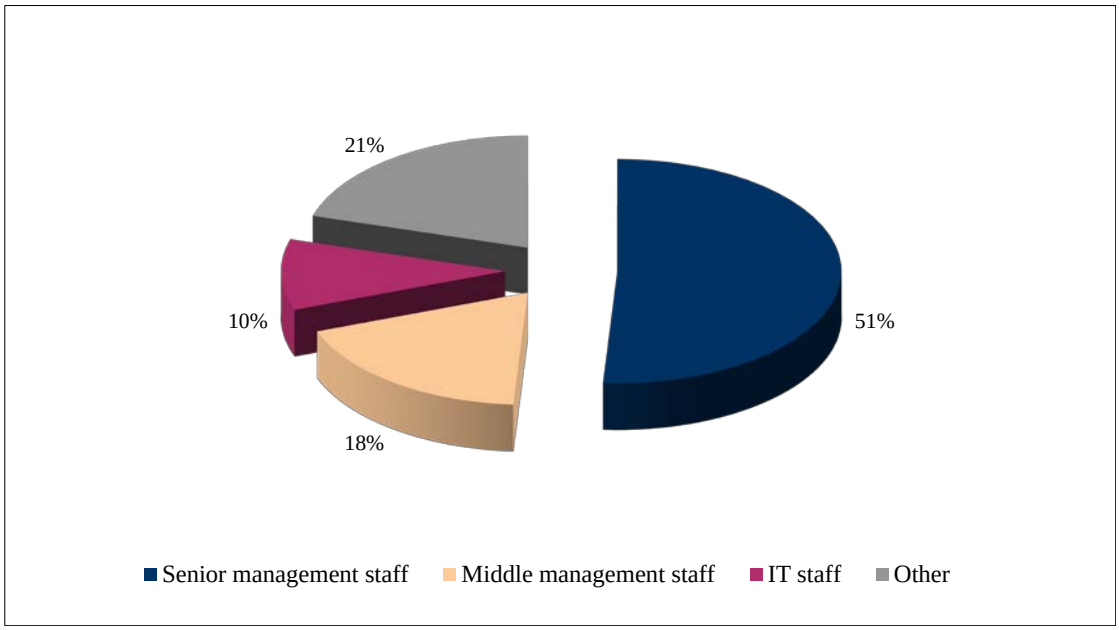


Figure 4.4 The Distribution of Respondents Based on Job Title

4.3.2 e-Business within the Organisation

This section considered the current status of industry members in implementing e-business. The observed areas included 1) e-business activities, 2) communication networks, and 3) level of e-business usage.

4.3.2.1 e-Business Activities

The core of e-business is transaction (Schneider, 2010). Information transaction tools enable organisations to perform computerisation and electronic transfer (Issa et al., 2003). In the construction industry, every project involves the production and exchange of a large number of documents at both inter- and intra- organisational level (Ruikar, et al., 2002). These documents must be computerised and exchanged electronically in order to perform transactions. Previous research indicated that documents such as specifications and design drawings were exchanged electronically, while the exchange of documents such as purchase orders/invoices and estimating documents was seldom done in an electronic format (Ruikar, et al., 2002). The newly emerged e-business solutions (e.g. construction collaboration tools, project ERP systems and e-procurement systems) have the potential to produce and exchange all types of construction documents electronically (Davenport, 2000; Wilkinson, 2005; Schneider, 2010). To determine how e-business has penetrated into the construction industry, an investigation is required on the extent to which its documents have been computerised and transferred.

The survey attempted to identify the documents that were produced and exchanged both inside and outside the construction firms, and tried to establish the degree to which these documents were computerised and exchanged electronically. Different types of documents are produced and transferred as a project progresses. The production and exchange of documents involved in construction industry business transactions include: 1) tendering documents, 2) design drawings and specifications, 3) estimating documents, 4) project programming, 5) administration documents, and 6) purchase invoices/orders. The survey participants were asked to identify the degree to which the above documents were transferred electronically based on their organisations' practices.

The findings of survey indicated that the main industry business documents were frequently computerised or exchanged electronically, but not always. There was still

some room to improve to reach the goal of transferring 100% of these documents electronically (see Figure 4.5).

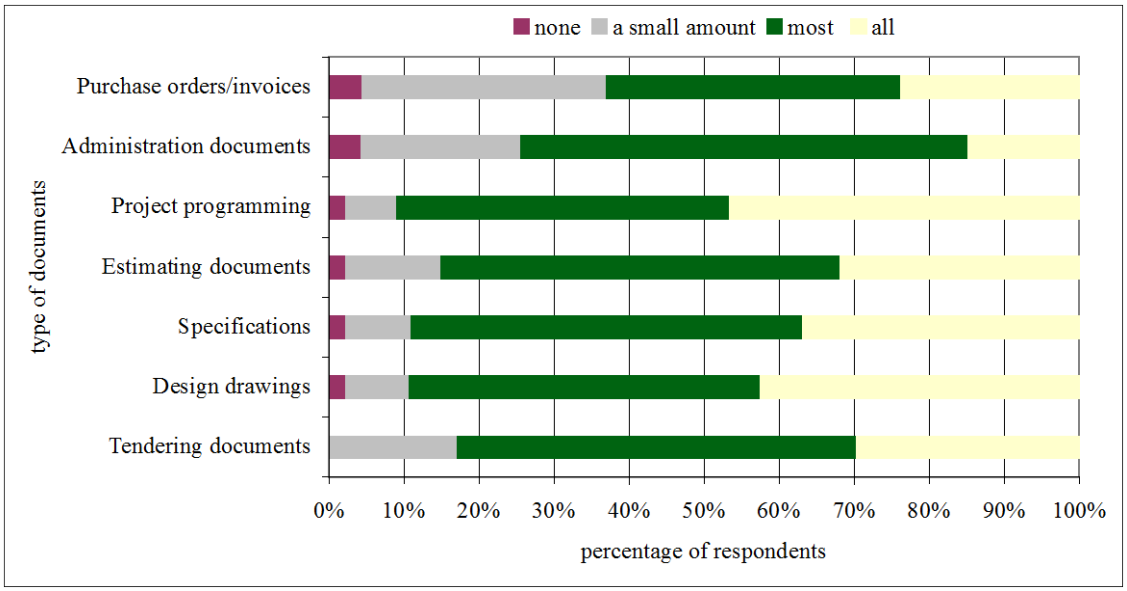


Figure 4.5 Degree to Which the Documents Were Transferred Electronically

The survey respondents stated that project programming documents (91%), specifications (89%), and design drawings (89%) were the most frequently computerised and exchanged construction documents within their organisations. The survey respondents also stated that purchase orders/invoices (63%) and estimating documents (85%) were frequently computerised and electronically exchanged. This indicates that the exchange of the above documents in an electronic format has increased dramatically compared to the results in previous research (e.g. survey done by Ruikar et al., in 2002). However, there were still 37% of the surveyed respondents stated that the electronic exchange of purchase orders/invoices was not common in their organisations. This indicates that industry organisations need work more to improve the level of computerisation of purchase orders/invoices, or there will be a gap in the industry business transactions.

Moreover, the degree to which documents were transferred electronically was associated with the size of organisations. For example, the degree to which documents were transferred electronically within the large organisations was higher than that within the small organisations.

4.3.2.2 Communication Networks

Regarded as large and information-intensive (Morton, 2008), the construction sector values efficient and timely communications all the time. Web-based communication networks were built up in the industry to improve information sharing, enhance communications, reduce processing, and save cost (Wilkinson, 2005). Intranets enable employees to access and share information using Web publishing technology, while extranets enable access to an organisation's Web services to be extended to selected users outside the organisation (Chaffey, 2009). Both intranets and extranets are crucial for supporting e-business activities.

The survey tried to examine two aspects of the usage of Web-based communication networks: 1) the type of communication networks used by industry practitioners; and 2) the degree to which communications were carried out electronically. The survey participants were invited to specify the communication networks used within their organisations, and as well as to identify the degree to which they conducted internal and external communication electronically.

The survey findings showed that having both intranet and extranet was much more common than only one or the other. The majority of the survey respondents (82%) stated that they had both intranets and extranets (see Figure 4.6). This indicates that the industry practitioners have established both intranets and extranets as their communication networks.

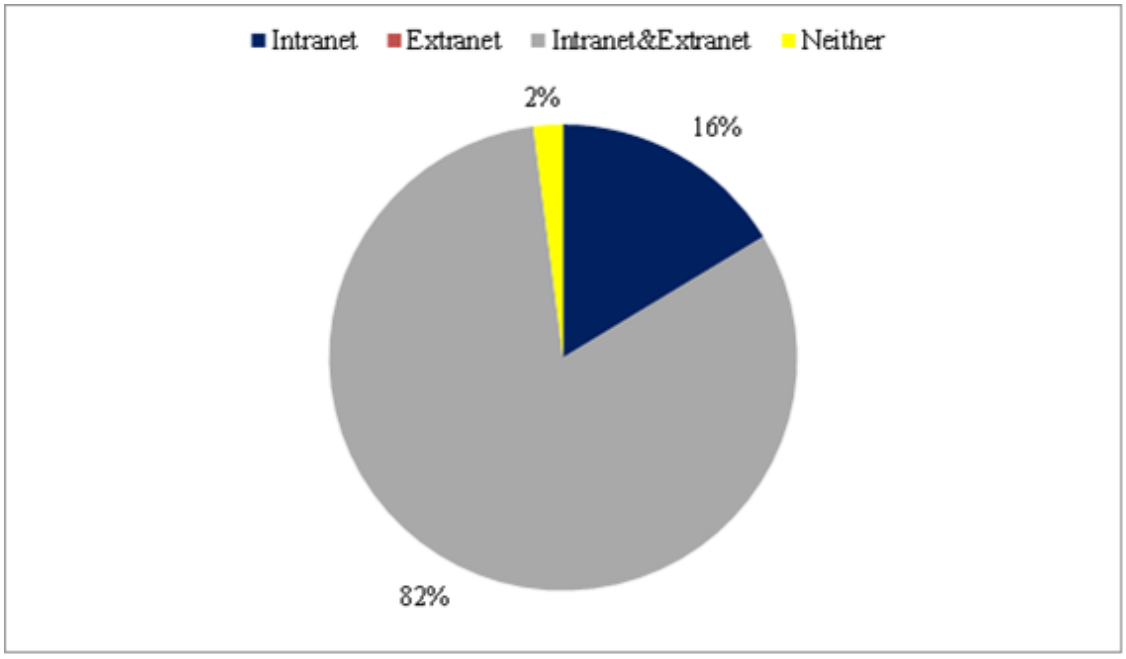


Figure 4.6 Type of Communication Networks Used by Organisations

Moreover, the e-business benchmarking study report produced by DTI indicated that only 17% of organisations in the construction industry had extranets (DTI, 2004). Comparing the current survey results with the findings of DTI (2004) in extranet usage, it can be concluded that the use of extranets in the construction industry has increased significantly since 2004. The reason possibly associates with the increasing uptake of construction collaboration tools among construction organisations.

Additionally, the survey findings showed that the usage of communication networks was associated with the type of organisation. For example, a greater percentage of consultants stated that they were using both intranet and extranet (see Table 4.1). This indicates that consultants are slightly more advanced in the usage of communication networks compared to contractors.

Table 4.1: Type of Communication Networks Used by Contractors and Consultants

Type of Communication Networks	Contractors	Consultants
Intranet	20%	14%
Extranet	0%	0%
Both	76%	86%
Neither	4%	0%

On the other hand, the survey results showed that most of the communications, both internal and external, were carried out electronically (see Figure 4.7).

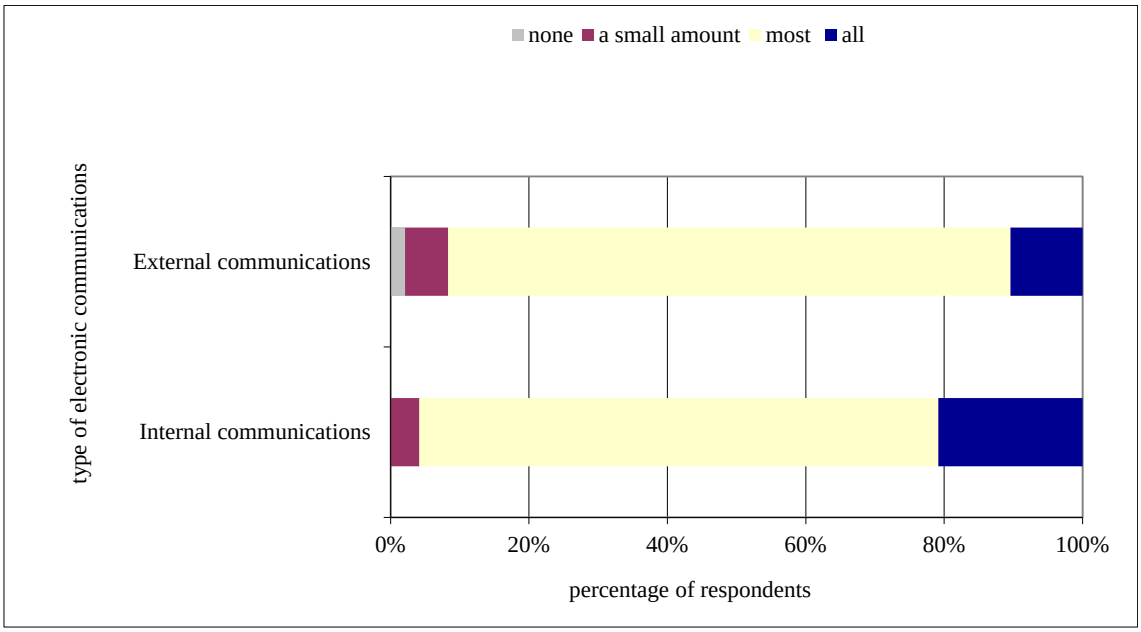


Figure 4.7 Degree to Which Communications Were Carried out Electronically

Ninety-six per cent of the respondents stated that they frequently carried out internal communications electronically. Ninety-one per cent of the respondents stated that they frequently carried out the external communications electronically. This indicates that the networks are used slightly more often in internal communications than in external communications.

4.3.2.3 Level of e-Business Usage

E-business enables industry organisations to conduct more advanced and complicated business activities, such as product/service promotion, electronic procurement (e-procurement), project collaboration and management, customer relationship management (CRM), supply chain management (SCM) and other activities (Ruikar and Anumba, 2008). However, many have argued that the uptake of those e-business-enabled activities was slow in the construction industry compared to other traditional sectors, such as manufacturing (Martin, 2003; Voordijk, et al., 2003; Chen, 2006; Martin, 2009). To determine the level of e-business usage in the industry, it is essential to examine the current status of e-business-enabled activities within the construction industry.

The survey endeavoured to identify the degree to which the various e-business-enabled activities were undertaken, and aimed to establish the level of their usage. The examined activities included 1) product/service promotion, 2) e-procurement, 3) project collaboration and management, 4) CRM and 5) SCM. Survey participants were asked to identify the degree to which the e-business-enabled activities were undertaken within their organisations. They were also invited to provide additional information about any other e-business-enabled activities performed in their organisations.

The survey findings showed that the uptake of the e-business-enabled activities was limited. Product/service promotions (58%) and project collaboration and management (67%) were stated more than all the other activities, such as e-procurement, CRM and SCM (see Figure 4.8). This indicates that the level of usage of product/service promotions, and project collaboration and management, is more advanced than the level of usage of all the other activities. This result is compatible with what has been found in previous research work (Ruikar et al., 2002; DTI, 2004).

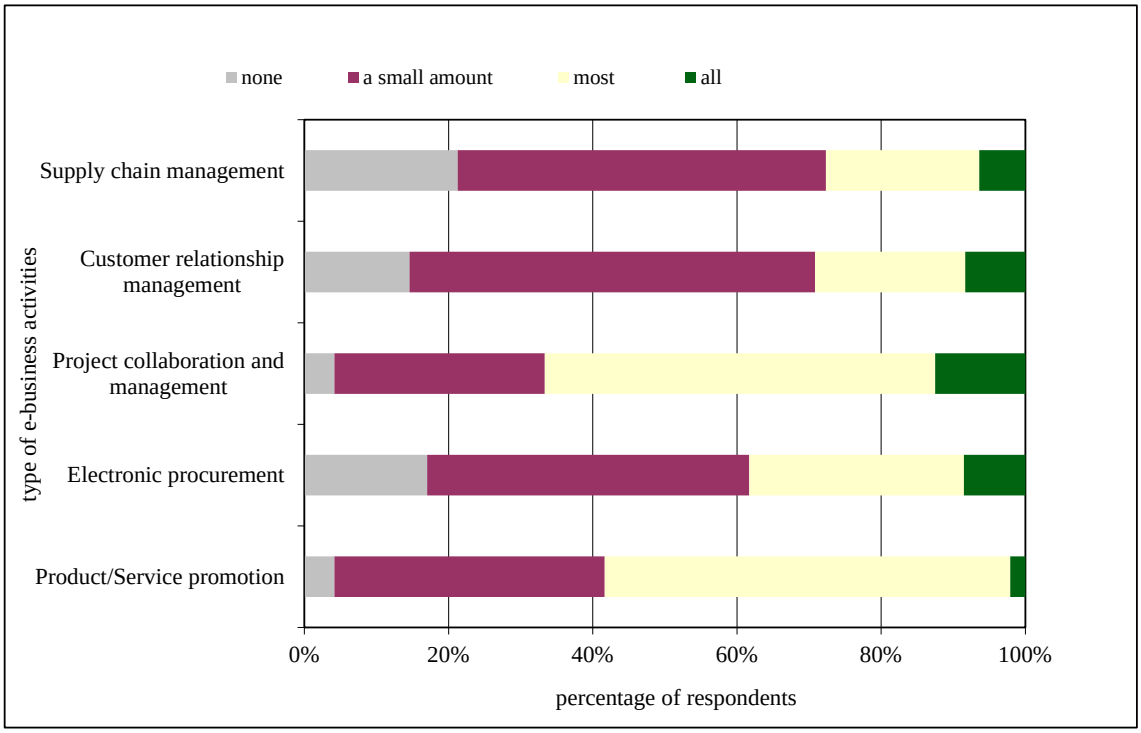


Figure 4.8 Degree to Which e-Business Activities Were Undertaken

Moreover, most respondents identified the degree of performing the e-business-enabled activities, such as e-procurement, CRM and SCM, as a small amount of (also see Figure 4.8). This fact indicates that the level of usage of such e-business-enable activities in the industry was still low. The low uptake of such activities is associated with many issues, such as training of personnel, integration with legacy systems, and interoperability of distributed software applications (Lewis, 1999; Ugwu et al., 2000; Cheng et al, 2001; Badii and Sharif, 2003; Love et al., 2004; Rankin et al., 2006; Zou and Seo, 2006). Literature indicates that construction organisations have started to integrate their internal systems to improve the usage of e-business-enabled activities (DTI, 2004; European Commission, 2006). However, the uptake of such activities would not increase significantly in short-term unless the appropriate strategic approach were developed and applied to guide the implementation (Albers, and Clement, 2007; Alshawi, et al., 2008; Ruikar and Anumba, 2008).

4.3.3 IT Investment Advice and e-Skill Development

This section tried to determine the role of the IT department within organisations and how organisations provide IT training to their staff. The observed areas included: 1) IT investment advice; 2) IT expenditure; and 3) e-skill development.

4.3.3.1 IT Investment Advice

Previous research indicates that IT investments of the industry participants are mainly management-driven or market-driven (Ruikar et al., 2006; Henderson and Ruikar, 2010), and the role of the IT departments is in providing technical support and maintenance (Alshawi et al., 2008). However, the strategic role of IT departments will be critical in the future compared to their current technical and supportive role (O'Neil, 2007; Alshawi et al., 2008; Pritchard, 2011). When planning IT investments, it is important for organisations to consider the advice of their IT departments. Nevertheless, it is critical to inquire into the role of IT departments in IT investment decision-making.

The survey attempted to determine the sources of advice when construction organisations were considering IT investment. Survey participants were invited to state their experiences in obtaining IT investment advice. Suggested options included: 1) getting advice from professional IT service providers; 2) getting advice from an organisation's own IT department; 3) learning from university or other research organisations; 4) learning through government/third party; and 5) other.

The survey findings confirmed the important role of an organisation's IT department in providing IT investment advice. Over 80% respondents stated that they got IT investment advice from their own IT departments (see Figure 4.9).

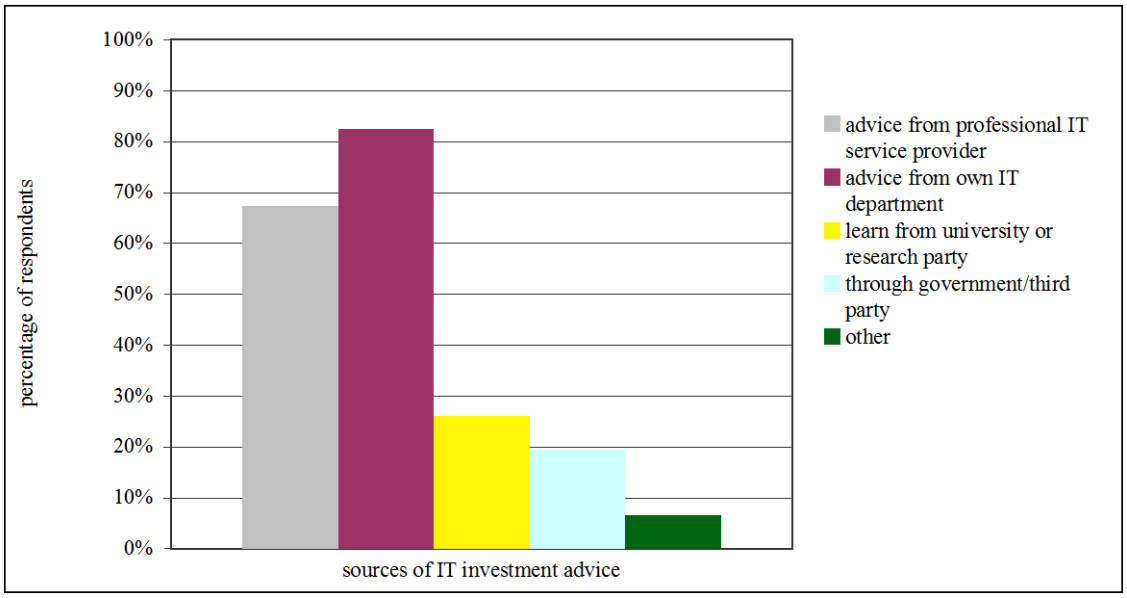


Figure 4.9 Sources of IT Investment Advice

Professional IT service providers also provide IT consultancy and IT training for their customers. Previous research indicated that professional IT service providers were the most common external sources for organisations to get IT investment advice (DTI, 2004). The survey results confirmed the above statement. Many respondents (67%) emphasised that they got IT investment advice from external professional IT service providers (also see Figure 4.9). Some of respondents also commented that the good relationships between them and their IT vendors (one type of professional IT service providers) ensured their successes in IT investment decision-making.

4.3.3.2 IT Expenditure

The construction industry is cost-driven and very sensitive to financial and economic change (Morton, 2008). Most organisations in the industry constantly struggle to find the resources to invest in IT (Elliman and Orange, 2000; Wolstenholme, 2009). Those who did have the ability to investment often failed to maximise their leverage by investing smartly and matching the investment to their IT needed (Salah, 2003; Wolstenholme, 2009). The European Commission (2006) suggested organisations in the industry to leverage their IT investment so as to create unique e-business resources and capabilities to improve a firm's effectiveness instead of over investing in e-business. Therefore, it is essential to determine the IT expenditure within construction organisations to predict an appropriate expenditure for future investments.

This survey was aimed at examining two aspects of IT expenditure: 1) the past expenditure, and 2) future expenditure. This section looked at the average annual share of IT budget in the total company expenditure. In this section, survey participants were asked to state the average annual share of organisations' IT budget, including hardware, software, services and personnel, as percentage of their total company expenditure over last 5 years. The percentages listed as options included 0~5%, 5%~10%, 10%~15%, and other.

Nearly half of the respondents stated that in the last five years their average annual share of IT budget was 0~5% of their company expenditure, 33% stated the share was 5%~10%, and only 7% stated the share was 10%~15% (see Figure 4.10). The findings showed that most of the surveyed organisations (89%) had at least some IT expenditure in the last 5 years. The result indicates that IT has continued to receive significant levels of investment in the construction industry, which is compatible with

the results from other research work (Construction Industry Computing Association, 1982; National Computer Center, 2009; Underwood and Khosrowshahi; 2012).

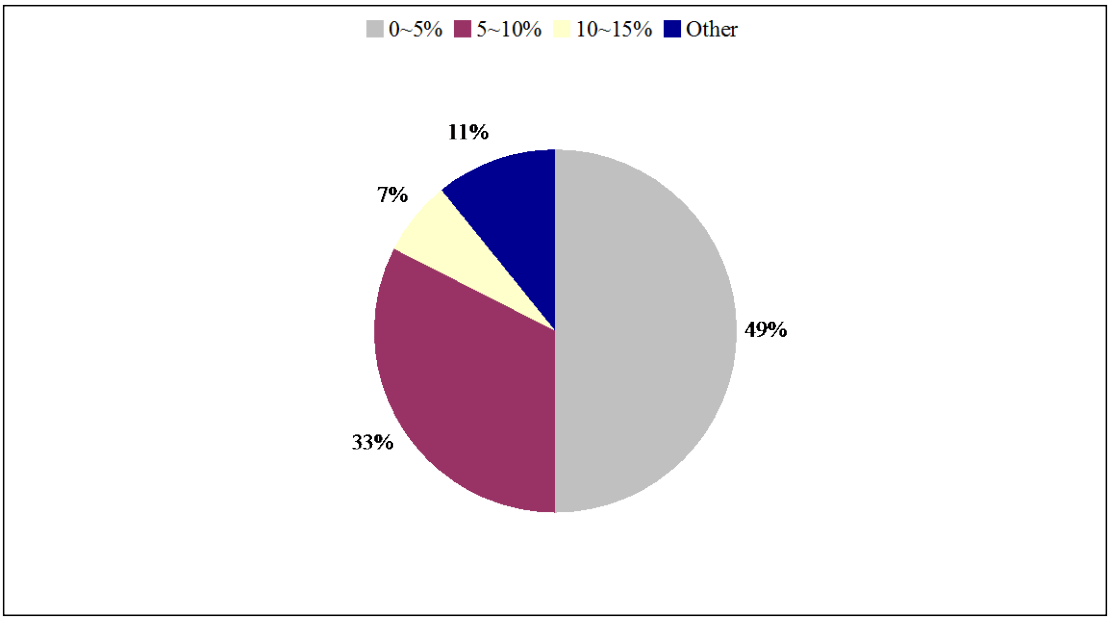


Figure 4.10 Percentage of the Average Annual Share of IT Budget

The survey findings also showed that the common average annual share of IT budget was 0~5% of the total company expenditure. Previous research reported that the annual share of IT budgets of construction companies corresponded to about 4% of their total company expenditures (European Commission, 2006). The survey findings were compatible with the results from previous work. However, this share (0~5% of the total company expenditure) is relatively low compared to other sectors (National Computer Center, 2009).

Moreover, the level of IT expenditure was associated with the type of organisation. For example, compared to contractors, a greater percentage of consultants stated that their average annual share of IT budget was 5~10% (see Table 4.2). This indicated that the IT expenditure of consultants was slightly more than those of contractors over the past 5 years.

Table 4.2: Average Annual IT Share of Contractors and Consultants (in the last 5 years)

Average Annual IT Share	Contractors	Consultants
0~5%	61%	43%
5~10%	30%	43%
10~15%	0%	7%
Other	9%	7%

Among the surveyed organisations, there was no evidence showing that the level of IT expenditure increased with the size of organisation.

4.3.3 3 e-Skill Development

Efficient in-house IT training should include IT education and the training of employees, management and customers (Phan, 2003). The development of e-skills among employees builds their confidence in using new technologies and motivates them to use e-business tools/applications. Chaffey (2009) pointed out that e-skill development plays an important role in the full utilisation of e-business benefits and also creates value. However, in the construction industry, IT training is quite limited, specifically for employees in the SMEs (European Commission, 2006).

The surveyed focused on determining the level of in-house IT training within the industry. Survey participants were invited to state whether or not they had in-house IT training. Also, they were invited to identify the additional sources of IT training used besides the in-house IT training.

The results indicated that most of the surveyed organisations (77%) had in-house IT training. Also, the level of in-house IT training was associated with the type of organisation. For example, compared to contractors, a greater percentage of consultants stated that they had in-house IT training (see Table 4.3). This indicates that consultants are much likely to have in-house IT training compared to contractors.

Table 4.3: In-house IT Training among Contractors and Consultants

	Contractors	Consultants
IT in-house training (YES)	64%	93%
IT in-house training (NO)	36%	7%

The survey results also indicated that self-training was the most important additional source for e-skill development (see Figure 4.11). Seventy-seven per cent of respondents stated that their employees used self-training for e-skill development. The other additional sources included hiring IT professionals to conduct training sessions (60%) and attending training courses outside (60%).

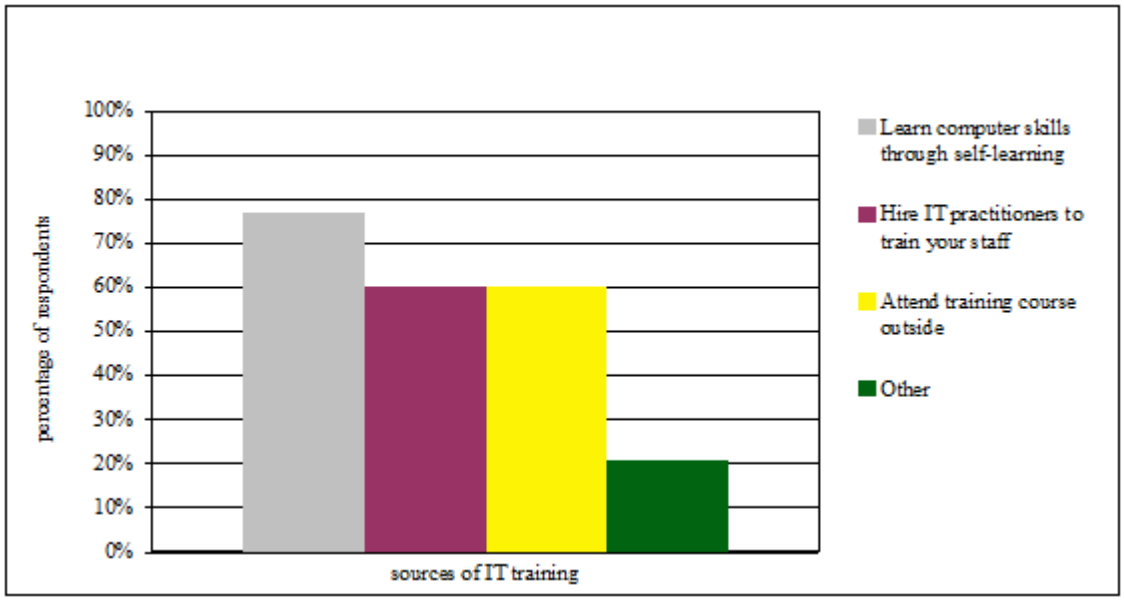


Figure 4.11 Other Sources of IT Training

Previous research indicated that online training was another additional source for employees in construction organisations to develop e-skills (European Commission, 2006). Here online training refers to the trainings conducted online. The findings of the survey also confirmed the above fact. Some respondents stated that they used online training and commented that the online training was a useful source for e-skill development.

4.3.4 Drivers, Impact and Barriers of e-Business

This section attempts to determine the main issues of e-business implementation among industry practitioners, and the observed areas included 1) drivers, 2) impact and 3) barriers.

4.3.4.1 Drivers of e-Business

The literature indicates that innovators in the construction industry were motivated to implement e-business in the early 1990s because of the promised benefits, such as increased revenue, higher profit, and dramatic business success (Wilkinson, 2005; Chaffey, 2009; Schneider, 2010). However, most organisations in the industry adopted a wait-and-see approach to e-business. It has been argued that the driving force was not positive enough for members of the construction industry, specifically the SMEs, to take further steps in e-business unless there was a superior strategic solution (Albers and Clement, 2007). Nowadays, with the emergence of construction-specific e-

business solutions, such as construction collaboration technologies and BIM, experts believe that the drivers of e-business implementation centred on the competitive advantages that an organisation can achieve (DTI, 2000; Chaffey, 2009). Further investigation is required in order to determine the major driving forces for the wide adoption of e-business initiatives, specifically those construction-specific solutions.

The survey was intended to investigate the driving forces that motivated industry members to implement e-business. The investigation included two parts: 1) an investigation in general (this Section); and 2) an investigation of the drivers that had a particular impact in influencing the decision to implement e-business practices (Section 4.3.4.2).

In this section, five factors were listed as the drivers that motivated industry members to undertake e-business: 1) competitors' engagement into e-business, 2) expectation from customers, 3) expectation from suppliers, 4) belief in the competitive advantage of e-business, and 5) other. Survey participants were invited to identify the reasons that motivated them to engage in e-business.

The survey findings confirmed that the drivers of e-business were centred on competitive advantages. Most of the respondents (76%) acknowledged their belief that e-business offered a competitive advantage and stated that this was the primary reason that they implemented e-business practices (see Figure 4.12).

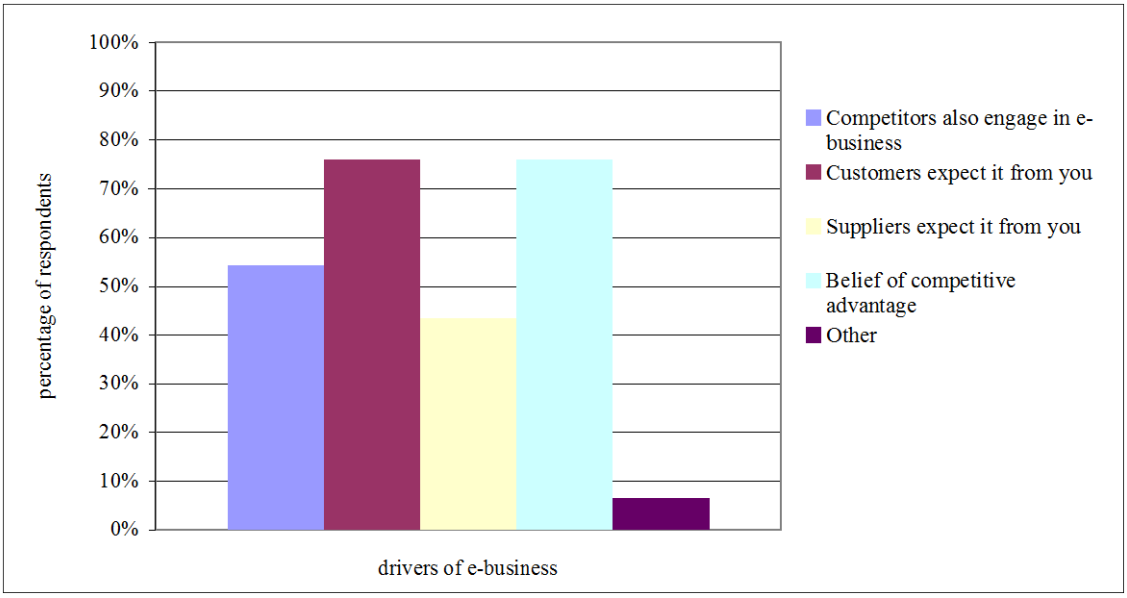


Figure 4.12 Drivers of e-Business

Customers' expectation was also regarded as a main driver by the surveyed organisations. Most respondents (76%) stated that they undertook e-business solutions because their customers expected them to do so (also see Figure 4.12). Especially for large size organisations (annual turnover over £100 million), customers' expectation (83%) was reported as the most important driver to implement e-business compared to competitors' engagement (50%), suppliers' expectation (41%), and gaining competitive advantage (77%). The findings of the survey were compatible with the results from previous research (European Commission, 2006).

Moreover, previous research indicated that the actions of competitors had important influences on e-business decisions (DTI, 2004; European Commission, 2006). The findings of survey confirmed the above statement. The influences coming of competitors were also emphasised by the survey respondents. Over half of the respondents stated that competitors' engagement in e-business was one of drivers for them to consider e-business implementation (also see Figure 4.12). The other drivers identified by the respondents included:

1) Pursuing increased speed of communication;
2) Organisational management required an e-business model;
3) Supporting the improvement to business processes;
4) Only way to conduct long-distance business; and
5) Web-based portals were developed for information security reasons, and to reduce email traffic.

4.3.4.2 Impact on Making Decisions of e-Business

This section is intended to look at the drivers that had a particular impact in influencing the decision to implement e-business practices. Chaffey (2009) stated that business adoption of e-business was driven by benefits to different parts of organisations and that first and foremost, organisations were interested in how the benefits of e-business would impact on profitability or generating value to their organisations. The impact can be both tangible (for which monetary savings or increased revenues can be identified) and intangible (for which it is more difficult to calculate cost savings or revenues). This part of the survey questionnaire aimed to identify among the survey respondents the factors that contributed to their decision to implement e-business.

Survey participants were invited to rank the different factors that influence their e-business decision-making. The factors for ranking were identified based on previous work (Anumba and Ruikar, 2002; Issa et al., 2003; DTI, 2004; Rankin and Chen, 2005; European Commission, 2006; Chaffey, 2009). The listed options included: 1) tangible impacts, such as revenue, efficiency of business processes, procurement costs, productivity, accounting and administration, staff training and market reach; and 2) intangible impacts, such as quality of product, quality of customer service, management and control, internal organisational relationships, innovation, and research and development.

The survey respondents ranked the impacts such as growth of revenue, efficiency of business processes, productivity, management and control, administration and accounting, innovation, and research and development as high (see Table 4.4), which meant that the above factors had high impact on their e-business decision-making.

Table 4.4: Impact on e-Business Decision Making

Name of Advantage	Type of Advantage	Impact
Growth of revenue	Tangible	High
Efficiency of business processes	Tangible	High
Productivity	Tangible	High
Accounting and administration	Tangible	High
Management and control	Intangible	High
Innovation	Intangible	High
Research and development	Intangible	High
Market reach	Tangible	Medium
Internal organisation relationship	Intangible	Medium
Quality of customer service	Intangible	Medium
Quality of products	Intangible	Low

The DTI's benchmarking study indicated that the primary reasons businesses cited for implementing new e-business technologies were to increase efficiency of business processes and improve communications with customers (DTI, 2004). Ruikar et al. (2002) suggested that the usage of e-business tools could increase productivity, specifically in area of company administration. The findings of the survey confirmed the factors that have been identified as critical to e-business decision-making in the previous research. Furthermore, the findings also reported other factors that were regarded as important in e-business decision-making by the surveyed organisation, such as management and control.

Additionally, respondents ranked impacts such as quality of products as low, which meant that quality of products had low impact on their e-business decision-making. In the construction industry, the final product is made from many specialised systems of components (structural, electrical, mechanical, etc.). The complexity of the final products makes it difficult to determine the improvement of quality of products compared to other benefits (e.g. time savings and decrease of costs) after implementing e-business tools/applications. This is a possible reason why the survey respondents ranked quality of products as low to their e-business decision-making.

4.3.4.3 Barriers to e-Business Implementation

According to Ruikar and Anumba (2008), the barriers associated with e-business need to be recognised, identified and addressed in order to improve public confidence in adopting it. At present, many industry experts believe that the barriers to the effective use of e- business in the industry are mostly related to organisational policies and management, as well as human resources and culture (Ruikar et al., 2006; Zou and Soe, 2006; Hjelt and Bjork, 2007). To explore the recent barriers to e-business within the construction organisations, various issues were investigated in this section.

The survey was intended to identify the barriers encountered during the current e-business implementation. Survey respondents were asked to rank the different barriers. Several barriers categorised from previous research studies were provided for the survey participants to rank. The barriers listed in the questionnaire were as follows (Chen, 2006; Ruikar et al., 2006; Zou and Soe, 2006; Hjelt and Bjork, 2007; Ruikar and Anumba, 2008):

- Cost and financial barriers: such as cost of investment;
- Human and culture barriers: such as resistance to change, and confidence in using new technology;
- Organisational barriers: such as lack of technical skills, and changeable IT technical needs of an organisation;
- Technological barriers: such as interface with other systems, security of data transaction and submission, and modification of legacy systems; and
- Legal barriers: such as legal issues.

The survey respondents ranked cost issues (e.g. cost of investment) higher than technological and organisational issues (see Table 4.5), which meant that cost was a greater barrier to e-business implementation. Experts have stated that the cost of

currently available construction-specific solutions were affordable to most organisations, even the SMEs (Wilkinson, 2005; IFS, 2010). Why then is cost still the major concern of the industry members? Many have argued that the highest costs of e-business solutions come after the initial investment, and are associated with building essential infrastructure, training personnel, and rationalising business processes (Robeiro and Love, 2003; Rankin et al., 2005; Zou and Seo, 2006; Chaffey, 2009). Therefore, in order to minimise financial expense it is better to consider the implementation of e-business as a comprehensive solution to business problems instead of a simple software installation.

Table 4.5: Barriers to e-Business Implementation

Name of Barrier	Type of Barrier	Ranking
Cost of investment	Cost and financial	High
Resistance to change	Human and culture	High
Confidence in using new technology	Human and culture	Medium
Lack of technical skills	Organisational	Medium
Changeable IT technical needs of an organisation	Organisational	Medium
Interface with other systems	Technological	Medium
Security of data transaction and submission	Technological	Medium
Modification of legacy systems	Technological	Medium
Legal issues	Legal	Low

Moreover, human and culture issues (e.g. resistance to change) were also ranked as high (i.e. a greater barrier to e-business implementation) by the survey respondents. This finding confirmed results from previous research (Ruikar et al., 2006; Zou and Soe, 2006; Hjelt and Bjork, 2007).

Furthermore, the survey results also revealed that technological issues were no longer the most important barriers that prevent industry members from implementing e-business. However, the respondents still reported a number of concerns about technological issues, such as the availability of appropriate software tools, and the frequency of updating the immediate legacy status. The technological barriers to e-business should be overcome if the infrastructure for e-business use was properly created (Ruikar and Anumba, 2008). However, technological problems will stem from the development and implementation of different e-business systems built upon the infrastructure (European Commission, 2006). Therefore, construction organisations must establish sufficient technical support to deal with such issues.

4.3.5 Improvement to e-Business Practices

This section attempted to assess the understanding of industry practitioners about improvements to e-business practices within their organisations. The investigated areas include 1) internal resources, 2) business processes, 3) organisational culture, and 4) business goal.

4.3.5.1 Internal Resources

The implementation of e-business opens up new sources of value creation in resources and capabilities (Amit and Zott, 2001). The value of e-business is created through the transformation of e-business investments into e-business resources and capabilities (Teece et al., 1997). In an electronic environment (e.g. on the Internet), resources can be combined and integrated into unique functionalities that enable distinctive capabilities within a firm, which cannot be substituted for or easily imitated (e.g. shared information) (Pavic et al., 2007; Raymond and Bergeron, 2008; Zhao et al., 2008). However, in the construction industry, many organisations that have invested in IT failed to maximise their leverage by investing intelligently and matching the size of their needs for e-business solutions (Salah, 2003; Wolstenholme, 2009). Therefore, it is necessary to investigate the ways in which internal resources relate to the improvement to e-business practices.

The survey aimed to access the opinions of industry practitioners on improvement to e-business practices by leveraging different types of internal resources. Johnson et al. (2008) internal resources include: 1) physical, 2) financial, 3) human and 4) intellectual capital. In this part of the survey questionnaire, several types of internal resources relevant to e-business practices were provided for the survey participants to select, such as more IT training for staff, increasing IT support staff or hiring external IT professionals, more involvement of senior management, more expenditure in IT infrastructure, and more funds to invest IT. Survey respondents were asked to indicate the types of internal resources that they believed were required in order to improve e-business practices.

The survey findings showed that better training for staff was seen as the most necessary action to enable the improvement of e-business practices of all the internal resources. Sixty-eight per cent of the survey respondents thought that more training for staff was useful to the improvement of e-business practices (see Figure 4.13). Previous study indicated that only 12% of construction companies carried out regular IT training

for their staff (European Commission, 2006). Based on the previous research, it can be concluded that there is still room to improve e-business training for staff in construction organisations. The findings of Section 4.3.2.3 (e-Skill Development) showed that most of the surveyed organisations (77%) had established in-house IT training. Therefore, construction organisations need to consider the kind of in-house IT training that will be given to staff and the way to assess the effectiveness of such training in order to improve their e-business practices.

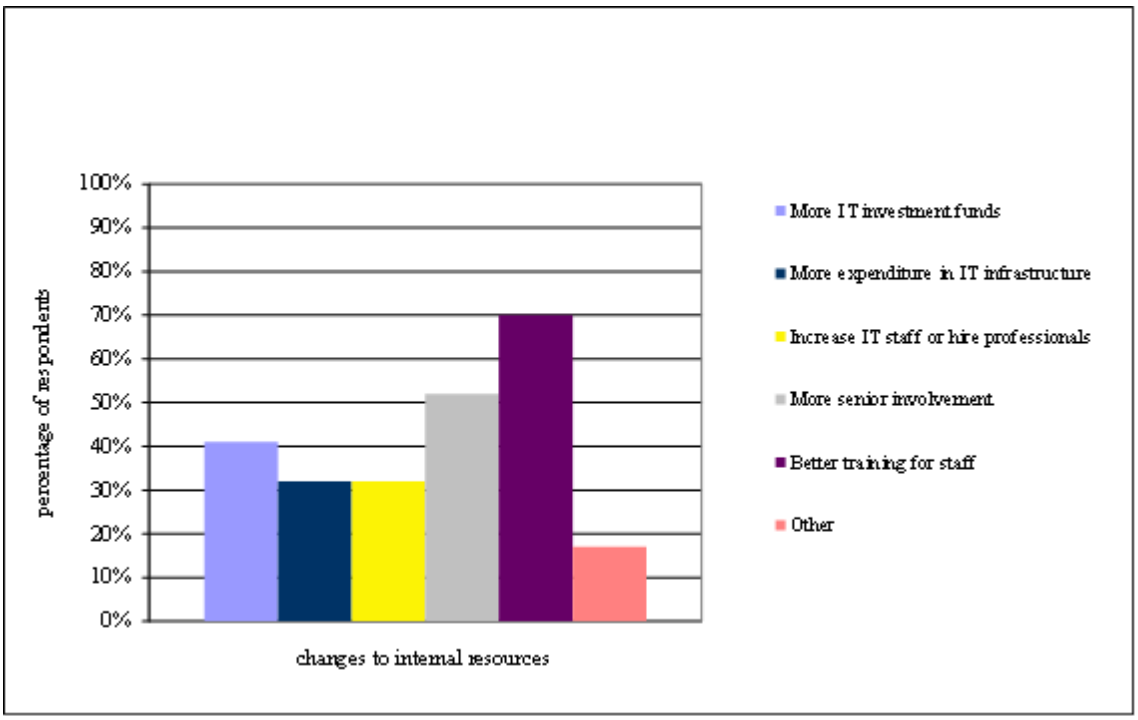


Figure 4.13 Improving e-Business Practices by Changing Internal Resources

Half of the respondents thought that more involvement of senior management was also useful to the improvement of e-business practices (also see Figure 4.13). Management involvement to ensure the effective uptake of e-business has been documented by experts for years (Ruikar et al., 2004; The McKinsey Quarterly, 2005; Chaffey, 2009). The survey findings also confirmed the importance of management in improving e-business practices.

4.3.5.2 Business Processes

In the construction industry, e-business creates value through reengineering the workflows and the way of sharing information (Ruikar et al, 2003; Industry Canada, 2004). The implementation of e-business requires change in business processes (Porter,

1985; Ruikar et al, 2003; Industry Canada, 2004; Chaffey, 2009; Laudon and Laudon, 2009). However, the process-related innovation is limited in the construction industry (Ruikar et al, 2003; Chen, 2004; DTI, 2004; European Commission, 2006). Many organisations adopt e-business applications without thinking of process change and try to twist the technologies to fit in their existing processes (European Commission, 2006). Therefore, it is necessary to investigate the ways in which business processes relate to the improvement to e-business practices.

The survey tried to reveal the opinions of industry members about how to improve e-business practices by implementing process changes. Three types of process-related changes were identified as crucial to e-business practices: 1) automation of business processes, 2) business process improvement (i.e. integration of business processes), and 3) business process reengineering (Davenport, 1993; Cope and Waddell, 2001; Chaffey, 2009). In this part of the questionnaire, survey respondents were invited to clarify their opinions about how best to improve e-business practices by making process-related changes. Altogether, five options were listed for selecting: 1) automation of business processes, 2) integration of business processes, 3) reengineering of business processes, 4) connecting e-business value with business performance, and 5) other.

Seventy-five per cent of respondents stated that automation of business processes was useful to the improvements of e-business practices (see Figure 4.14). The results revealed that respondents believed that it is effective to improve e-business practices through automation of business processes. Previous research indicated that automation of business processes focused on automating existing manual ways of working through information technology (Chaffey, 2009). Benefits can be achieved through process automation, but the improvements may be modest (Ruikar et al., 2005; Chaffey, 2009; Laundon and Laundon, 2009). Organisations need to adopt alternative approaches (e.g. business process improvement and business process engineering) to gain more improvement in performance (Davenport, 1993; Hammer and Champy, 1993; Willcocks and Smith, 1995; Ruikar et al., 2003; Chaffey and Wood, 2005). The survey findings revealed the fact that process and its automation were still crucial at current stage of e-business implementation in the industry because many organisations have not automated their business processes (Department for Business and Innovation & Skills, 2011).

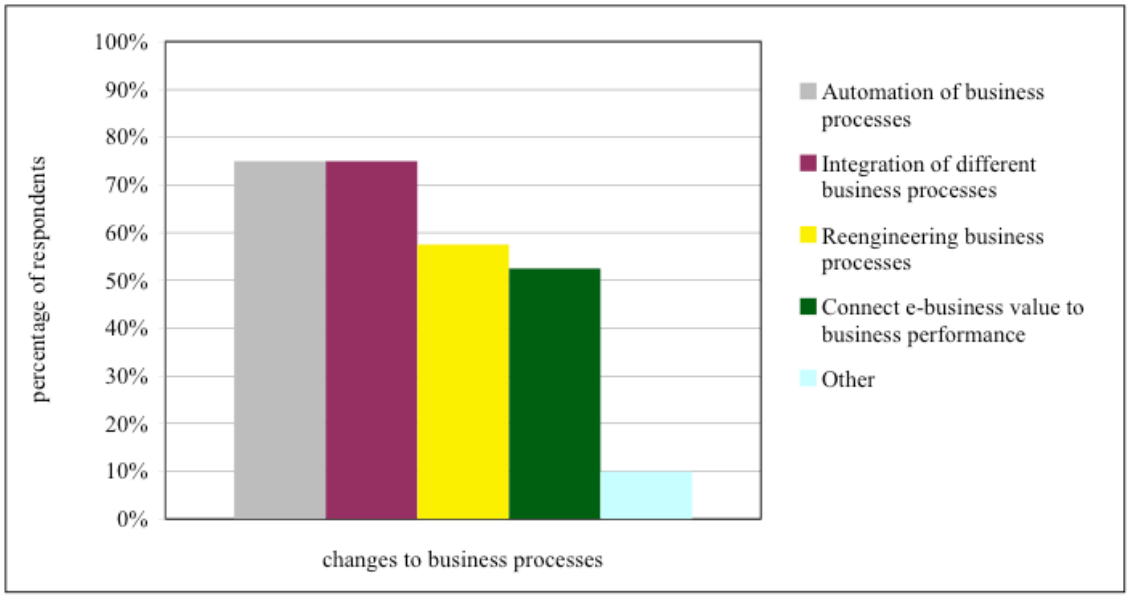


Figure 4.14 Improving e-Business Practices by Making Process-related Changes

Also, the importance of process integration was also emphasised by the survey respondents (also see Figure 4.14). This revealed that respondents believed that it is effective to improve e-business practices through the integration of business processes. Experts suggest that business process improvement (i.e. integration of business processes) is more practicable for traditional business sectors, such as construction industry (Cope and Waddell, 2001; Chaffey, 2009). Previous research indicated that organisations in the construction industry have started to integrate their different ICT systems (DTI, 2004; European Commission, 2006), which will lead to the integration of associated business processes. The survey findings confirmed the importance of the integration of business processes to improvement of e-business practices.

Moreover, the survey respondents also commented on the importance of reengineering business processes. Fifty-eight per cent of respondents stated that reengineering business processes was useful to the improvement of e-business practices (also see Figure 4.14). However, reengineering business processes was not common in the construction industry because of the required knowledge, the fundamental changes involved, and the associated high risk (Ruikar et al., 2005; Laundon and Laundon, 2009; Chaffey, 2009). Additionally, the respondents also suggested that the ability to introduce new processes and enhance customer choice was helpful to improve e-business practices.

4.3.5.3 Organisational Culture

Through establishing a unique organisational culture, organisations can obtain a capability that is organisation-specific, rare and difficult to imitate or substitute (Barney, 1991; Eisenhardt and Martin, 2000; Amit and Zott, 2001). The construction industry has been criticised for its conservative attitude towards innovation and new technologies (Paulson, 1995; Morton, 2008). Many experts have suggested that it is important for organisations in the industry to create a positive organisational culture that informs, equips and encourages staffs to learn and adopt e-business initiatives (Aranda-Mena, and Stewart, 2005; Hjelt and Bjork, 2006; Ruikar et al., 2006; Zou and Soe, 2006; Ruikar and Anumba, 2008). However, the ways in which organisational culture related to the improvement to e-business practices has not been investigated.

The survey strove to obtain the opinions of industry members about how to improve e-business practices through changes to organisational culture. Survey respondents were asked to define their belief about what changes to the culture within their organisations would assist in improving their e-business practices. Ruikar et al. (2006) defined several organisational culture issues to help construction organisations to gauge their e-readiness, such as recognising the benefits of e-business, encouraging staff to use e-business tools, and committing to address issues/inhibitions. These issues were applied in this part of the questionnaire to examine the survey respondents' opinions.

The majority of the surveyed organisations (75%) stated that recognising the benefits of using e-business was useful to the improvement of e-business practices (see Figure 4.15). This percentage is greater than those of other listed issues, such as encouraging staff to use e-business tools (69%), committing to address issues/inhibitions (50%), and changing other culture elements to suit e-business implementation (47%). This indicated that the surveyed organisations believed that recognising the benefits of using e-business was the most crucial aspect of organisational culture to the improvement of e-business practices.

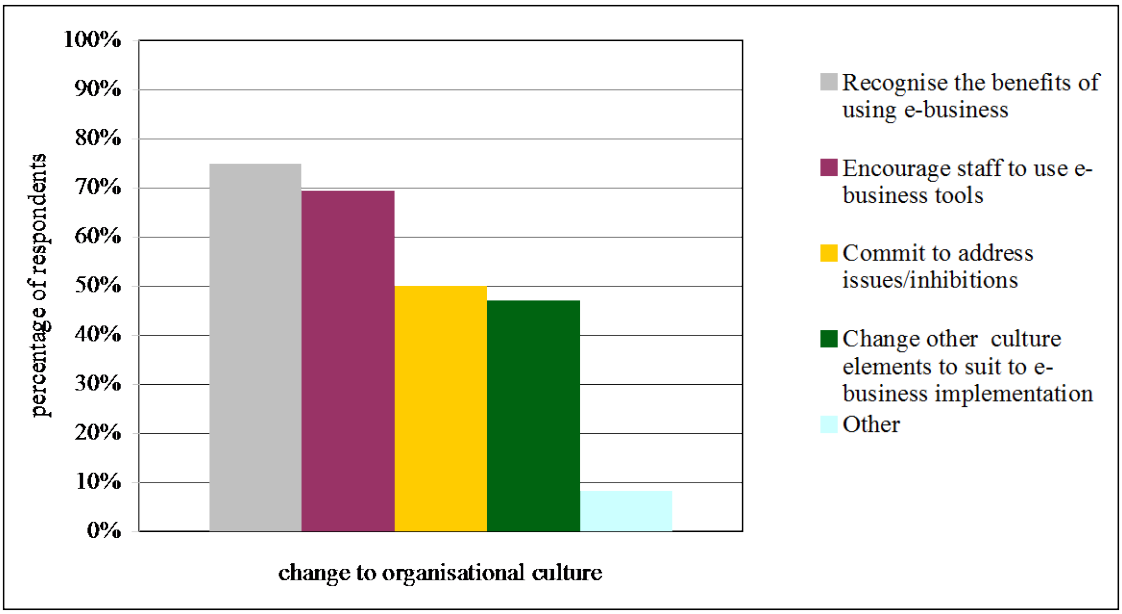


Figure 4.15 Improving e-Business Practices through Changing Organisational Culture

Moreover, the survey respondents also commented on how best to recognise the benefits of e-business. Their suggestions include: 1) better demonstration of benefits, 2) full utilisation of existing investment including effective benefits realisation planning, and 3) good case studies and training.

The survey respondents also identified encouraging staff to use e-tools and committing to address issues/inhibitions as very important (also see Figure 4.13). Based on the survey findings and respondents comments, it can conclude that a good organisational culture for e-business implementation should include: 1) good benefits demonstration and effective benefits realisation planning within organisations, 2) sufficient training on e-business benefits to staff, 3) good organisation atmosphere to encourage staff to use e-business tools, and 3) commitment to address issues/inhibitions.

4.3.5.4 Business Goal

The leaders in e-business defined e-business as an element of their corporate strategy characterised by the recognition of the importance of e-business strategy by the senior management (Deise et al., 2000; Norton, 2002; Jelassi and Enders, 2009; Chaffey, 2009). In the construction industry, industry practitioners have started to become aware of the fact that the e-business policy should be related to overall business goals (DTI, 2004; European Commission, 2006). However, the relationship between business goals and the improvement to e-business practices has not been investigated.

The survey was intended to access the opinions of industry members about how to improve e-business practices by establishing a relationship between e-business policy and business goals. Survey respondents were asked to define their belief regarding to the above relationship. Chaffey (2009) defined four possible relationships between the e-business policy and business goals based on e-business development stages. These relationships include: 1) a one-side e-business policy (e.g. sell-side e-business policy), not integrated with the overall business goals; 2) an e-business policy that is integrated with the overall business goal; 3) an e-business policy that is incorporated as part of the overall business goal; and 4) other. These relationships were applied in this part of questionnaire to examine the survey respondents' opinions.

Forty-nine per cent of the respondents stated that e-business practices could be improved if the e-business policy was integrated with the overall business goal (see Figure 4.16). Thirty-two per cent of the respondents stated that e-business practices could be improved if the e-business policy was incorporated as part of the overall business goal. The results indicated that most surveyed organisations believed that e-business practices could be improved by establishing an appropriate relationship between the e-business policy and the overall company business goals.

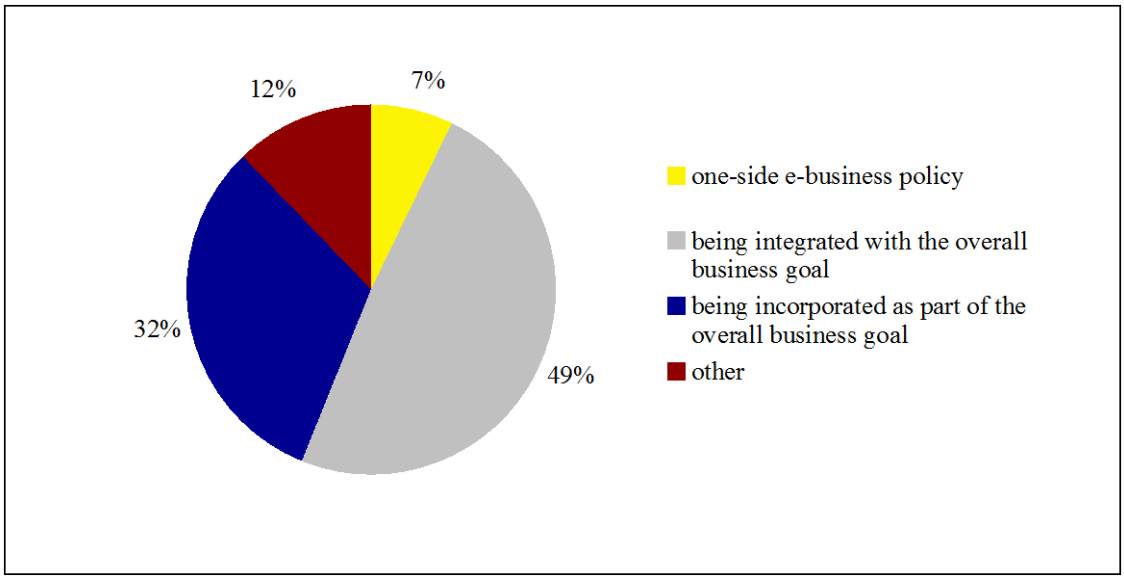


Figure 4.16 Improving e-Business Practices by Establishing a Relationship between e-Business Policy and Business Goals

Previous research indicates that an e-business implementation policy or strategy must be incorporated into the overall business goal in order to achieve the full potential of e-business (Chaffey, 2009). However, only 32% of the surveyed organisations thought e-business practices could be improved if the e-business policy was incorporated as part of the overall business goal. This result indicated that there was still some room for improving the awareness of industry practitioners about the appropriate relationships between e-business policy and the overall business goals.

4.3.6 Future Trends of e-Business

This section considered the future trends of e-business in the construction industry. The investigated topics included 1) future investment in e-business, and 2) future plans for launching a strategic e-business policy.

4.3.6.1 Future Investment in e-Business

Survey respondents were asked to state their organisation's plans for future e-business investment. The investment planning periods were classified into five categories: 1) 0 to 6 months, 2) 6 months to 1 year, 3) 1 to 1.5 years, 4) 1.5 to 2.0 years, and 5) other.

Only 23% of survey respondents stated that they would invest in e-business in the next six months, and 35% stated that they would invest in e-business in the next year (see Figure 4.17). This indicates that the surveyed organisations have limited e-business investments in the immediate future.

When asking about the reason why they did not plan to engage in such immediate investment, the survey respondents commented that the economic recession since 2009 strongly impacted on construction organisations' IT investments, and that many of them tended to cut their IT budgets. The construction industry is regarded as cost-driven and very sensitive to financial and economic change (Morton, 2008). The economic climate strongly impacted on investments in IT and construction organisations are inclined to cut IT budgets during a period of economic recession (Computer Economics, 2007). The survey findings confirmed the above statements.

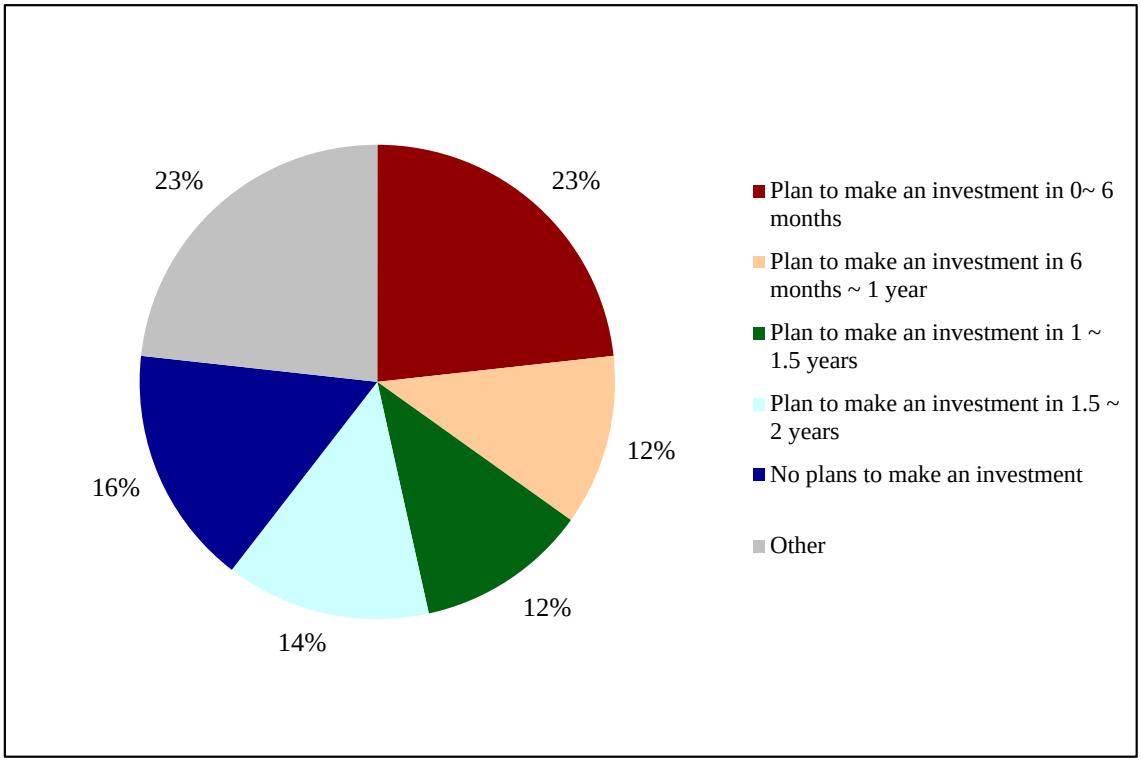


Figure 4.17 Future Investment in e-Business

Additionally, some respondents stated that they wanted to invest in e-business slowly because they constantly struggled to find the resources to invest in IT. Literature indicates that the construction industry is characterised as low margins, and low investments in research and innovation (Egan, 1998; Wolstenholme, 2009; Bew and Underwood 2010). The survey findings confirmed the above fact.

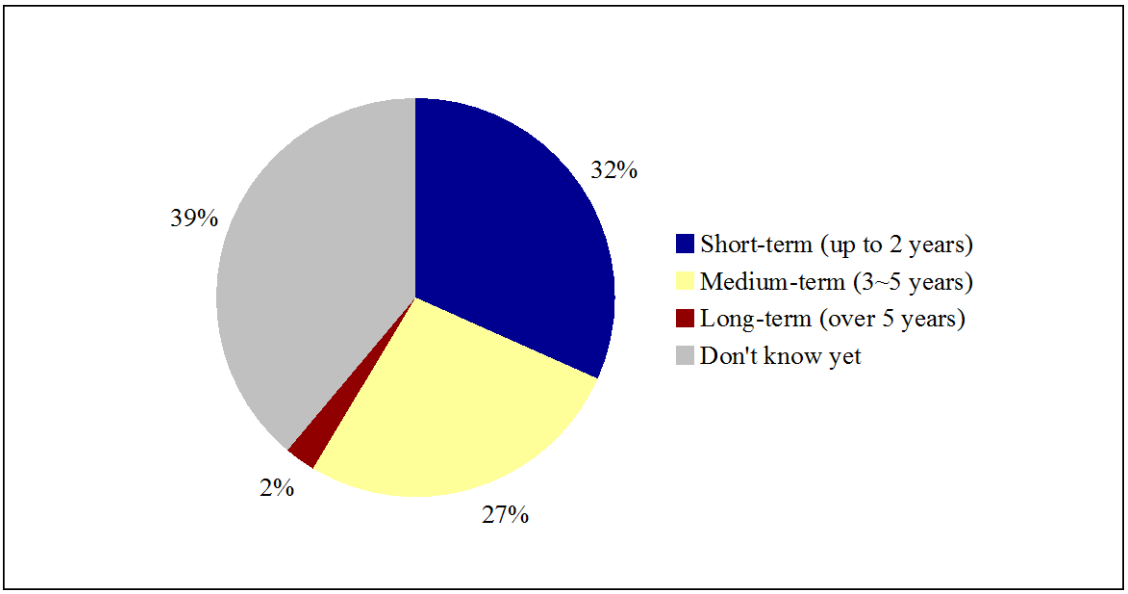
Furthermore, some surveyed organisations stated that their e-business investments were made from year to year, and the investment planned each year was based on business market relevance and perceived value of the output achieved from each opportunity. While other organisations stated that they had no specific targets and the investment would respond to requirements of the business. These comments indicate that the decision-making on e-business investments in the surveyed organisations is still reactive and focused on meeting the short-term business requirements. To have full utilisation of e-business practices, long-term business requirements need to be considered (Chaffey, 2009; Jelassi and Enders, 2009).

4.3.6.2 Launch of e-Business Policy

The reviewed literature suggested that strategic consideration of e-business implementation in the construction industry was also very limited, and that the current approaches were mainly 'reactive' and lack of long-term vision or strategy (Ruikar, 2004; European Commission, 2006; Alshawi, et al., 2008; Anumba and Ruikar, 2008). Therefore, it is important to determine their future strategic e-business plans.

The survey sought to identify the future trends among industry members in considering e-business implementation. Survey participants were asked to describe their plans for launching an e-business implementation strategy. The possible time frames for launching such a strategy were classified as: 1) short-term (up to two years), 2) medium-term (three to five years), 3) long-term (over five years), and 4) other.

Altogether, 61% of survey respondents stated that they planned to launch an e-business implementation strategy (see Figure 4.18), including long-term (2%), medium-term (27%), and short-term (32%). This indicates that the survey organisations still considered e-business implementation in short-term (up to two years) or medium-term



(three to five years), and the long-term (over five years) consideration is very rare.

Figure 4.18 Plans for the e-Business Implementation Strategy

Moreover, the survey findings showed that the most common answer was '*don't know*' when asked about plans for launching e-business implementation strategy (also see Figure 4.18). This result indicated that many respondents were not aware of whether there was a plan for launching the e-business implementation policy within their

organisations, or they knew about the plan but did not know when it would be launched. Organisations must improve the awareness of e-business implementation strategy within the entire organisation, or there will be associated gaps (e.g. unclear about the goal of the e-business strategy, and unclear about their roles and responsibilities during e-business implementation) when implementing the e-business strategy.

4.4 Summary

4.2 Background of the Survey	4.3 Key Findings and Analysis of the Survey
4.4 Summary	

This chapter introduced the exploratory study with organisations from different construction disciplines. The exploratory study employed an industry-wide survey as its research strategy, which was accomplished mainly based on an Internet-based questionnaire and a set of descriptive statistical analyses of the collected data. The study established the level of penetration of e-business in the construction industry, and assessed how much understanding industry members have in implementing e-business strategically. Moreover, the analysis and discussion of the survey findings assisted the researcher to determine the level of e-business activities and usage in the sector, explored how e-business has affected the sector in terms of product, process and organisational culture, identified the driving forces that motivated industry members to implement e-business, defined the barriers that prevented them from wider uptake of e-business, determined the awareness of industry members about e-business competitive advantages and strategic implementation, and identified the future trends of e-business both in investment and strategic planning. However, the analysis and discussions also revealed conflicts and problems associated with current implementation of e-business, such as the slow uptake of e-business-enabled activities, cost concerns in IT investment, the difficulties in achieving a competitive advantage, and the lack of long-term planning for launching e-business implementation. The next chapter contains an in-depth examination of e-business practices with specific industry end-user companies.

CHAPTER FIVE CASE STUDIES

5.1 Introduction

This chapter focuses on introducing the key findings of the multiple-case studies with the four selected industry practitioners. The chapter starts with a brief introduction of the multiple-case studies background. Section 5.2 introduces the aim and objectives, the adopted methods, the rationale for selecting the target organisations, and background information about the four selected organisations. Section 5.3 presents the findings and analysis of the multiple-case study in term of e-business strategies, implementation, and units of measurement. Section 5.4 concludes the chapter with a summary of the entire contents.

5.2 Background of the Case Studies	5.3 Key Findings and Analysis of the Case Studies
5.4 Summary	

5.2 Background of Case Studies

5.2 Background of the Case Studies	5.3 Key Findings and Analysis of the Case Studies
5.4 Summary	

5.2.1 Aim and Objectives

In Chapter Three, Section 3.4.3 introduced the approach for conducting the multiple-case studies, and described how the aim and objectives of the multiple-case studies were identified. The main purpose of the case studies was to investigate the actual practices of e-business implementation among the selected construction organisations. Three specific objectives associated with e-business strategy, implementation and units of measurement were established in order to achieve the main purpose of the case studies. The objectives were as follows:

- *Strategy*: to determine their current e-business strategy, what the strategy cover, how the strategy was worked out, and their future plan for the strategy;

- *Implementation:* to identify the e-business development stage of the studied organisations, investigate their actual e-business practices (in making improvements, managing changes and risks), and how e-business has impacted their products, processes and people; and
- *Units of measurement:* to investigate how the studied organisations measure e- business, including benefits, strategies, risks and implementation.

5.2.2 Methods for Carrying out the Multiple-case Studies

Section 3.4.3 discussed the general methods for carrying out the multiple-case studies. This section introduces the specific methods. The multiple-case studies were carried out through investigating two levels of e-business implementation inside the selected organisations:

- Organisational level investigation, and
- Project level investigation.

At the organisational level, investigation was focused on investigating the strategic mission and vision of e-business implementation in the target organisations. The investigation also included assessing the e-business capabilities of the organisation, identifying the drivers and risks when considering e-business; and exploring the management responses of the organisation to implement e-business. This stage was accomplished via two main methods: 1) a review of documents, which were available from various sources (e.g. Webpages, company profile, company documentation, industry news, and industry reports); 2) structured interviews with the IT Directors or Senior IT Managers who were responsible for e-business strategy development.

At the project level, investigation was concentrated on exploring the strategic practices of various e-business tools and applications in the target organisations. The project level investigation included determining the usage of various e-business tools and applications in the selected organisations during a project's lifecycle, and identifying how the organisations evaluated the efficiency of these e-business tools after their implementation. This stage was also accomplished via two main methods: 1) a review of documents, which were available from various sources (e.g. Webpages, company profile, company documentation, industry news, and industry reports); and 2)

structured interviews with project managers or other project experts who were familiar with the use of different e-business tools/applications applied in projects.

5.2.3 Rationale for Selecting the Multiple-case Study Organisations

Section 3.4.3 addressed the rationale for selecting organisations to carry out the multiple-case studies. The rationale for selecting the target organisations included three criteria:

- Organisations participated in the industry survey and expressed their interests in the follow-up study;
- Organisations have had years of experience in implementing e-business to effectively improve their core business activities and work practices; and
- Organisations stated in the previous industry survey that they had a plan for launching e-business implementation policy; this indicated that they had considered e-business implementation strategically.

5.2.4 Background Information about the Case Study Organisations

Four organisations were selected for the in-depth examination to participate the multiple-case studies. This section provides background information about each organisation.

Company 1 is an international engineering and construction company that has over 2900 employees employed across ten different sectors, such as infrastructure (highways, rail, and water), environment (water, waste, and chemicals), energy (power and nuclear), and construction (airports and education). The company had a vision of being the top service provider in the UK and defines its corporate strategy to meet the national needs based on the vision. The company identified innovation as the key for the company's success both now and in the future. The company has been committed to the implementation of e-business initiatives since the late 1990's. Interviewee 1a was the System and Technology Director and was responsible for the strategic development and implementation of IT systems across the global organisation. Interviewee 1b was a Senior Project Manager and he was working on airport projects. Interviewee 1c was a specialist working as part of the IT technical support team; and his role was to provide technical support for projects and mentor project team members in the use of specific e-business tools and applications.

Company 2 is an international construction company with expertise in construction, development, and infrastructure with over 4500 employees across the world. The core company business value was to be a leader in green construction, health and safety, and business ethics. To meet this goal, since 2005, the company has been committed to a specific e-business initiative to manage the design process, facilitate on-site construction activity and operation, and integrate facility management. Interviewee 2a was the Technical Service Director of the company and he was part of the senior management team responsible for the technical service, business development, and IT. Interviewee 2b was a Senior Project Manager, and he was involved in a large hospital project. Interviewee 2c was the company BIM Director who was leading a team to direct and ensure the commitment to BIM application on projects. Interviewee 2d was the Procurement Manager of the company who was able to explain how the electronic tools and applications were used during the procurement process.

Company 3 is a global integrated design and engineering consultant providing multi-disciplinary professional services for railways, buildings and infrastructure, environment and natural resources, and roads. The company had over 4500 employees with a worldwide network of offices. To achieve the value of being knowledgeable, the company targeted becoming a leading integrated enterprise and continuously invested in information technologies. In 2005, the company started an “e-project” to allow electronic transactions across the entire organisation instead of relying on isolated electronic applications in different departments. Interviewee 3a was the Information System Director and his main responsibility was to direct the implementation and development of IT strategically across the organisation. Interviewee 3b was the BIM/CAD Manager for managing all the technical issues to support the adoption of BIM/CAD within the organisation. Interviewee 3c was one of the Senior IT Managers, responsible for the IT infrastructure of the organisation. Interviewee 3d was the Procurement Manager of the company who were knowledgeable about the e-procurement tools and applications used in the organisation.

Company 4 was a global provider of planning, design and delivery solutions for the built environment. The company employed over 1800 professionals across a global network of 25 offices on three continents. In 2006, through working with leading companies in the construction industry the company defined its main corporate business strategy based on newly emerging technologies, such as BIM and IPD (Integrated

Project Delivery), to deliver better projects and more value to clients. Interviewee 4a was the IT Manager who was responsible for IT infrastructure support and development for the organisation to deliver a better service to the customers. Interviewee 4b was the BIM Manager; his roles and responsibilities included defining e-business strategies and executing plans, designing e-business technical training and arranging skill assessments methods and procedures. Tables 5.1 and 5.2 give a background of the case study organisations and that of relevant staff interviewed in each organisation.

Table 5.1 Companies for the Multiple-case Studies

Case Study Organisation	**Number of Employees**	**Construction Discipline**
Company 1	≥2900	Contractor, construction and engineering
Company 2	≥4500	Contractor, construction and development
Company 3	≥4500	Consultant, construction, engineering and technical service
Company 4	≥1800	Consultant, architecture and engineering

Table 5.2 Staff Interviewed in Each Organisation

Case Study Organisation	**Interview Indicator**	**Job Title**
Company 1	Interviewee 1a	Systems and Technology Director
	Interviewee 1b	Senior Project Manager
	Interviewee 1c	IT Specialist and Technical Support
Company 2	Interviewee 2a	Technical Service Director
	Interviewee 2b	Senior Project Manager
	Interviewee 2c	BIM Director
	Interviewee 2d	Procurement Manager
Company 3	Interviewee 3a	Information Systems Director
	Interviewee 3b	BIM/CAD Manager
	Interviewee 3c	Senior IT Manager
	Interviewee 3d	Procurement Manager
Company 4	Interviewee 4a	IT Manager
	Interviewee 4b	BIM Manager

5.3 Key Findings and Analysis of the Case Studies

5.2 Background of the Case Studies	5.3 Key Findings and Analysis of the Case Studies
5.4 Summary	

5.3.1 e-Business Strategy

The survey findings indicated that organisations in the construction industry were aware of the competitive advantages of e-business and they believed that appropriate strategic actions would lead to improvement to e-business practices (Sections 4.3.4 and 4.3.5 in Chapter Four). However, literature (Section 2.4.4 in Chapter Two) revealed that the approaches available currently for e-business implementation were mainly 'reactive' and lacked of long-term vision or strategy (Ruikar, 2004; European Commission, 2006; Construct IT, 2008; Anumba and Ruikar, 2008). The 'reactive' approaches will only meet the current needs of organisations and cannot address the emerging needs in the future to ensure the sustained competitiveness (Ruikar, et al., 2006; Johnson, et al., 2008; Chaffey, 2009). The survey findings confirmed the above statement, furthermore, indicated that many organisations (59% of the survey respondents) had a plan for launching e-business implementation in short-term or medium-term, but only very few (2% of the survey respondents) had a plan for launching e-business implementation in long-term (Section 4.3.6). The in-depth investigation was therefore needed to determine the reasons why organisations did not plan e-business implementation in the long-term.

The multiple-case studies attempt to examine the actual practices of industry practitioners in defining and planning e-business strategies. In this section, three areas were investigated: 1) currently available strategies for managing e-business practices among the target organisations; 2) how the strategies were developed; and 3) their future plans for implementing e-business.

5.3.1.1 Currently Available Strategies for Managing e-Business Practices

The findings of the case studies indicated that *none* of the target organisations had an independent e-business strategy. Other strategies were defined to guide and manage the e-business practices. Some organisations defined Information Systems (IS)

strategies to support the e-business activities. For example, Company 1 defined a business systems group (BSG) strategy to support its e-business activities in a variety of areas, including service promotion, e-procurement, project management and collaboration, and supply chain management. The other organisations defined technology (adoption) strategies for specific e-business solutions to guide the e-business practices. For example, Companies 2, 3 and 4 defined BIM as the appropriate e-business solution for their organisations and developed BIM strategies.

Information Systems (IS) Strategy for Managing e-Business Activities and Practices

In Company 1, a business systems group (BSG) strategy was defined to guide and manage its e-business practices. The BSG strategy was a three-year information systems (IS) strategy for the entire organisation. The strategy was defined to provide services in the following areas: 1) systems and processes; 2) computer technology; and 3) business improvement. The contents of the BSG strategy included:

- *A set of analysis on the company's situation*: including both internal analysis on resources and finance and external analysis on customers, competitors and other external factors;
- *The company vision on information systems*: the Vision statement described as "enabling Company 1 personnel have best systems, tools and technology", which sets a firm foundation for future information system development and growth;
- *Strategic objectives*: "specific accomplishment if achieved, will contribute towards achieving the critical success factors";
- *Critical success factors (CSFs)*: "areas that the BSG strategy need to do well if it is seen as having been a success by all stakeholders", and focusing on areas such as information technologies, business performance, business systems, and system operation and maintenance;
- *A high level Action Plan*: describing how the strategic objectives and CSFs will be achieved, and identifying the strategic issues, actions needed to perform, timescales and responsible team or personnel.

The IS strategy is crucial in supporting the e-business implementation (Chaffey, 2009). However, the e-business strategy and the IS strategy are not exchangeable. The reasons include:

1) *The role of an IS strategy and an e-business strategy is different*: an IS strategy is defined to support business functions (Zeng and Li, 2008), and an e-business strategy is defined to enable organisations to promote the alignment of business and IT infrastructure in order to derive maximum benefit from an organisation's investments in technology (Beal and Mosse, 2008);
2) *The essential part of an IS strategy and an e-business strategy is different:* the essential part of IS strategy is to provide a suitable technological infrastructure (Chaffey, 2009), and the essential part of e-business strategy is to define how organisations connect with external partners as well as how organisations operate within management activities, processes and systems (Zeng and Li, 2008).

Using Company 1 as an example, based on the main contents of the BSG strategy, it can be concluded that Company 1 had conducted careful analysis of their business situation and formulated the strategy. The BSG strategy identified the robust IT infrastructure necessary to support business functions and defined the future growth and development in technologies and systems. But the strategy did not identify how the company could interact with its external partners, and how the company should deal with changes related to management. Interviewee 1a, the Systems and Technology Director of Company 1, commented on this missing area as follows:

"*I believe there is a missed opportunity in general across Company 1 that we don't put data captured from either CAD or BIM modelling into the systems of our business partners. Also, we don't link the system that we had, like the planning system, and commercial procurement, into the information sets that come from the consultants, and equally that come back from the subcontractors. Absolutely, I believe that there need be changes in both how we apply the systems, and how people do the processes.*"

Section 2.4.4.2 (Chapter Two) noted that the goal of an e-business strategy was to define the future direction and actions of an organisation by which applications of both *internal* and *external* electronic communications could support and influence corporate strategy (Chaffey, 2009). To perform effective electronic communications, organisations in the construction industry need plan and structure the internal resources and processes that are associated with their e-business practices, and also need to identify how they can link to the systems of their business partners' or project

collaborators'. Moreover, many experts also emphasised the importance of collaboration between business partners as well as management involvement when defining and formulating an e-business strategy (Alhawamdeh, 2007; Chaffey, 2009; Pursultani and Akhgar, 2010). Therefore, issues that are associated with the external business partners, and changes that are related to management must be addressed when organisations define their e-business strategies.

Technology Strategies for Specific e-Business Solutions

In Companies 2, 3 and 4, technology strategies based on specific e-business solutions (i.e. BIM strategies) were defined to implement the solutions progressively. All these strategies were for medium-term (three to five years). In addition to the organisational specific issues, the technology strategies defined in Companies 2, 3 and 4 included the following contents (using BIM strategies as examples):

- *Current situation with respect to BIM*: describing the increasing visual representations of projects, and stating that BIM was prevalent in the market and the competitors are getting involved;
- *Staffing and Resources*: identifying the appropriate staff to be responsible for the BIM implementation and technical support, identifying training requirements and training sessions, and identifying the suitable technological infrastructure (i.e. hardware and software) to implement BIM;
- *Customers and supply chain business partners*: Determining customers' awareness about BIM and examining the engagement of supply chain business partners in BIM;
- *Financial budget*: identifying BIM budgets on different types of projects (e.g. small, medium and large projects) and on central administration;
- *Standards and processes*: identifying BIM standards and determining systems or processes referencing BIM;
- *Timescales/programme*: identifying high-level actions to be accomplished annually.

Based on the main contents of the technology strategies, it can be concluded that Companies 2, 3 and 4 also conducted situation analysis with regard to the specific e-business solution and formulated the technology strategies. The strategies identified the

essential actions by which organisations could utilise internal resources (e.g. staff, hardware, software and finance) and processes, and obtain buy-in from external business partners (e.g. customers and supply chain partners) in order to implement the specific e-business solution progressively. However, according to Johnson et al., (2008), to tie future developments to a single technology or technological solution can be both inappropriate and risky, and core competences may be found in the processes of linking technologies together rather than the technologies per se. In e-business implementation, defining technology strategies based on one specific e-business solution (e.g. as Companies 2, 3 and 4 did), and having no overall consideration for implementing e-business across the organisation, may result in problems such as missed opportunities of not benefiting from their intended capabilities, inappropriate direction in e-business development, limited integration, and resource wastage (Chaffey, 2009).

Using Company 2 as an example, Company 2 was planning to implement BIM progressively in the next 15 to 20 years. Several areas were defined for implementing BIM, such as visualisation, 4D, clash prevention, design, analysis, quantity take off, procurement, construction, logistics, facilities management, information management, lifecycle cost and etc. The areas, such as visualisation, 4D and clash prevention only require capturing data from a single source, but the other areas, such as design, analysis, quantity take-off, procurement, construction, logistics, facilities management (FM), information management, and lifecycle cost, require capturing data from a variety of sources. The organisation must consider how the BIM solution can integrate with other company electronic systems. For example, Company 2 needs to consider how the adopted BIM solution can integrate with its estimating software when doing quantity take-off. However, such practice (considering the integration of BIM and other electronic systems) was quite limited within Company 2. Interviewee 2c, the BIM Manager of the Company, stated that the organisation “only did things in clash detection, 4D planning, FM, and currently do 10% BIM can offer”. Therefore, a holistic e-business solution is required to improve their e-business practices, or the company is likely to end-up with a software installation rather than an implementation of a comprehensive solution to specific business problems. Company 2 has realised the problem in their e-business implementation. Interviewee 2a, the Technical Service Director of Company 2, stated that a holistic approach would be a big step forward to improve their e-business implementation.

Moreover, In Companies 2, 3 and 4, technology strategies based on specific e-business solutions (i.e. BIM strategies) were defined to match the target markets and distinguish themselves from their competitors. For example, Company 2 defined BIM as the appropriate e-business solution to help them remain competitive in the target market (i.e. construction, building development and infrastructure). Interviewee 2a, the Technical Service Director of Company 2, stated their commitments to BIM as:

"If we don't do it, we will see our market slowly disappear. We won't make a lot of money from it, and the large part of the benefits goes to the clients, but we won't win work if we don't do it".

Companies 3 and 4 defined BIM as the appropriate solution for them because they believed that BIM could meet the customers' needs better than the traditional way of doing business. Interviewee 4a, the IT Manager of Company 4, stated their commitments to BIM as:

"We are planning to use BIM across all types of work, anything from planning, interior, to new build, even refurbishment as well. This certainly is the vision and goal, we are not there yet, and we are learning as we can, but we are ahead of our competitors".

The role of strategy is to guide organisations regarding the critical decision on where and how they should compete (Lukac and Frazier, 2012). According to Tidd et al. (2005), the ways in which technological development can underpin competitiveness will vary depending on the nature of both the technology and the markets. Based on the novelty of technology and markets, the following approaches are available for organisations to match their technology strategies to markets in which they compete (see Figure 5.1):

- *Technological approach:* refers to apply new technologies to customers' needs, and products and services compete on the basis of enhanced performance against current product;
- *Complex approach:* are needed when both technologies and markets are novel and need to co-evolve;
- *Differentiated approach*: will be appropriated when both technologies and markets are mature, and product and service improvements are achieved by using existing technology to address a known customer requirement;

- *Architectural approach*: will work when existing technologies can be combined to create novel products, services or new applications.

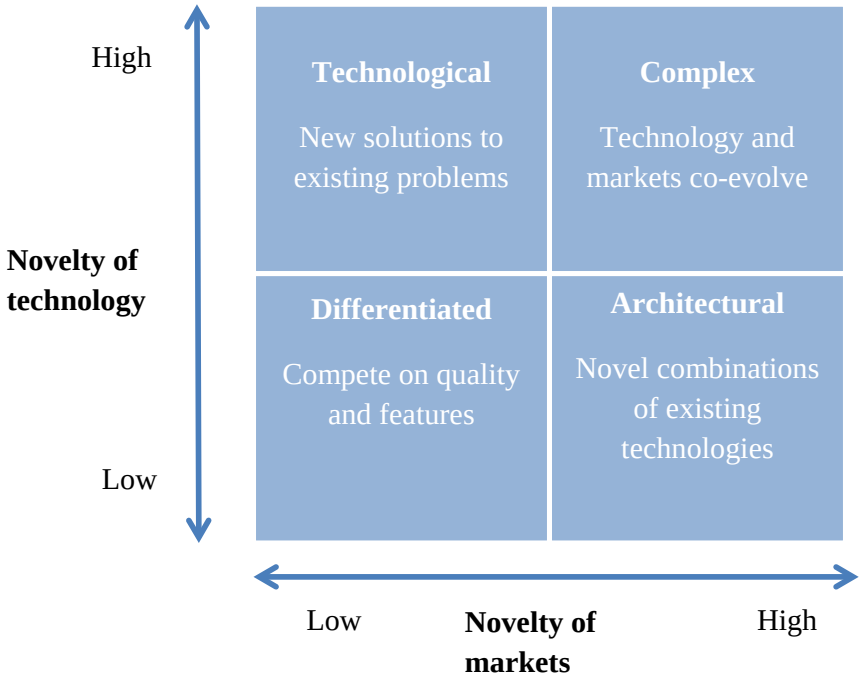


Figure 5.1 Matching Technology Strategies to Markets (Source: Bessant and Pavitt, 2005)

As a traditional industry sector, the markets in which construction companies compete are mature (Norton, 2008). As described in Section 2.3.4 of Chapter Two, the currently available e-business technologies are mature enough to meet construction-specific needs and requirements (Wilkinson, 2005; IFS, 2010). Therefore, construction organisations cannot use the technological approaches when they try to match their e-business strategies to the target markets because the fist-mover (i.e. being first to market with a new product, process or service) advantages no longer exist. They need to apply the differentiated approaches to distinguish themselves from their competitors based on creating e-business capabilities that are organisation-specific, rare and difficult to imitate or substitute in order to remain competitive (as Companies 2, 3 and 4 did). Examples of such e-business capabilities include information sharing capabilities and collaboration capabilities (Zhao et al., 2008). To identify these capabilities, a careful

analysis is required to scan an organisation as a whole (Johnson et al., 2008; Chaffey, 2009).

5.3.1.2 How the Strategies Were Developed

The findings of case studies indicated that no sequential approaches, such as the models or frameworks described in Section 2.4.4.5, were used to guide the development of e-business relevant strategies (either IS strategy or technology strategies for specific e-business solution) in the target organisations. For example, in Companies 1, 3 and 4, the IT Directors or Senior IT Managers developed the strategies based on personal experience (i.e. working experience, past research, knowledge about the organisation's structure, culture and processes). The required strategic actions and timescales were also defined based on what the IT Directors or Senior IT Managers thought was realistic to achieve over the time period covered by the strategies. In Company 2, the key business leaders (i.e. Sector and Regional Managers) defined the strategies based on their sectors' or regions' needs, and the IT Managers and their team only provided technical supports when required.

Thus, it is important for e-business strategies to be incorporated into the business strategies so that the internal processes fully integrate with the elements of the value network. This finding is consistent with those of Chaffey (2009). Moreover, the strategic role of IT departments is currently becoming critical compared to their traditional technical and supportive role (O'Neil, 2007; Alshawi et al., 2008; Pritchard, 2011). However, strategy development is usually equated with formalised strategic planning systems and may take the form of systematised, step-by-step, chronological procedures involving different parts of organisations (Johnson et al., 2008). A strategy maker's personality, position or reputation may result in others willingly deferring to them and seeing strategy development as their province. However, according to Johnson et al. (2008), a mature strategy development requires facilitating converting an intended strategy into organisational actions by: 1) communicating intended strategy from the centre (i.e. strategy makers or their teams) to operation units; 2) providing agreed objectives or strategic milestones against which performance and progress can be reviewed; and 3) coordinating resources required to put strategy into effect. This is specifically beneficial in dynamic environments (Andersen, 2004). The effective implementation of e-business requires engagement across organisation boundaries. Developing e-business strategies only based on specific strategy makers (as all four

companies did) may result in problems such as excessive risk taken or unrealistic objectives (Chaffey, 2009). Therefore, when developing e-business strategies, strategy makers or their team should collaborate with other staff or teams from the organisation, such as human resource managers who are familiar with the roles and responsibilities of staff, operation managers who are knowledgeable about daily business activities and processes, and commercial or market managers who know well about the organisation business plans and target markets.

5.3.1.3 Future Plans for e-Business Implementation

The findings of case studies indicated that the companies would implement e-business continuously in future, they believed that e-business, specifically BIM, was the future of construction, and it would emerge everywhere in the next 25 years. For example, Companies 2, 3 and 4 would keep on using BIM in the next 10 to 15 years, and Company 1 would implement BIM into all their projects in future if its customers required such services.

However, the findings also indicated that all the companies planned to continue to define their e-business relevant strategies in medium term (three to five years). The interviewees stated that the current time scope would enable them to be more proactive in responding to the constant changes within the e-business domain. The interviewees also pointed out several challenges that prevented their organisations from developing long-term e-business strategies. The emphasised points included: 1) the fast pace of change within the e-business domain, specifically the emergence of new information technologies; 2) the fragmentation of the industry; 3) the historical way of how the industry members shared their information and cooperated (i.e. one to one correspondence); 4) the systems did not exist for capturing, storing, exchanging and sharing the data through project life cycle, and the organisations needed to build their own systems for this function, and 5) financial difficulties, such as the high cost after the initial investment of e-business solutions including cost associated with building essential infrastructure, training personnel, and rationalising business processes. The interviewees also commented that these challenges would not disappear in short-term and they only could change a small bit of things at a time.

Challenges that prevented the organisations from developing long-term e-business strategies won’t disappear shortly, so it may be not realistic to push organisations in the construction industry to define a long-term e-business strategy. However, their medium-

term strategies are not sufficient enough to address both the current and emerging needs. For example, although Companies 2, 3 and 4 had the intension to use BIM continuously in the next 10 to 15 years, none of them in their e-business relevant strategies had clearly defined how the currently available e-business solutions (including BIM) would transform their organisations to reach the goal of full integration between all internal organisational processes. Moreover, the strategies had not defined how to react to the emergence of new information technologies. These strategies were still 'reactive', not 'proactive'. Chaffey (2009) suggested that a vision for e-business was helpful since it could contextualise e-business in relation to an organisation's strategic initiatives (business alignment) and its marketplace. Furthermore, it also could help give a long-term emphasis to e-business transformation initiatives within an organisation. Ruikar et al. (2006) also suggested that the role of long-term vision is to correct the negative consequences of the short-term strategies and take into account emerging and future business needs to ensure sustained competitiveness. Therefore, a long-term e-business vision needs to be defined when organisations develop their e-business strategies in order to reinforce the medium-term strategies, address both the current and emerging needs, and ensure sustained competitiveness of an organisation (see Figure 5.2).

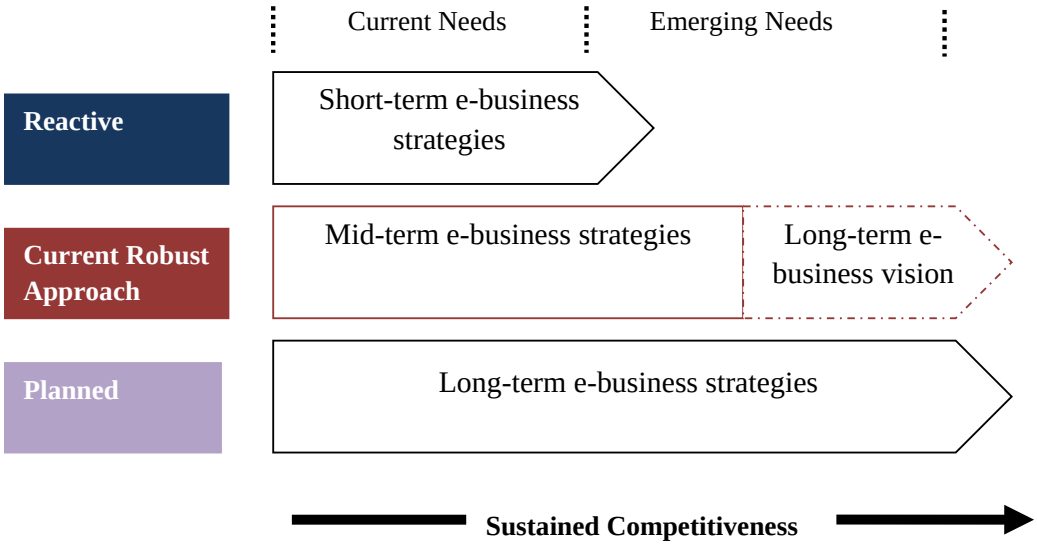


Figure 5.2 Defining a Long-term e-Business Vision to Reinforce the Medium-term e-Business Strategy (Adapted from Ruikar et al., 2006)

5.3.2 e-Business Implementation

This section is an attempt to explore how e-business is implemented in the target organisations. The investigation involves two levels: 1) at the organisational level, to assess the e-business development stages of the four companies as well as exploring how they manage the changes and risks associated with e-business practices; and 2) at the project level, to determine what e-business solutions were used and the impact of those solutions on products, processes and people.

5.3.2.1 Organisational Level Investigation: e-Business Development Stages of Companies

According to Chaffey (2009), the overall e-business development stage of an organisation can be assessed through reviewing:

1) *Service available*: what e-business enables the organisation to do currently;
2) *Organisational scope*: how e-business helps the organisation to transfer information and communication across departments or beyond;
3) *Transformation*: how the organisation define e-business to fit into its internal business activities and processes;
4) *Strategy*: how e-business strategy is associated with the overall business goal of the organisation (e.g. being integrated in the overall business goal, being incorporated as part of the overall business goal, and etc.).

Based on the above four aspects, the e-business development could be classified as four stages (from low to high): 1) web presence; 2) e-commerce; 3) integrated e-commerce; and 4) e-business. Organisations can assess their position on the continuum between stage 1 and 4.

The findings of case studies indicated that it was very difficult to assess the target organisations' e-business development stages. The main reason was that the current e-business development within these organisations was a mixture: it was characterised by advanced and mature implementation in some departments or functions, along with slow and recent implementation in other departments or functions. For example, all four companies were advanced in using construction collaboration tools and BIM solutions, but they were slow in using e-procurement systems. In the four companies, construction collaboration tools were used to perform collaboration design, project management, document management, customer relationship management and project programming; BIM solutions were used to do visualisation, clash detection, 4D planning and design,

quantity take-off, bidding and tendering, and project management. However, e-procurement systems were only used for electronic invoicing and payments, and other procurement activities such as electronic requisition, authority, order and purchase were rare.

Before the burst of the dotcom bubble in the late 1990s, organisations were rushing in e-business without hesitation, specifically in e-marketing and e-procurement (Chaffey, 2009; Schneider, 2010). Many organisations in the construction industry also invested in e-business solutions (Wilkinson, 2005). After the burst of the dotcom bubble, organisations started to reconsider the promised benefits and added value of e-business, and industry-specific solutions, such as construction collaboration tools and BIM, were adopted by organisations progressively (Wilkinson, 2005; Eastman et al., 2008). This historical fact about e-business may have caused the mixed adoption/developments in e-business within case study organisations.

The findings of case studies also indicated that the organisations were working on bridging the gaps in e-business implementation and enhancing this mixed development in e-business within their organisations. For example, Interviewee 1a, the Systems and Technology Director of Company 1, stated that:

"*To enhance the slow and recent e-business practices in some departments or functions, we are trying to do small bit of things at a time, for example, could be people, the willingness of people, and some specific changes for the particular project*".

The actions conducted by the organisations to enhance the mixed development in e-business included:

- *Increasing commitment from the senior management staff*: Many interviewees emphasised that the commitment from senior management was crucial for enhancing the e-business development, and it was much more efficient to manage gaps or changes from top-down than bottom-up. For example, in Company 1, the BSG strategy was submitted to and approved by the Senior Management Board (i.e. Group Business Development Director, Group Financial Director, and Chief Executive Officer). The review from the Senior Management Board was to ensure that the BSG strategy was based on the organisation's overall business goal and supported the corporate strategy. In Company 4, the President was the strategic leader of their e-business relevant technology strategies.

He personally devoted to many e-business research activities, actively collaborating with many research associations. This commitment set a firm foundation for the entire organisation to advance in e-business.

- *Changing the organisational culture to be conducive to e-business*: Almost all the interviewees agreed that the organisational culture must be changed if a company wished to enhance their development in e-business. Such changes included: a) changes in people's mind-set about using e-business tools and applications; b) changes in staff skill requirements and responsibilities; c) changes in committing to addressed issues/inhibitors in e-business implementation (e.g. risks and gaps during adoption). The four companies all had invested massively to manage these changes. Training sessions, skill assessment programme and workshops were planned and executed to improve staff's e-skill, improve their confidence in using e-business tools and applications, and increase the commitments to the addressed issues/inhibitions in e-business implementation.
- *Rationalising processes and identifying appropriate standards*: Some interviewees also commented that the internal organisational processes needed to be changed and the appropriate standards needed to be identified in order to enhance the e-business development and conduct electronic communications and transactions seamlessly. However, only Company 3 had rationalised its internal processes to simplify the description of technologies and ways of working. The rationalisation included two areas: a) processes for capital project delivery, such as the processes for the requirements, design and procurement stages; and b) the processes for operational asset management, such as the processes for commission, handover, operation and occupation stages. Moreover, e-business standards had been issued to enhance the e-business development in the case study companies. For example, in Companies 3 and 4, the BIM standards (i.e. Industry Foundation Classes (IFC)) had been issued to supersede the old CAD standards.

Chaffey (2009) defined four key aspects of change that needed to be assessed in order to maximise the benefits of e-business after its implementation: 1) market and business model; 2) business processes; 3) organisational culture, structure and staff

responsibilities; and 4) technological infrastructure. According to Chaffey (2009), all these changes must be specified in the organisations' e-business strategies and managed through project management approach in line with operational plans. Based on the findings of case studies discussed above, it can be concluded that the case study organisations have conducted a variety of actions to manage the required changes to enhance their e-business development, but their actions were not systematic and step-by-step. This may lead to low performance in e-business implementation. Therefore, the case study organisations need to consider project management approach in line with operational plans (e.g. an Action Plan) in order to plan and conduct the required changes and the associated actions systematically and step-by-step.

5.3.2.2 Project Level Investigation: e-Business Tools and Applications Used in Projects

The findings of case studies showed that a variety of e-business tools and applications were used at project level in the target organisations. The tools and applications included: 1) emails; 2) communication networks (intranets and extranets); 3) document management systems; 4) project management and collaboration tools; and 5) CAD and BIM tools. The degree to which these tools and applications were used in projects was depended on project type, project value, project complexity and customers' requirements. The findings showed that these e-business tools and applications were applied more in large and complicated projects than in small projects. For example, in a Science and Technology Research Centre project (valued £600 million), Company 4 used a variety of CAD/BIM tools (e.g. AutoCAD Revit, Bentley Structure, NavisWorks and AutoCAD MEP) to perform design tasks, the Codebook to track all the management of equipment with cost consultant, a web collaboration application named NewForma to conduct document management (e.g. audit, track, upload, download, portal and etc.), a BIM tool, NavisWorks, to communicate with contractors, and an ERP system, Deltek, to carry out project management. Interviewee 4a, the IT Manager of Company 4, stated their experience as:

"Without the help of currently available e-business tools, the completion of some of our (large and complicated) projects was impossible".

Also, in a rail project, Company 3 also used CAD tools (e.g. Mac Station, Autodesk, Bentley, some rail design tools) to complete design, BIM tools (e.g. Linear BIM and Revit) to perform surveying, creating rail digital grade model, and delivering

data beyond the design phase, collaboration tools (i.e. BIW) to conduct project management and document share, and enable the client to get into their intranet to get and publish information, and planning tools (i.e. Primavera) to carry out project programming.

The findings of case studies showed that the adoption of these e-business tools and applications improved the project delivery, reduced project risks, improved relationships with customers, and improved communication and collaboration with project collaborations. Other benefits emphasised by the interviewees included: 1) improved productivity; 2) decreased defect; 3) saved time and money; 4) decreased waste; and 5) decreased accidents. However, the adoption of such tools and applications also raised challenges. For example, challenges coming from the mix of technologies, such as the creation of a super BIM model, and how to split it into small models. The legal issue of design ownership also raised concerns. The project collaborators need to adopt an agreed approach and originally share the risk. Moreover, there were challenges associated with project processes. The findings of case studies showed that there was a resistance in the change of current project processes because the industry practitioners believed that the intelligent processes for delivering quality data were still not available. Interviewee 2a, the Technical Director of Company 2, commented that:

"If you got good process and procedures, but bad people, that is a disaster; if you got bad process and procedures, but really good people, that turns to be OK. The emphasis is to school with the people, not the processes".

Interviewee 3c, the Senior IT Manager of Company 3, stated their practices in project processes as:

"The project working processes cannot be changed, and if the technology is not suited to the processes, we twist the technology to fit in".

Good people and teams are crucial for the success of project completion (Lewis, 2007; Billingham, 2008; Kerzner, 2009). When applying e-business tools and applications for project management, the knowledge, experience and skills of people are extremely important for maximising the benefits from technology adoption (Ruikar et al., 2006; Chaffey, 2009). However, project processes also need to be examined and mapped in order to identify the bottlenecks in e-business adoption and devise changes to remove such bottlenecks or process inefficiency (Ruikar et al., 2006; Laudon and Laudon, 2009). The resistance in the change of current project processes must be

addressed in e-business implementation and more efforts are required to improve those processes.

5.3.3 Units of Measurement for e-Business Strategy and Implementation

This section investigates how the target organisations evaluate their e-business implementation and how they review their e-business relevant strategies. The investigated areas include: 1) measures for e-business implementation; and 2) measures for e-business strategies.

5.3.3.1 Units of Measurement for e-Business Implementation

The findings of case studies showed that the companies evaluate their e-business implementation mainly through identifying the tangible benefits of e-business. Units of measurement used by the companies included: 1) calculating the ROI (return on investment); and 2) determining the cost savings at project level. For example, Companies 2 conducted a project on evaluating the ROI of BIM adoption in 2008. The result was that the ROI of applying BIM within its company was five to one. Also, Company 1 carried out a financial analysis on one of their projects which have adopted collaboration tools and 3D design. The use of the e-business tools led to a cost saving of £ 130,000 in that project.

Moreover, the case studies indicated that the companies also tried to evaluate their e-business implementation through determining the intangible benefits of e-business. For example, Company 3 tried to define the critical process factors that had great influence on e-business implementation. Company 4 attempted to define the critical human factors that would represent their staff's e-business or IT capabilities. However, those factors have not been adopted widely within the two organisations.

Section 2.4.1 (Chapter Two) introduced three main research approaches that focus on identifying the benefits and created value of e-business: 1) calculating the return-on-investment (ROI); 2) performing value decomposition; and 3) identifying the benefits and created value of e-business through a resource-based view. Organisations could use the ROI Calculator Tool to measure and quantify the costs versus the benefits of undertaking an e-business project (as Company 2 did). However, the calculation of ROI was criticised because there are challenges in calculating the complete ROI of e-business within organisations, such as determining what constitutes the total cost of a

certain e-business application and what constitutes the total return of the application (Mogollon and Raisinghani, 2003).

The value decomposition technique and resource-based view were both applied to e-business so as to examine the intangible benefits of e-business. However, the practices associated with both approaches would be very difficult and complicated if there were a variety of technological solutions involving in e-business implementation within a given organisations (Subramaniam and Shaw 2002; Fink, 2006; Raymond and Bergeron, 2008; Zhao et al., 2008; Jelassi and Enders, 2009). Therefore, ROI is still the most common approach for organisations in all sectors to identify the benefits of e-business (Chaffey, 2009). Moreover, all these three approaches covered how to identify value once it has been created or how to identify some of the actions that can create it, but they did not cover how to guide any particular organisation regarding the critical decisions on where and how they could achieve the value (Lukac and Frazier, 2012). It's the role of the strategy to perform such tasks. Therefore, identifying the benefits of e-business will not ensure the success of e-business implementation. Units of measurement for e-business implementation must be defined jointly with the actions in the e-business strategies.

5.3.3.2 Units of Measurement for e-Business Strategies

The findings of case studies indicated that the review of e-business relevant strategies (either the IS strategies or the technology strategies for specific e-business solution) was limited. In all the companies, the strategies were evaluated through yearly review. Milestones, not the units of measurement were used to review the effectiveness of the strategies. Moreover, the review was conducted among strategy makers and senior management staff. Other people or teams in the organisations were not involved in the review.

According to Johnson et al. (2008), any strategy should be evaluated based on three aspects: 1) suitability; 3) acceptability; and 3) feasibility. Suitability is concerned with whether a strategy addresses the key issues related to the strategic position of the organisation; acceptability is concerned with the expected performance outcomes of a strategy and the extent to which these meet the expectations of stakeholders; feasibility is concerned with whether a strategy can work practically, and whether an organisation has the capabilities to deliver a strategy. Appropriate tools, techniques and measures for reviewing the strategies based on the three aspects are required in order to ensure that

the strategies are executable and realistic and will not turn into intelligent exercises limited in senior management (Johnson et al., 2008; Chaffey, 2009). In addition, e-business strategies are defined to enable organisations to promote the alignment of business and IT infrastructure in order to derive the maximum benefit from their investments in technology (Beal and Mosse, 2008). According to Chaffey (2009), identifying critical success factors (CSFs) of e-business will connect the organisational performance with strategic objectives and help organisations to promote the alignment of business and IT infrastructure. Moreover, as described in Section 5.3.1.1, organisations in the construction industry should apply the differentiated strategies to distinguish themselves from their competitors based on creating e-business capabilities that are organisation-specific, rare and difficult to imitate or substitute in order to remain competitive. Therefore, organisations in the industry need consider how to connect the critical success factors with their organisational-specific e-business capabilities when attempting to identify units of measurement for reviewing e-business strategies.

5.4 Summary

5.2 Background of the Case Studies	5.3 Key Findings and Analysis of the Case Studies
5.4 Summary	

This chapter introduced the findings of multiple-case studies with four industry companies, presented and analysed the findings mainly based on their actual e-business practices in three areas: strategy, implementation and units of measurement.

None of the target organisations had defined an independent e-business at organisational level. Information systems (IS) strategies and technology strategies for specific e-business solutions (e.g. BIM strategies) were defined to support their e-business activities. None of them had used any logic-approach for the development of the strategies. Moreover, many challenges prevented them from developing a long-term (five to ten years) e-business strategy.

It was difficult to assess the target organisations' e-business development stages. The main reason was their development in e-business was a mixture. The mixed

development was associated with the historical fact of industry members in adopting e-business solutions. A variety of actions had been taken by the organisations to enhance their e-business development, such as increasing commitments from the senior management, changing the organisational culture to be conducive to e-business, and rationalising business processes and identifying appropriate standards. However, such actions will be sufficient only when they are planned in a project management approach in line with an operational plan. A variety of e-business tools and applications had used in the target organisations at project level. The findings indicated many benefits of applying these tools and applications. However, challenges, specifically associated with technologies and project processes, were also raised for further consideration.

Calculating ROI of e-business solutions was still the main approach for the organisations to evaluate their e-business implementation. Milestones, not units of measurement, were used for the companies to review the effectiveness of their e-business strategies. To achieve both the tangible and intangible benefits of e-business, organisations need to consider units of measurement to connect their organisational performance and their strategic actions. Defining CSFs of e-business implementation may be an appropriate approach to perform this task.

Combined the findings of the case studies, the strategic needs and requirements in e-business for organisations in the construction industry can be summarised as: 1) the organisations need to apply the differentiated strategies to distinguish themselves from their competitors based on creating e-business capabilities that are organisation-specific, rare and difficult to imitate or substitute in order to remain competitive; 2) a long-term e-business vision needs to be defined when organisations develop their e-business strategies in order to reinforce the medium-term strategies, address both the current and emerging future needs, and ensure the sustained competitiveness of an organisation; 3) organisations need to consider units of measurement to connect their organisational performance and their strategic actions in order to achieve both the tangible and intangible benefits of e-business; and 4) a holistic approach is required to help organisations to consider a comprehensive e-business solution. The next chapter will introduce the Strategic e-Business Framework developed to help organisations in the construction industry to plan, execute and review their e-business strategies.

CHAPTER SIX A STRATEGIC E-BUSINESS FRAMEWORK FOR ORGANISATIONS IN THE CONSTRUCTION INDUSTRY

6.1 Introduction

This chapter describes the development of a Strategic e-Business Framework for organisations in the construction industry to define, execute and review their e-business strategies. The chapter is structured in five sections. Section 6.2 describes the background and development of the Framework, including the rationale for its development, its aim and objectives, the key principles adopted in it, the way it was developed, and guidance on how to read and use it. Section 6.3 presents the five functional factors defined in the Framework and justifies why their inclusion. Section 6.4 presents the six phases of the Framework, including the outputs of each phase as well as the main activities. Section 6.5 is the summary of the chapter contents.

6.2 Background and Development of the Framework	6.3 Factors of the Framework	6.4 Phases of the Framework
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6.2 Background and Development of the Framework

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6.2.1 Rationale for the Development of the Framework

Croft (2007) stated that a framework refers to a basic structure that underlies systems, concepts or texts, and includes a set of tools, libraries, conventions, and best practices that attempt to abstract routine tasks into generic modules that can be repeated. In other words, frameworks are concerned with a logical structure for practical use. In contrast to this, Kuhne (2005) stated that a model is used for reflecting or describing the original attribute. Section 2.4.4 of Chapter Two noted that frameworks were sufficient

for traditional organisations to formulate their e-business strategies because frameworks could address the fragmented needs and requirements within organisations ((Jelassi and Enders, 2009; Pursultani and Akhgar, 2010). Therefore, a framework is more suitable than a model in addressing the needs and comprehensive requirements of e-business implementation in the construction industry.

Against this background, the rationale for considering a Strategic e-Business Framework includes:

- Although a few models such as the Chaffey's generic process model for e-business (2009), aims to help traditional organisations to improve their e-business implementation, there is little guidance available for advising them on how to review e-business strategies after execution, which makes the promised continuous improvement impossible;
- Members of the construction industry are aware of the strategic benefits of e-business across organisations as opposed to benefits to individual departments or projects, however, their e-business strategies are still focused on functions or projects rather than the organisation as a whole;
- Although members of the industry are aware of the opportunities created by linking systems (e.g. planning systems, and commercial procurement systems) to people and to process, such linkages are not happening in reality;
- Although the members of the industry are aware that the successes of their e-business implementation requires the engagement of players in the organisations' external environment, (e.g. supply chain partners or collaborators in a project), this realisation is not often acted upon.

6.2.2 Aim and Objectives of the Framework

The main purpose of the Strategic e-Business Framework was to provide a holistic approach for e-business strategy development and implementation in order to achieve the aim of the research. The Framework is a comprehensive manual on how to develop e-business strategies for organisations in the construction industry. It provides guidance for organisations in the industry to help them to utilise their available IT resources and maximise the benefits of e-business through strategic practices.

The Framework is designed specifically for the senior IT management staff (e.g. company Senior IT managers, or corporate IT Directors) to define organisational level e-business strategies and implementation plans. However, the Framework also requires the involvement of other staff in the organisation, from the senior management to end-users. To achieve the main purpose of the Framework, five objectives are defined as follows:

- To provide a sequential approach for defining, managing and reviewing e-business strategies, and enable continuous improvement in e-business implementation;
- To provide guidance for the IT leaders to carry out consistent planning and review procedures throughout the e-business implementation;
- To consider functional factors related to both the internal and external environments, and prepare organisations to be able immediately implement e-business;
- To specify the roles and responsibilities in relation to defined activities and provide a basis for the organisations to utilise its available resources;
- To identify the critical success factors (CSFs) that affect the implementation of e-business; this enables organisations to identify areas where improvement is required, execute required changes and review the effectiveness of their e-business strategies.

6.2.3 The Key Principle of the Framework

The rapid change within the domain of e-business brings difficulties not only to academic research and prediction of future trends in e-business (Clarke, 2000; Drew, 2002), but also to IT Managers in organisations when developing e-business strategies. Section 5.3.1 (Chapter Five) discussed how organisations included in the case studies defined their strategies associated to e-business practices in the medium-term (three to five years). The reason for selecting this relatively short period was that they believed that their e-business technologies would be out-of-date within three years or five years. Because of this, they require a framework for defining e-business strategies that has the feature of being dynamic, to enable continuous improvement in process while accommodating future technological developments. Moreover, the framework also needed to be consistent in contents and procedures in order to make long-term e-

business planning possible. To achieve these two main features, the Plan-Do-Study-Act (PDSA) model was applied as the key principle to guide the design of the Framework. The origin of the PDSA is the “Deming wheel” for learning and improvement (Deming, 1993), which can also be broadened into a model for process improvement (Langley et al. , 2009).

According to Moen and Norman (2009), the Plan stage of the PDSA model identifies a problem and tries to determine a way in which to solve it. This stage usually requires setting up objectives and preparing for the execution of a plan, which may include the communication of the plan within the organisation and to selected external parties. The output of this stage is usually an Action Plan. The Do stage of the PDSA model refers to the execution of the Action Plan and documenting the problems, which is easy to say and hard to do. The Study stage of the PDSA model identifies the reasons why the Plan does not work or why the objectives are difficult to achieve. The output of this stage is a document or feedback summarising the conclusions of the review and analysis. The Act stage of the PDSA model refers to the actions related to monitoring the results and making changes for future improvement.

The rationale for applying the PDSA model to the design of the framework includes: 1) the model provides a method that manages changes and allows process continuous improvement to be effectively; and 2) the model provides a learning and feedback loop that enables lessons learnt from the past to be incorporated in the required process improvements.

As described in Section 3.4.4 (Chapter Three), the analysis of collected data (i.e. findings from the industry survey and case studies) was reviewed to generalise the shared main themes. The review of the main themes indicated six elements for e-business strategy and its development. The six elements were defined as phases to follow when developing an e-business strategy. The six phases were: 1) Analyse Situation, 2) Establish Vision, 3) Define Critical Success Factors (CSFs), 4) Develop Action Plan, 5) Implement Action Plan, and 6) Review Strategy. Translating the PDSA model into actions for e-business implementation in the construction industry, the Plan stage covers the first four phases: Analyse Situation, Establish Vision, Define Critical Success Factors, and Develop Action Plan. The Do stage covers the fifth phase: Implement Action Plan. The Study and Act stage are considered and applied during the

sixth phase: Review Strategy. Figure 6.1 illustrates the PDSA model and how it is adopted for the proposed Framework.

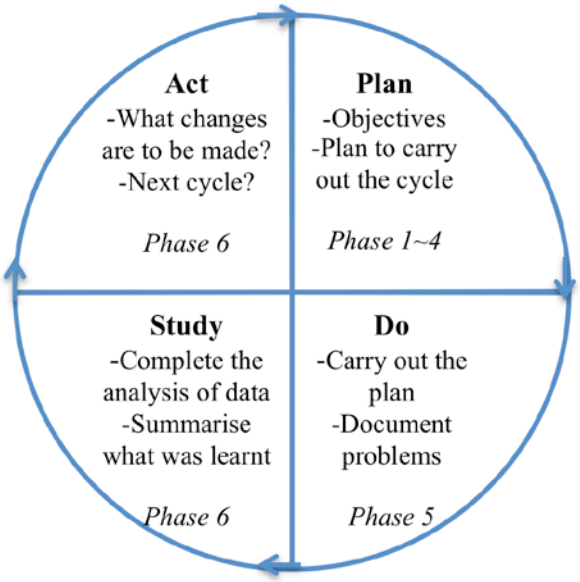

Figure 6.1 Key principles of the Strategic e-Business Framework (Langley et al., 1994)

6.2.4 Framework Development

In this section, the development of the Strategic e-Business Framework is justified and demonstrated. Section 5.5 (Chapter Five) established that a Strategic e-Business Framework could provide potential solutions to the issues of the construction industry in implementing e-business. Section 3.4.5 (Chapter Three) showed that the literature review and the results of the industry survey and case studies form a good foundation for the development of the Strategic e-Business Framework. Using this foundation, a number of models, frameworks and tools were reviewed for the development of the Strategic e-Business Framework.

The approaches for developing e-business strategies for organisations in all sectors were reviewed first. Three approaches were discussed and introduced in Section 2.4.4.5 (Chapter Two). These approaches built on the theory of strategy formulation and management, but each had a different focus. The *Roadmap for e- Business* model (Kalakola and Robinson, 2004) has an emphasis on the continuous review and prioritisation of investment in new applications. However, this model is not suitable for organisations that wish to leverage their resources to improve e-business capabilities

and provide an integrated approach for long-term e-business implementation. The *e-Business Strategy Framework* (Jelassi and Enders, 2009) suggests that organisations should undertake e-business strategy options based on the created value of implementing such options. However, the created value of e-business is difficult to be quantified in monetary terms sometimes when the value is associated with intangible benefits (Al-Mashari, 2002; Mogollon and Raisinghani, 2003; Fink, 206; Chaffey, 2009). Therefore, it would more persuasive to show the role of e-business strategy in improving the overall performance of the organisations and supporting the corporate goal (Chaffey, 2009). The Generic e-Business Strategy Process Model (Chaffey, 2009) defined the elements of an e-business strategy and its development in a dynamic manner, and can be used as a guide for organisations to determine e-business strategic issues at a high level. Therefore, among the three approaches, the Generic e-Business Strategy Process Model (Chaffey, 2009) was the most relevant. However, since it is a generic model for all business sectors, industry-specific elements must be added when planning a holistic approach for organisations in the construction industry.

Other than the Generic e-Business Strategy Process Model, four other construction-specific approaches (models, frameworks or tools) relevant to the current study were also reviewed. These approaches included the PIECC Decision-Making Framework (Shelbourn, et al., 2006), the e-business readiness assessment tool VERDICT (Ruikar, 2006), the IS/IT Organisational Readiness Model (Alshawi, 2007), and the Construction Process Protocol (Copper et al., 1998). The following gives an overview of each:

1) *The PIECC Decision-Making Framework:* The PIECC (Planning and Implementing Effective Collaboration in Construction) Decision-Making Framework was designed to guide organisations in the planning and implementing effective collaborative working (Shelbourn, et al., 2006). The Framework defines four key aspects and a set of sub-processes for each aspect to work through in order to develop a mutually acceptable collaboration strategy. The Framework also defined two activities for reviewing the collaboration strategy (e.g. reflections and feedback of collaboration, and measure the collaboration performance). However, it does not identify the way in which feedback and measures can be shared across the collaboration teams and project teams, so it will be difficult for

organisations to learn lessons from previous collaboration practices. Moreover, the Framework defines an activity to obtain support externally (i.e. collaboration support from external sources), but the role of the external business partners is not clearly identified.

2) *The VERDICT Application*: VERDICT (Verify End-user e-Readiness using a Diagnostic Tool) was designed for organisations in the construction industry to gauge their e-readiness (Ruikar et al., 2006). VERDICT defines the categories of criteria necessary to assess the ability of an organisation to adopt, use and benefit from e-business. The categories include Management, People, Process and Technology. VERDICT can also help in highlighting areas that must be addressed to achieve e-readiness. However, VERDICT does not define measures for organisations to address the issues of highlighting areas and the necessary procedures for them to go through to make improvement in such areas.
3) *The IS/IT Organisational Readiness Model*: this was designed to assist organisations in the construction industry to successfully implement IT/IS (Alshawi, 2007). The Model identifies four categories of criteria to assess the ability of an organisation to successfully implement and evaluate IT/IS: People, Processes, Technology and Environment. The Model also defines the maturity level of each category for units of measurement. However, how organisations can improve their organisational readiness (e.g. improve the maturity level from the lowest to the highest) has not been addressed in the model.
4) *The Construction Process Protocol:* this was developed to help construction project participants work together seamlessly through bringing together diverse functions/companies involved in construction projects under the common framework of a structured process (Process Protocol, 2011). The Process Protocol Framework incorporates the concepts of process gate and process review. The process gate concept (soft gate and hard gate) is designed to ensure that the key decision points in the process are respected, and the process review concept (feedback from the results of previous decisions) enables continuous process improvement (Copper et al., 1998). The Framework can be adapted to

manage different processes sequentially. However, the Framework is not suitable for managing processes that are not sequential and not repeatable (e.g. one-off events or activities).

The Strategic e-Business Framework developed as part of the current research combines the aspects of five approaches: Chaffey's Generic e-Business Process Model, the PIECC Decision-Making Framework, the VERDICT application, the IT/IS Organisational Readiness Model and the Process Protocol Framework, and builds on them. The Generic e-Business Process Model was used as a guide to define the phases of the Strategic e-Business Framework, the PIECC Decision-Making Framework helped to identify the main activities of each phase, the VERDICT application and the IT/IS Organisational Readiness Model helped determine the factors responsible for the main activities of each phase in the Strategic e-Business Framework, and the Process Protocol Framework was adopted to identify the layout of the Strategic e-Business Framework. Figure 6.2 illustrates the development of the Strategic e-Business Framework.

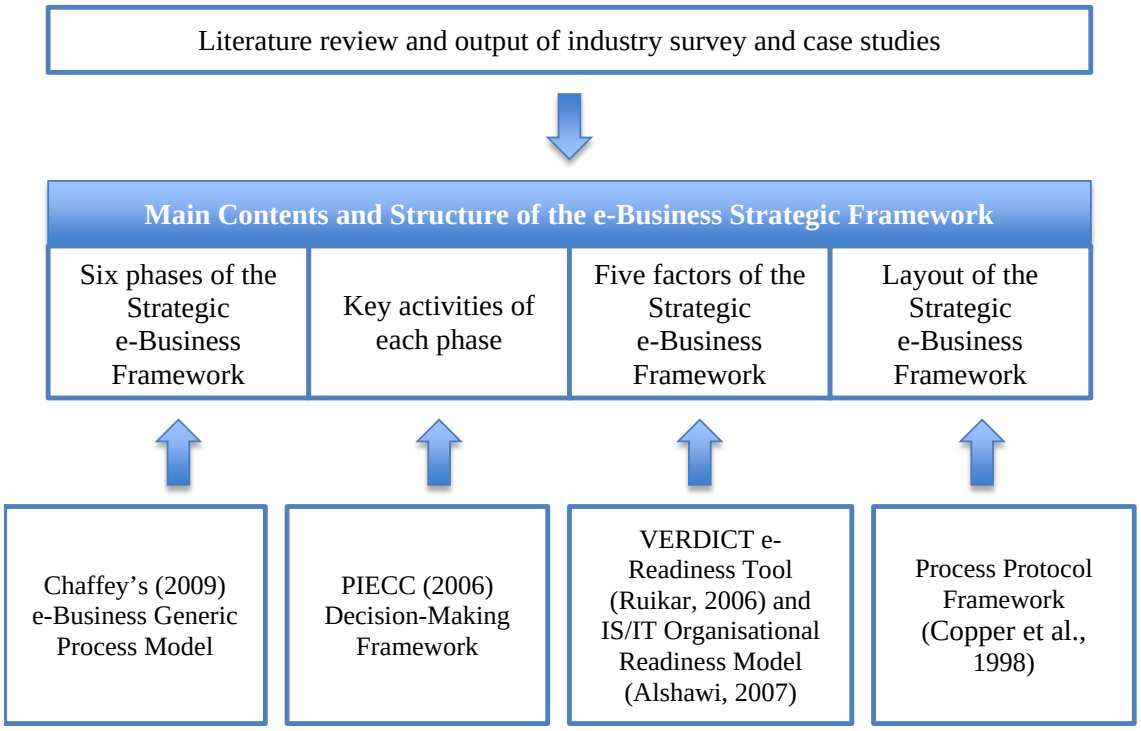

Figure 6.2 Development of the Strategic e-Business Framework

6.2.5 How to Understand and Use the Framework

The Strategic e-Business Framework (Figure 6.3) presents a holistic approach for organisations in the construction industry to perform e-business strategy formulation, implementation and review. The Framework comprises the following six main components:

- *Phases*: the high level elements of the Strategic e-Business Framework, which are the main subjects that organisations in the industry must work through when developing their e-business strategies. The Framework consists of six phases: Analyse Situation, Establish Vision, Define Critical Success Factors, Develop Action Plan, Implement Action Plan and Review Strategy. The details of each phase and the included activities will be presented in Section 6.4.
- *Activities*: the actions within each phase. Once all the activities have been fully accomplished, the relevant phase has been successfully completed.
- *Factors*: the categories used to group the activities within each phase. Factors emphasise the importance of different functions within an organisation to ensure strategic implementation of e-business and its continuous improvement. The Framework includes five factors: Internal Environment (Management, People, Process and Technology) and External Environment. The details of each factor will be presented in Section 6.3.
- *Sub-activities*: the actions within some activities, which are defined when these activities requires input from people, process and technology.
- *Phase Gates*: including soft gates and hard gates, which are defined to ensure that the key decision points in the process are respected. The Framework consists of four hard gates and two soft gates.
- *Roles and Responsibilities*: the teams or people identified as the appropriate parties responsible for carrying out the activities. Five groups of people were assigned to the activities and sub-activities: Senior Management Board, IT Manager and their teams, Middle Level Management, Lower Level Management and other End-users, and External Collaborators.

A proposed framework for organisations in the construction industry to define, execute and review their e-business strategies is shown in Figure 6.3.

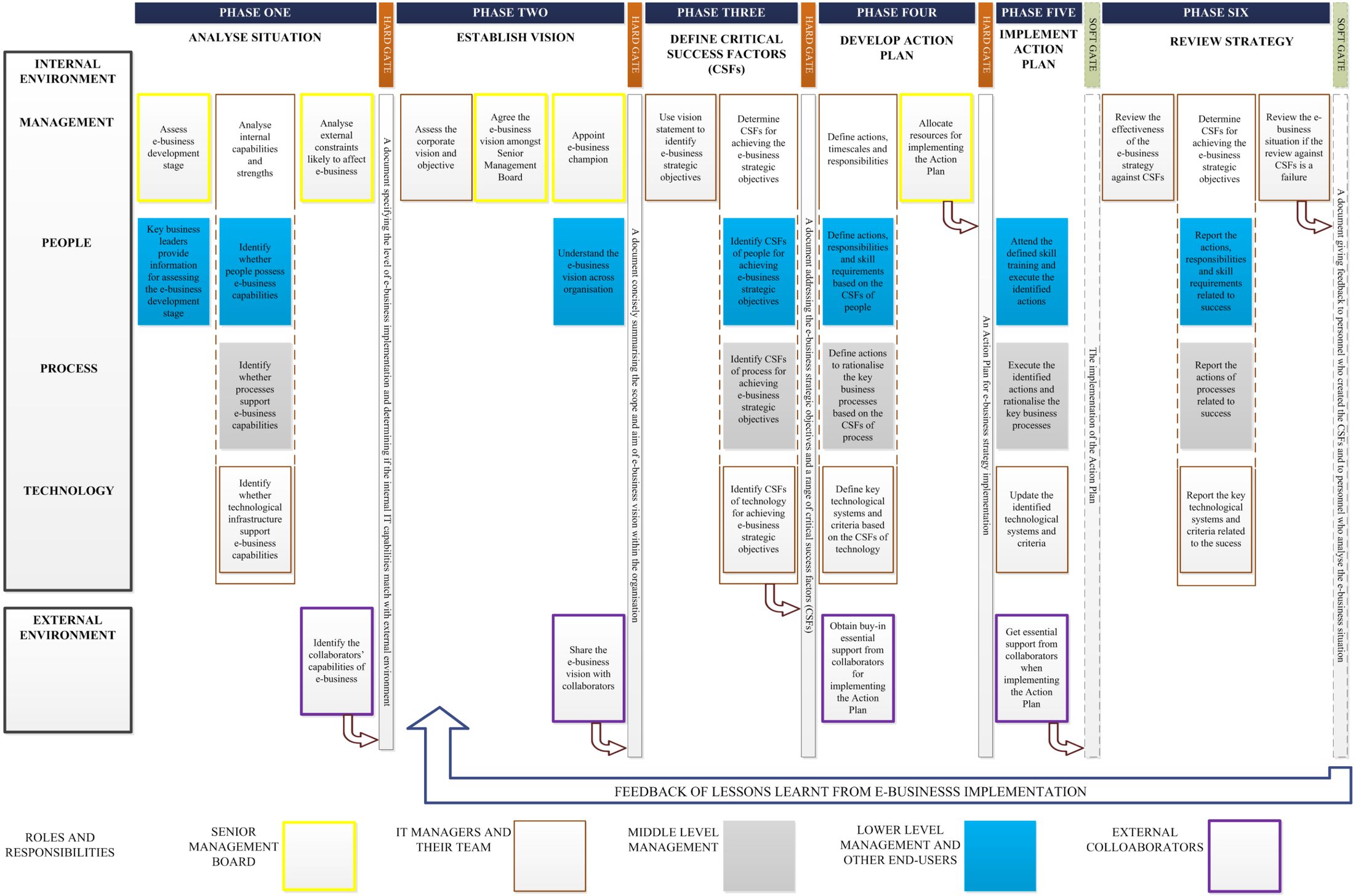

Figure 6.3 Strategic e-Business Framework for Organisations in the Construction Industry

6.2.5.1 How to Understand the Framework

The Strategic e-Business Framework can be understood as a process map consisting of an *X* and *Y* axis, which show process sequence (or time) and process participants, respectively. The horizontal *X*-axis illustrates the individual process activities (the activities of each phase) and the gates (soft or hard phase gates). The *Y*-axis shows the departments or functions participating in the process (the five factors).

As shown in Figure 6.3, the six phases of the Framework are laid out horizontally from left to right. Six phase gates are placed horizontally between the phases. The outputs of each phase are displayed in the phase gates. The phase gates are classified as either soft or hard. A soft gate means that the activities in a given phase can be executed sequentially or concurrently with those in the following phase. For example, in the Implement Action Plan Phase, the activity, *review of the effectiveness of e-business strategies against the CSFs of people*, can be carried out either during or after the activity, *attending the defined skill training and executing the identified actions*. A hard gate means that the activities in the following phase can commence only when all the activities in the previous phase have been accomplished.

As shown in Figure 6.3, each phase of the Framework includes several activities. For example, the Analyse Situation Phase includes five activities and three sub-activities. The five activities are as follows:

- Assess e-business development stage;
- Key business leaders provide information for assessing the e-business development stage;
- Analyse internal capabilities and strengths;
- Analyse external constraints likely affecting e-business; and
- Identify the external collaborators' capabilities of e-business.

Moreover, the activity of *Analyse Internal Capabilities and Strengths* includes three sub-activities which are: 1) identify whether people possess e-business capabilities; 2) identify whether processes support e-business capabilities; and 3) identify whether technological infrastructure support e-business capabilities.

Also as shown in Figure 6.3, the activities and their sub-activities of each phase are arranged into various categories. Using the Analyse Situation Phase as an example, the five activities and three sub-activities are grouped into five categories. The details are presented below:

1. *Management Activities*: include activities of *assess e-business development stage*, *analyse internal capabilities and strengths*, and *analyse external constraints likely affecting e-business*;
2. *People Activities*: include the activity of *key business leaders provide information for assessing the e-business development stage*, and the sub-activity of *identify whether people possess e-business capabilities*;
3. *Process Activity*: includes the sub-activity of *identify whether processes support e-business capabilities*;
4. *Technology Activity*: include the sub-activity of *identify whether technological infrastructure support e-business capabilities*; and
5. *External Environment Activity*: include the activity of *identify the external collaborators' capabilities of e-business*.

Also as shown in Figure 6.3, all activities and sub-activities are illustrated with different colours, which distinguish the activities from one another according to the responsible teams or people. The responsible teams or people include:

1) *Senior Management Board*: refers to a team of individuals at the highest level of organisational management who have the day-to-day responsibilities of managing a company or corporation (Griffin, 2005). It consists of board of directors, chief executive or managing director;
2) *IT Managers and Their Team*: refer to a team of individuals that are responsible for any on-going program of IT services and IT technical support within organisations;
3) *Middle Level Management*: refer to individuals that are responsible for implementing the policies and plans developed by the senior management and for supervising and coordinating the activities of lower-level managers. It usually consists of branch managers, departmental managers and division heads.
4) *Lower Level Management and other End-users*: refers to individuals that are responsible for supervising and coordinating the activities of working employees. It consists of section officers, project manager, engineers, designers, planners, supervisors, and foreman.
5) *External Collaborators*: refer to external business partners or project collaborators.

Using the Analyse Situation Phase as an example, the Senior Management Board is responsible for the activity of *assessing e-business development stage*. The IT Managers and their team are responsible for activities of *analyse internal capabilities and strengths* and *analyse external constraints likely affecting e-business*, and the sub-activity of *identify whether technological infrastructure support e-business capabilities*. The Middle Level Management is responsible for activity of *key business leaders provide information for assessing the e-business development stage*, and the sub-activity of *identify whether processes support e-business capabilities*. The Lower Level Management and other End-users are responsible for the sub-activity of *identify whether people possess e-business capabilities*.

6.2.5.2 How to Use the Framework

Organisations must go through the Framework phase by phase strictly when developing their e-business strategies. After accomplishing all the activities of each phase, they must check whether or not they have worked out the outputs that are displayed in the phase gates. For example, at the end of the Analyse Situation Phase, a document that specifies the level of e-business implementation and determines if the internal IT capabilities match with external environment should be produced when all the activities in the Phase are completed. If the outputs of the Phase are not obtainable, organisations need to review the performance of each activity and determine the reasons that cause the unachievable results.

Moreover, the senior IT management staff (e.g. company Senior IT managers, or corporate IT Directors) are responsible for tracking the accomplishment of each activity before the e-business champion is assigned, which includes ensuring the right people (check the role and responsibilities of each activity) do the right thing (check the performance of each activity) at the right time (check the activity is strictly performed phase by phase). The e-business champion is responsible for the tracking task when he/she is assigned.

6.3 Factors of the Framework

6.2 Background and Development of the Framework	6.3 Factors of the Framework	6.4 Phases of the Framework
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6.3.1 Internal Environment

A complete e-business strategy requires a concerted effort within an organisation, including the commitment and involvement of senior management, the awareness and skills of employees, the rationalisation of key business processes and the support of technological infrastructure, systems and criteria. Management, people, process and technology are the four factors that were used to categorise the main activities of each phase in the Strategic e-Business Framework. The meaning and function of each factor in the Framework are explained in the next a few sub-sections.

6.3.1.1 Management

Management can be defined as a set of activities (including planning and decision making, organising, leading and controlling) directed at an organisation's resources (human, financial, physical and information) with the aim of achieving an organisation's goals in an efficient and effective manner (Griffin, 2005). Ruikar et al (2006) highlight the role of management in dealing with the strategic change. In the Strategic e-Business Framework, management refers to all the activities related to planning, decision making, organising, leading or directing, controlling, and staffing in order to define, implement and review the e-business strategies. In the Framework, the development of e-business strategies heavily relies on such management activities. Management acts as one of the major categories necessary to ensure the accomplishment of each phase.

6.3.1.2 People

In e-business implementation, the people factor includes the social and cultural aspects related to the people within an organisation (Ruikar et al., 2006). In the Strategic e-Business Framework, the people factor takes into account the awareness, understanding and skill requirements of staff within an organisation when implementing

e-business. This factor acts as one of the major categories necessary to ensure the accomplishment of each phase.

6.3.1.3 Process

Process means a practice, or a series of actions, done for a specific purpose (Craig, 2004). In e-business implementation, process refers to part of a system that has a clearly defined purpose or objective and clearly defined inputs and outputs (Chaffey, 2009). In the Strategic e-Business Framework, process refers to the key business working rules and procedures used by construction organisations to implement e-business. The function of process in the Strategic e-Business Framework is similar to the people factor, and it is a necessary part of accomplishing each phase.

6.3.1.4 Technology

In e-business, technology refers to information and communication technologies (ICT) including both hardware and software availabilities and usage within an organisation (Chaffey, 2009). In the Strategic e-Business Framework, the technology factor refers to e-business tools/applications as well as the technological infrastructure or systems supporting information transaction and sharing. The function of technology in the Strategic e-Business Framework is similar to people and process, being a necessary part of accomplishing each phase.

6.3.2 External Environment

The External Environment gives organisations their means of survival but also represents a source of threats (Porter, 1985). In e-business implementation, the External Environment refers to the elements of the external environment that are likely to impact e-business implementation, which includes a consideration of both the micro-environment and the macro-environment (Chaffey, 2009). The micro-environment refers to the immediate competitive environment that a company faces, such as customer demand, competitor activity, marketplace structure and relationships with business partners. The macro-environment refers to the wider environment in which a company operates, which includes economic, social, legal and ethical factors (Johnson and Scholes, 2006). In the Strategic e-Business Framework, external environment also acts as one part that is necessary to complete each phase.

6.4 Phases of the Framework

6.2 Background and Development of the Framework	6.3 Factors of the Framework	6.4 Phases of the Framework
6.5 Summary		

6.4.1 Analyse Situation

Analyse Situation refers to the review of information about an organisation's internal processes and resources and external marketplace factors in order to define and plan e-business strategies (Chaffey, 2009). Figure 6.4 illustrates the Analyse Situation Phase.

Organisations need to have clear picture of their available IT (or e-business) resources, the way in which their current internal processes work, and the kind of external environment they compete in. They then must decide when and how to respond to the macro-environment and the competitors (Smith and Taylor, 2004; McDonald, 2008; Jelassi and Enders, 2009; Chaffey, 2009). Section 5.3.1.1 (Chapter Five) noted that Company 1 in the Case Studies considered the elements of their e-business strategies formally and carried out a set of analysis on their situation (e.g. Strength-Weakness-Opportunity-Threat (SWOT) analysis, customer analysis, competitor analysis, and internal resource analysis). The analysis made their current situation clear, and led to an Action Plan and a complete information system strategy (e-business was incorporated into the IS strategy).

To define a complete and precise e-business strategy, organisations must design the analysis with a practical purpose in mind (Johnson and Scholes, 2006). This phase provides guidance and techniques to allow organisations to analyse their e-business situation. The outputs of this phase include: 1) a document specifying the desired level of e-business implementation in the future, and 2) A determination of whether or not the company's internal IT capabilities and processes match with the capabilities and processes used by external partners and customers. The process gate at the end of this phase is a hard gate, which means that only when all the activities in this phase have been accomplished, can organisations initiate the activities described in the following phase.

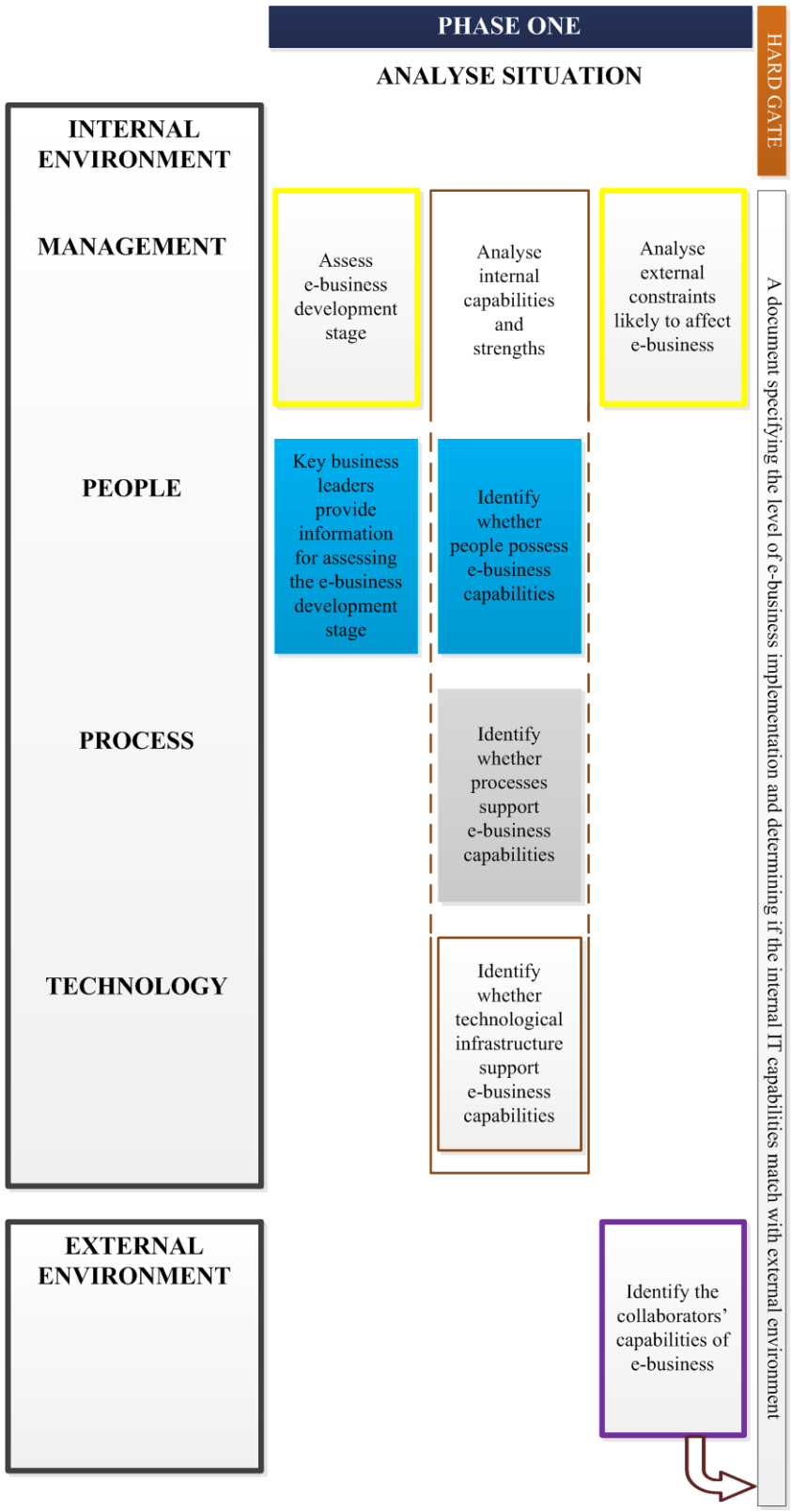

Figure 6.4 Phase One: Analyse Situation

The main activities included in this phase are as follows:

- *Assess e-business development stage*: refers to a review by senior management of how advanced an organisation is in using ICT resources to support its core business processes. Various models of stages of e-business development can be applied for completing this activity.
- *Key business leaders provide information for assessing the e-business development stage*: refers to the key business leaders from within the organisation provide information about e-business tools and applications applied in and e-business-enabled activities conducted in their departments or divisions. This activity involves Middle Level Management staff. Meetings should be scheduled for accomplishing this activity.
- *Analyse internal capabilities and strengths*: refers to reviewing the abilities of a company to use resources effectively to support value creation during implementing e-business and identifying the resultant competitive advantages possessed by the company. Three sub-activities are defined to help organisations to execute specific checks: determine whether or not people possess e-business capabilities, determine whether or not the company's processes support these e-business capabilities, and determine whether or not the company's technological infrastructure supports these e-business capabilities. This activity mainly requires the involvement of IT Managers and their team, but it also requires the cooperation of Middle Level Management, and Lower Level Management and other End-users.
- *Analyse external constrain likely affecting e-business*: refers to reviewing the immediate competitive environment including customer demand and behaviour, competitor activity, marketplace structure and relationships with business partners, and also reviewing the wider environment in which a company operates, including economic, social, legal and ethical factors. IT Managers and their teams are responsible for implementing this activity.
- *Identify the collaborators capabilities of e-business*: refers to briefly reviewing the e-business capabilities of a company's main collaborators', and trying to make integrated electronic communications and transactions

with the collaborators possible. The Company must do this review with the cooperation of the collaborators. The Company and the collaborators must both be involved.

6.4.2 Establish Vision

An e-business vision refers to a concise summary of the scope and broad aims of a company's future e-business activities, including the explanation of how these activities will contribute to the organisation and support its core business activities. Establishing a Vision requires the participation of a broad cross-section of company staff to work out the Vision that is usually captured in the form of a written document. Figure 6.5 illustrates the Establish Vision Phase.

The case studies (Section 5.3.1.3 of Chapter Five) revealed that the companies had developed medium-term e-business strategies, but had not established a long-term vision. Defining a specific vision can help organisations contextualise e-business in relation to the overall corporate strategies. It also helps place a long-term emphasis on e-business transformation within an organisation (Jelassi and Enders, 2009; Chaffey, 2009).

This phase provides guidance to help companies establish their e-business vision. The output of this phase is a document concisely summarising the scope and broad aim of e-business activities within the organisation. The process gate at the end of this phase is a hard gate.

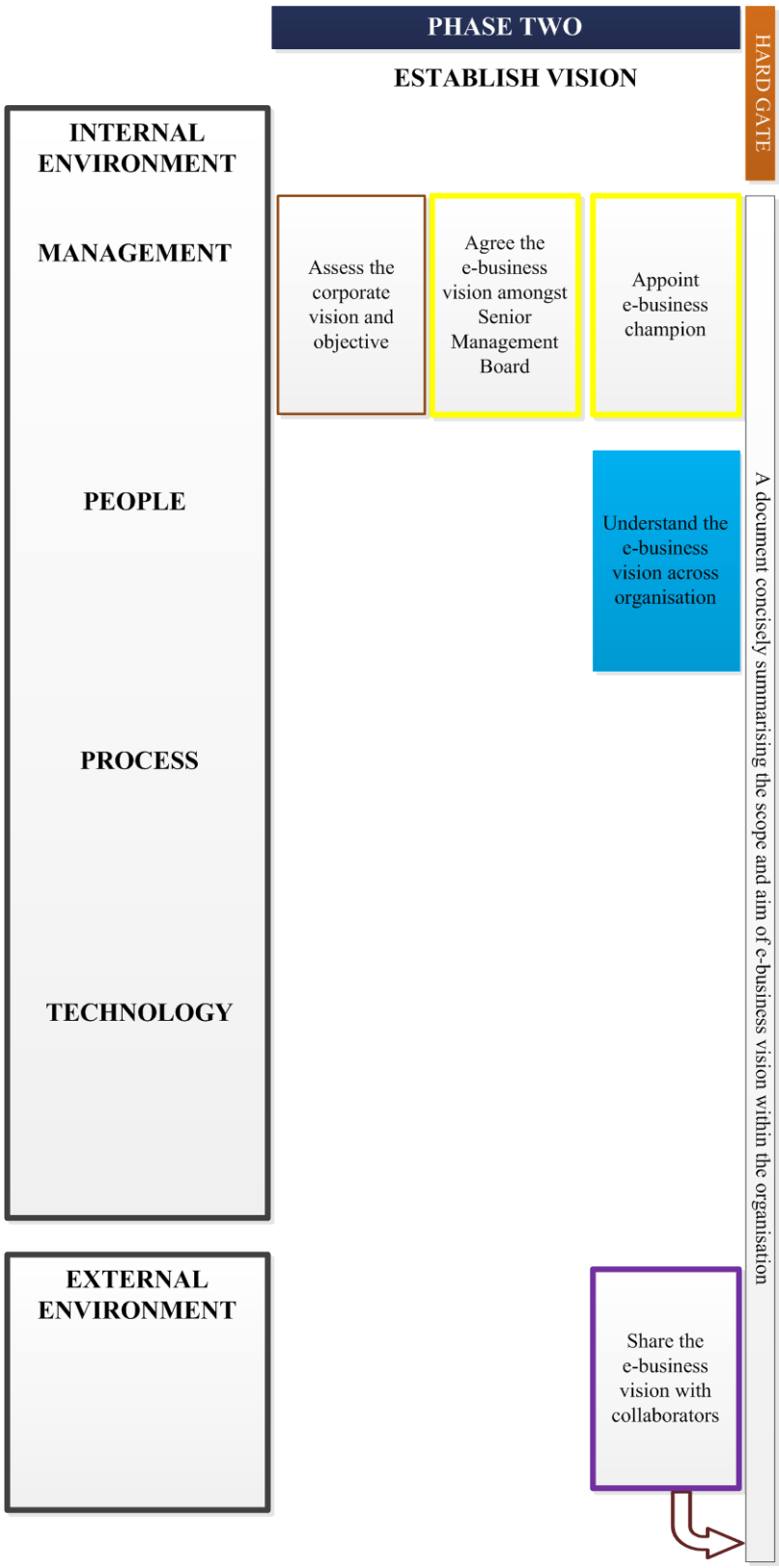

Figure 6.5 Phase Two: Establish Vision

The main activities included in this phase are as follows:

- *Assess corporate vision and objectives:* refers to reviewing the organisation's overall corporate vision and objectives and then defining an e-business vision based on them. The IT Directors or Senior IT Managers are responsible for this activity. A SWOT analysis or a Scenario-based analysis (e.g. exploring a set of possibilities or scenarios) could be used to help build the e-business vision statement.
- *Agree the vision amongst Senior Management Board:* refers to the approval of the e-business vision by the CEO and the other members of the Senior Management Board. The Senior Management Board is responsible for this activity. Ample opportunity must be provided to allow senior management to provide their feedback.
- *Appoint e-business champion:* refers to harnessing the efforts of a key employee, who drives the implementation of e-business with their energy and commitment. The e-business champion needs show strong personal leadership so as to instruct, encourage and inspire other employees to enhance their knowledge and use of e-business techniques. It's the Senior Management Board's role and responsibility to appoint a suitable e-business champion for the organisation.
- *Understand the vision across the organisation:* refers to ensuring that the e-business vision is known and shared throughout the organisation. All staff of the organisation must understand the e-business vision statement through the help and instruction of the e-business champion. So the e-business champion and all company staff are jointly responsible for this activity. Workshops are a good potential tool for carrying out this activity.
- *Share the e-business vision with collaborators*: refers to spreading the organisation's e-business vision outside the organisation and in particular, making it known to project collaborators. The Company must spread the vision and the external collaborators receive it. So the company and the external collaborators are both involved.

6.4.3 Define Critical Success Factors (CSFs)

Critical Success Factors (CSFs) refer to elements that are vital for a strategy's success. Defining CSFs can help organisations to translate their e-business vision into practical actions, investigate the applicability of strategic objectives, and review the effectiveness of the e-business strategy. Figure 6.6 illustrates the Define Critical Success Factors Phase.

Previous research has suggested that the CSFs of information technology are primarily technological related elements (Chaffey, 2009). Defining CSFs for e-business implementation should not be limited to considering technologies and systems, but also requires identifying CSFs related to people and process. Section 5.3.3.2 (Chapter Five) described how CSFs would help organisations to connect their business performance with strategic objectives, and how this approach would promote the alignment of organisations' business and IT infrastructure.

This phase of the framework provides guidance to help a company define CSFs related to e-business implementation. The outputs of this phase include the e-business strategic objectives and a range of critical success factors. The process gate at the end of this phase is a hard gate.

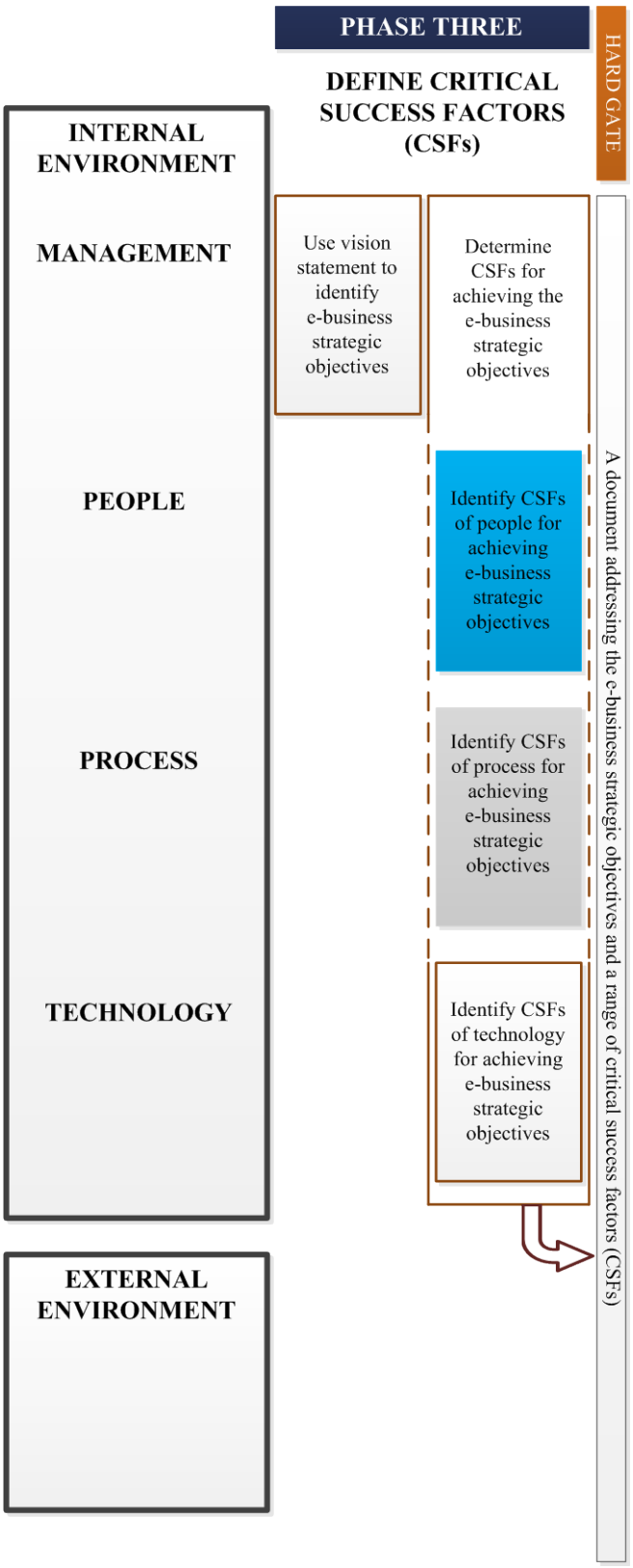

Figure 6.6 Phase Three: Define Critical Success Factors

The main activities include in this phase are as follows:

- *Use vision statement to identify e-business strategic objectives*: refers to translating the e-business vision by breaking it down into a series of short-term objectives. IT Managers and their teams are responsible for this activity.
- *Determining CSFs for achieving the e-business strategic objectives:* refers to defining quantitative or qualitative metrics to link e-business strategic objectives to the company's performance. This activity includes three sub-activities: determining CSFs in relation to people, process, and technology. This activity mainly requires the involvement of IT Managers and their teams, and also requires the cooperation of other management and non-management staff.

6.4.4 Develop Action Plan

Develop Action Plan refers to identifying the required actions time horizons and resources for implementing the e-business strategic solutions within an organisation. Figure 6.7 illustrates the Develop Action Plan Phase.

Section 5.3.2.1 (Chapter Five) describes how to manage changes and enhance the e-business development through planning a project management approach in line with an operation plan. Therefore, after analysing the situation, establishing the vision and determining the strategic objectives and CSFs, organisations need to plan their actions for e-business implementation. In strategy development, an Action Plan refers to "a sequence of steps that must be taken, or activities that must be performed well, for a strategy to succeed" (Business Dictionary Online, 2011). A workable Action Plan should provide confidence that the strategic objectives are achievable within the constraints of time and cost (Billingham, 2008).

This phase provides a guide for organisations to prepare for carrying out all the tactics that will be used to achieve the strategic objectives. The output of this phase is an Action Plan for e-business implementation. The process gate at the end of this phase is a hard gate.

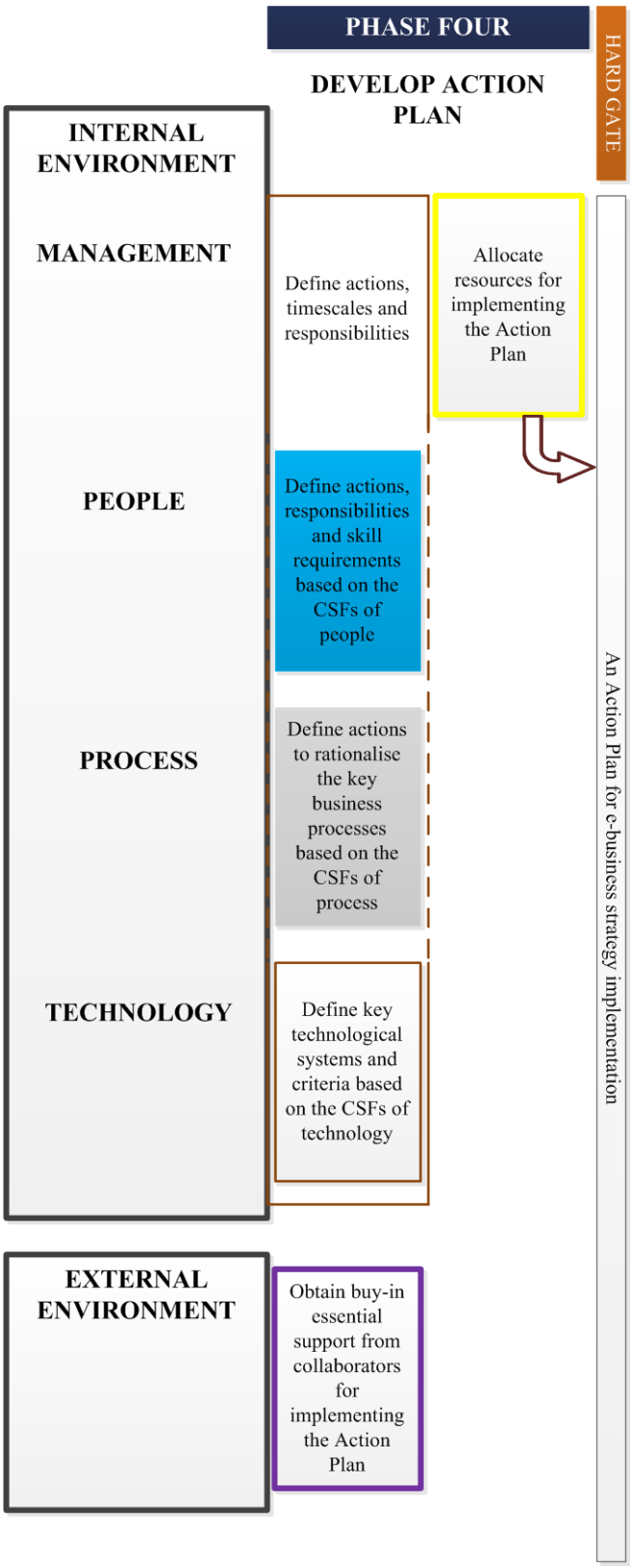

Figure 6.7 Phase Four: Develop Action Plan

The main activities included in this phase are as follows:

- *Define actions, timescales, and responsibilities:* was designed to help organisations in the construction industry to: a) determine the changes required within the organisation to allow the implementation of e-business solutions, b) decide what actions to take in order to make the required changes, and c) identify the deadlines and responsibilities for implementing those actions. This activity includes three sub-activities: 1) identify actions, responsibilities and skill requirements based on the CSFs related to people, 2) identify actions to rationalise the key business processes based on the process-related CSFs and 3) identify key technological systems and criteria based on the CSFs pertaining to technology. This activity mainly requires the involvement of IT Managers and their teams and also requires the cooperation of Middle Level Management, and Lower Level Management and other End-users.
- *Obtain buy-in essential support from collaborators for implementing the Action Plan:* refers to having an agreement with project collaborators outside the organisation about electronic communication and transaction according to defined e-business actions. The activity is that the organisation must convince the collaborators to buy-in, so the IT managers and others within the organisation also have a big responsibility.
- *Allocate resources for implementing the Action Plan:* refers to distributing and allocating the required resources to support the implementation of the Action Plan. The Senior Management Board allocates the appropriate amount of resources to complete the Action Plan. Decisions about where and how these resources are allocated should be based on the Action Plan and the allocations should be made under the guidance of the e-business champion. The Senior Management Board and the e-business champion are responsible for this activity.

6.4.5 Implement Action Plan

Implement Action Plan refers to executing all the planned actions to achieve the strategic objectives. Implementing a solution is the crucial part of strategies planning

and execution (Johnson et al., 2008). Figure 6.8 illustrates the Implement Action Plan Phase.

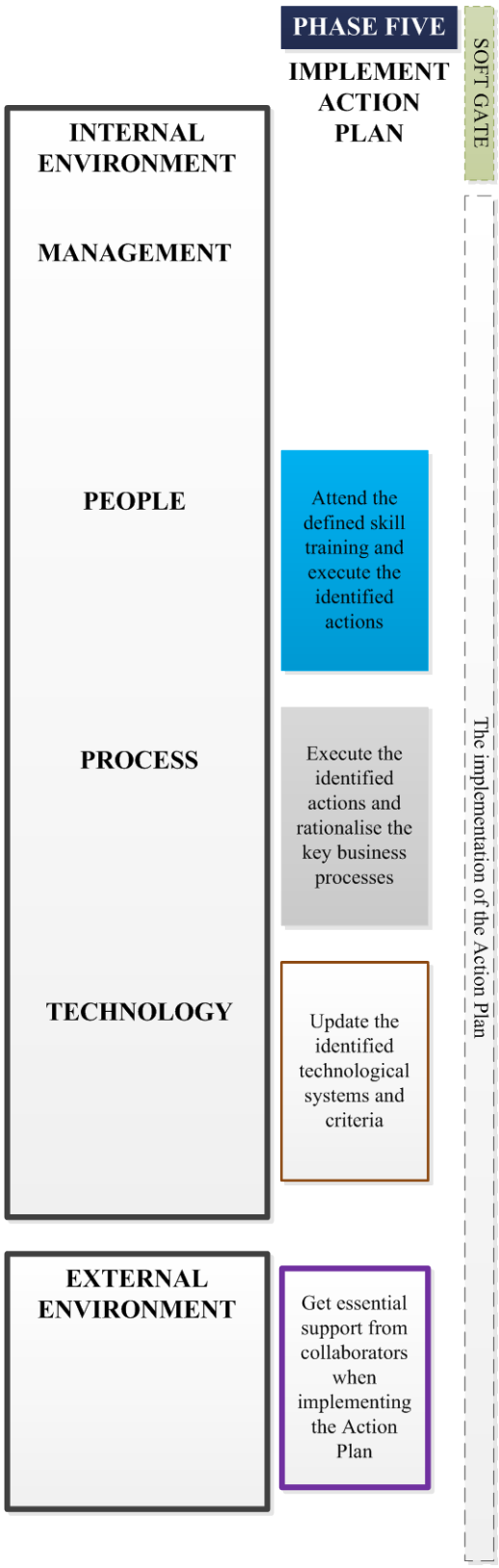

Figure 6.8 Phase Five: Implement Action Plan

As discussed in Section 6.2.3, this phase is a very difficult one to implement. At the Implement Action Plan Phase, Senior Management Board is not directly involved and other members in the organisation, such as Middle Level Management staff, and Lower Level Management staff, and other End-users, carry out all the actions. The e-business champion is crucial at this phase as a leader for the implementation of the Action Plan. The champion must ensure the execution of all the defined actions and seek a suitable management approach to monitor the roll out of the Plan and address the problems that may arise during or after the execution of the various actions. This means that the e-business champion may have to carry out some corrective actions (e.g. the defined actions are not correctly executed). When problems arise, the e-business champion must consider the answers to the following key questions:

- *Evaluate the current situation*: What will happen if things continue as they are?
- *Consider various corrective solutions*: Are there any measures that could be applied and to assess the pros and cons of adopting each alternative course of action?
- *Select and implement one of the course action*: What should be done to solve the problem,
- *Link back into the monitoring process*: Has the corrective action had the desired effect?

The output of this phase is the implementation of Action Plan. The process gate at the end of this phase is a soft gate, which means that the activities in this phase and their related activities in the following phase can be executed sequentially or concurrently. For example, organisations can review the effectiveness of their e-business strategies against the CSFs of people, either during or after executing the defined actions related to people. The activities included in this phase are as follows:

- *Attend the defined skill training and execute the identified actions:* The crucial part of this activity is managing people. The knowledge and experience of people is the key factor influencing the success of strategies. At the Implement Action Plan Phase, the e-business champion must create a climate within the organisation where people strive to achieve successful completion of all the relevant actions.

- *Execute the identified actions and rationalise the key business processes:* The crucial part of this activity is managing process changes. Middle Level Management is responsible for this activity.
- *Update the identified technological systems and criteria:* the crucial part of this activity is managing technological systems and their integration. The IT Manger and their teams are responsible for this activity.
- *Get essential supports from collaborators when implementing the Action Plan:* This activity will be easy to accomplish if the previous activity of getting essential buy-in support from the collaborators has been accomplished successfully.

6.4.6 Review Strategy

Review Strategy refers to the process for evaluating the adopted strategies after they had been implemented, and determining lessons learnt from the review, which may include reshaping the vision and objectives, and modifying the CSFs. Figure 6.9 illustrates the Review Strategy Phase.

Section 5.3.3.2 (Chapter Five) indicated that the review of e-business strategies was not practised well in the target organisations. To achieve both the tangible and intangible benefits of e-business, organisations need to consider units of measurement to connect their organisational performance and their strategic actions. Moreover, organisations need to consider how to connect the critical success factors with their organisational-specific e-business capabilities when attempting to identify units of measurement for reviewing e-business strategies. The Review Strategy Phase provides an effective way of reviewing e-business strategy, and more importantly, it enables companies to learn from their previous e-business implementation experience.

The outputs of this phase include two reports: 1) a report giving feedback to the personnel who identified the CSFs, and 2) a report to personnel who analysed the company's e-business situation. The process gate at the end of this phase is a soft gate, which means that the activities in this phase and their related activities in the following phase can be executed sequentially. At this phase, the feedback loop is adopted to connect the Review Strategy Phase to the Analyse Situation Phase. This enables the Strategic e-Business Framework to act as a cycle for carrying out all the phases once again.

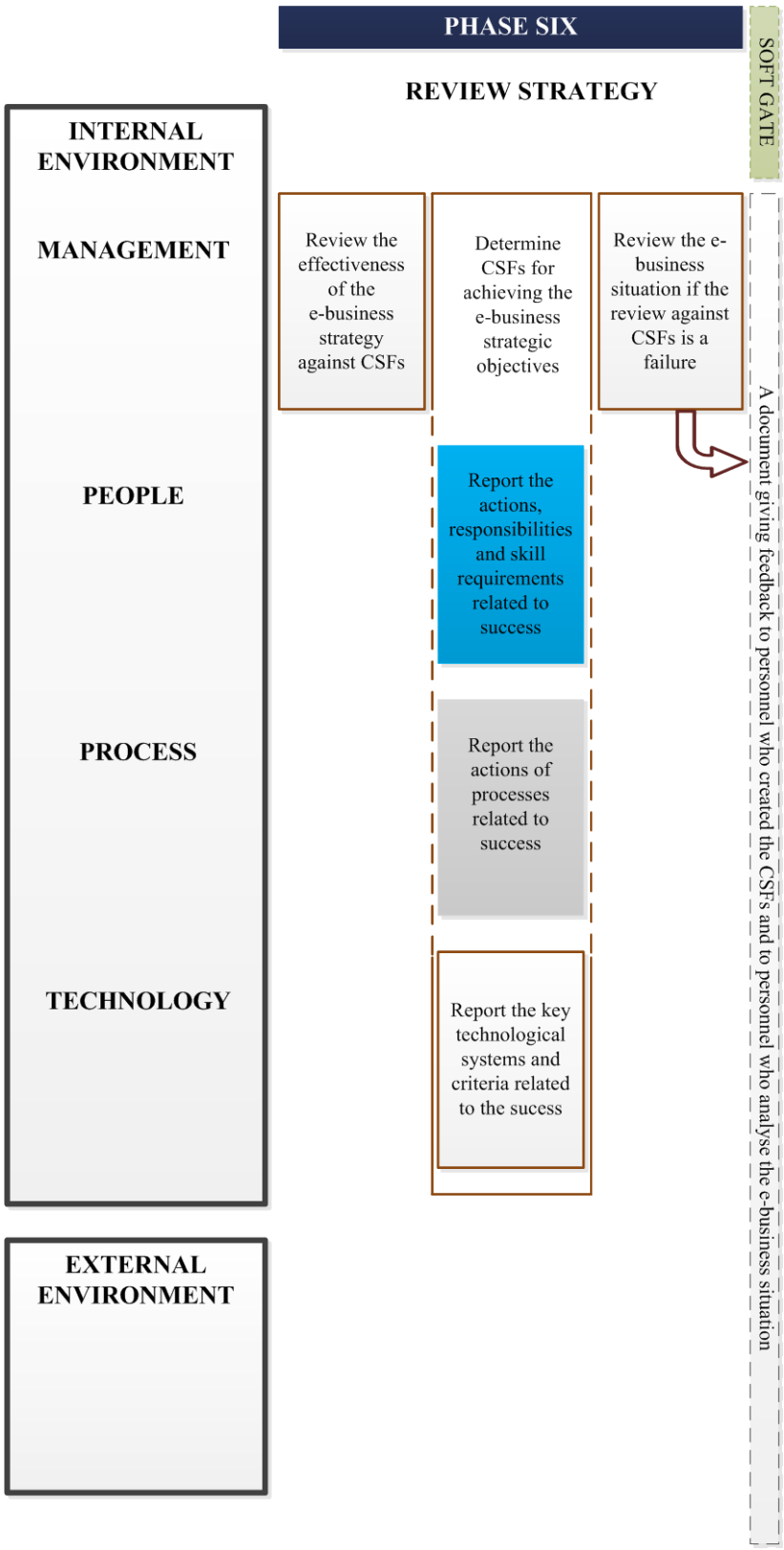

Figure 6.9 Phase Six: Review Strategy

The activities included in this phase are as follows:

- *Review the effectiveness of the e-business strategy against CSFs:* refers to reviewing the CSFs and the Action Plan by the end of the time sequence and checking if the target actions were completed on time and confirming that the e-business strategic objectives were achieved. The e-business champion is responsible for this activity.
- *Share the success of e-business strategy implementation across the organisation:* This happens when the review of the effectiveness of e-business strategy against CSFs is a success, or in other words, the actions have been completed on time and the strategic objectives have been achieved. At this point, success has been confirmed and can be shared within the entire organisation. This includes three sub-activities: 1) Report the actions, responsibilities and skill requirements that were instrumental to the success; 2) Report the process actions that were used to achieve the success; and 3) Report the key technological systems and criteria related to the success. This activity mainly requires the involvement of the e-business champion. Workshops are a good way to share the success of e-business implementation.
- *Review the e-business situation if the review against CSFs is a failure:* This happens when the actions have not been completed on time and the strategic objectives have not been achieved. In this case the organisation must review the e-business situation again and determine if the e-business vision and objectives are realistic. The IT Directors or Senior IT Managers are responsible for this activity.

6.5 Summary

6.2 Background and Development of the Framework	6.3 Factors of the Framework	6.4 Phases of the Framework
6.5 Summary		

This chapter presented a Strategic e-Business Framework that organisations in the construction industry can use to define, execute and review their e-business strategies.

The literature review and the results of the industry survey and the case studies establish the context for the Strategic e-Business Framework development.

The Strategic e-Business Framework combined the aspects of the five approaches: Chaffey's Generic e-Business Process Model, the PIECC Decision-Making Framework, the VERDICT application, the IT/IS Organisational Readiness Model and the Process Protocol Framework, and built on them.

The Strategic e-Business Framework was developed to provide a holistic approach for e-business strategy development and implementation in order to achieve the aim of the research. To serve the main purpose of the Strategic e-Business Framework, five objectives were defined. The objectives were achieved through the following:

1) Six phases and phase gates (hard gates or soft gates) were defined in the Strategic e-Business Framework to ensure a sequential approach for defining, managing and reviewing e-business strategies, and a feedback loop was defined to enable the Strategic e-Business Framework to act as a cycle for going through repeatedly, which makes the continuous improvement of e-business implementation possible within organisations;
2) The six phases including Analyse Situation, Establish Vision, Define Critical Success Factors, Develop Action Plan, Implement Action Plan and Review Strategy, were defined to guide the IT leaders in carrying out consistent e-business planning. The outputs of each phase were defined to assist IT leaders in the review of procedures during their e-business implementation;
3) Five factors including Management, People, Process, Technology and External Environment, were identified to ensure organisations have the opportunities to improve their capabilities in these areas, and to make organisations ready for immediate e-business implementation;
4) Five groups of people or teams were assigned to the activities of the Strategic e-Business Framework. The five groups were the Senior Management Board, IT Managers and their teams, Middle Level Management, Lower Level Management and other End-users, and external collaborators. This provided a basis for organisations to utilise their resources, specifically human resources; and

5) Three groups of Critical Success Factors (CSFs), people, process and technology, were defined to ensure that organisations can improve, execute and review their e-business implementation effectively and purposefully.

The next chapter will introduce the evaluation of the Strategic e-Business Framework based on industry context and review.

CHAPTER SEVEN EVALUATION OF THE STRATEGIC E-BUSINESS FRAMEWORK

7.1 Introduction

This chapter presents the evaluation of the Strategic e-Business Framework. The chapter begins with a discussion of evaluation background, which includes the aim of the evaluation, the design of the evaluation questionnaire, and the steps for conducting the evaluation. The findings of the evaluation are then presented and analysed in the subsequent sections. The chapter concludes with a chapter summary.

7.2 Background of Evaluation	7.3 Key Findings and Analysis of the Framework Evaluation
7.4 Summary	

7.2 Framework Evaluation

7.2 Background of Evaluation	7.3 Key Findings and Analysis of the Framework Evaluation
7.4 Summary	

7.2.1 Aim and Objectives of the Evaluation

The main purpose of the framework evaluation process is to gauge the appropriateness and effectiveness of the Strategic e-Business Framework from the industry perspective. The evaluation was guided by the following objectives:

- To demonstrate that the Framework achieved the aim of the research;
- To identify the weaknesses and strengths of the Framework; and
- To obtain comments and recommendations for further improvements.

7.2.2 The Evaluation of the Strategic e-Business Framework

According to Rutman (1977, Page 25), evaluation is “a process of applying scientific procedures to accumulate reliable and valid evidence in the manner and the extent to which specific activities produce particular effects or outcomes”. Therefore,

evaluation is primarily concerned with a critical examination of such aspects as the appropriateness, effectiveness and efficiency of an intervention (Kumar, 2011).

In the research, the Strategic e-Business Framework was developed to help organisations in the construction industry to plan, execute and review their e-business strategies. Thus, the design of the evaluation should focus on investigating the appropriateness and effectiveness of the proposed Framework in leading the industry practitioners to deal with practical strategic e-business issues within their organisations. To do so, the industry evaluation was adopted for the current study.

Section 3.4.5.2 (Chapter Three) previously introduced the steps for undertaking an industry evaluation. It involved three steps: 1) preparing a questionnaire for conducting structured interviews; 2) carrying out the structured interviews with the industry practitioners; and 3) analysing the interview results and presenting the findings.

This section demonstrates the evaluation questionnaire design and describes the structured interviews with the industry practitioners. The results and findings will be presented and analysed in Section 7.3.

7.2.2.1 Evaluation Questionnaire Design

As previously noted in Section 3.4.5.2 (Chapter Three), a questionnaire (see Appendix 10) was designed for conducting the industry evaluation. The questionnaire aimed to examine the appropriateness and effectiveness of the Strategic e-Business Framework in delivering a holistic approach for the industry members to improve their e-business implementation. Appropriateness refers to the quality of having the properties that are right for a specific purpose or the quality of being specifically suitable (Merriam-Webster Online, 2011). In evaluation, appropriateness has been considered as an important criterion (Sharp et al., 1993). In management practices, it is crucial to consider the appropriateness in an evaluation in order to judge the worth of the results (Baume, 1991). The questionnaire was designed to evaluate the appropriateness of the Framework at two levels: 1) a high level investigation, and 2) a more detailed investigation. The high level investigation tried to inspect the general appropriateness of the Framework according to five concepts: 1) whether it presented an appropriate set of instructions; 2) whether it identified the appropriate provision of phases; 3) whether it defined the activities at an appropriate level; 4) whether it specified the appropriate roles and responsibilities for the activities; and 5) whether it considered the appropriate factors. The detailed-level investigation attempted to

investigate the propriety of the main activities included in each phase, and examine the importance of each functional factor.

In evaluation, effectiveness was investigated through measuring the extent to which targets were being met, and detecting the factors that hinder or facilitate their realisation (Business Dictionary Online, 2011). Effectiveness is another important criterion in checking an intervention (Kumar, 2011). In the questionnaire design, the effectiveness of the Framework was probed mainly in two areas: clarity and applicability. The clarity aspect strived to investigate the Framework in three aspects: 1) whether it clearly defined an industry specific e-business solution; 2) whether it clearly addressed the specific industry needs; and 3) whether it clearly delivered the specific requirements. The applicability aspect ventured to inquire into the Framework in another three facets: 1) user-friendliness; 2) usefulness; and 3) strengths.

Altogether, the main part of the questionnaire included 32 questions organised into five sections (see Appendix 10). Each section contained open-ended statements with a likert-scale of 1-5 on key criteria factors, where 1=Strongly Disagree (SD), 2=Disagree (D), 3=Neutral (N), 4=Agree (A) and 5=Strongly Agree (SA). The sections are:

- *Section I*: to review the appropriateness of the Framework at a high level, five questions were defined to address the five high level evaluation concepts described above (instructions, phases, activities, roles/responsibilities and factors);
- *Section II*: to review the effectiveness of the Framework in clarity, three questions were identified to address the three clarity investigation aspects described above (solutions, needs, and requirements);
- *Section III*: to review the appropriateness of the Framework in depth, this section was focused on examining the propriety of the main activities included in each phase. Eleven questions were included to carry out this further investigation;
- *Section IV*: to review the effectiveness of the Framework in the area of applicability, eight questions were designed to inspect the Framework in three previously described applicability facets: user-friendliness, usefulness and strengths;

- *Section V*: to review the appropriateness of the Framework in depth, the five questions in this section were focused on determining the importance of each functional factor.

In addition, three questions were included at the beginning of the questionnaire, designed to gather background information about the evaluators, their companies, their roles and responsibilities, and their experience in industry in general and in IT/e-business management in particular. These questions were intended to ensure that the evaluators were those who had the sufficient knowledge about their organisations in e-business implementation and e-business strategy development.

Furthermore, two open-ended questions were included at the end of the questionnaire to obtain comments and recommendations from the evaluators for future development of the Framework. One question was intended to obtain their general comments on improvements or changes of the Framework, and the other question was about whether or not they would use this Framework for the e-business strategy development within their organisations.

7.2.2.2 Structured Interviews with Industry Practitioners

The Strategic e-Business Framework was designed specifically for the senior IT management staff (e.g. corporate IT Directors or company Senior IT managers) to help them define organisational level e-business strategies and the implementation plans (e.g. the Action Plan). Therefore, the evaluation primarily aimed to gather comments and recommendations from the senior IT management staff.

As discussed in Section 3.4.5.2 (Chapter Three), the industry evaluation was conducted based on structured interviews with industry practitioners. Altogether, six evaluations were completed. Four evaluations were undertaken by the industry practitioners who took part in the multiple-case studies described in Chapter Five, which aided in the development of the Framework. The involvement of the same personnel sought to inspect the internal validity and consistency of the current research (Creswell, 2003). Industry practitioners who were new to the study carried out another two evaluations, which offered different perspectives and tested the applicability of the Framework in a wider scope (Wellington, 2000). Table 7.1 displays the industry practitioners that participated in the framework evaluation processes.

Table 7.1 Industry Practitioners Participating in the Framework Evaluations

Evaluator	Organisation Discipline	Role of Interviewee	Experience	
			Industry	IT
Evaluator 1	Contractor, construction and engineering	System and Technology Director	38	22
Evaluator 2	Contractor, construction and development	Technical Service Director	25	20
Evaluator 3	Contractor, construction and engineering	Senior IT Manager	25	20
Evaluator 4	Consultant, construction, engineering and technical service	Information System Director	20	20
Evaluator 5	Consultant, architectural and engineering	Senior IT Manager	22	22
Evaluator 6	Consultant, construction and assess management	Technical Service Director	34	25

The evaluations were conducted face-to-face or by phone, mainly depending on the availability, location and convenience of the interviewees. The evaluations consisted of three parts. The first part was a presentation on the Strategic e-Business Framework and its development. The presentation explained the structure and functionality of the Framework in detail. This gave the evaluators the background and rationale for performing the evaluation. The second part invited the evaluators to complete the evaluation questionnaire. The questionnaire asked the evaluators to state their opinions about the Framework as described in Section 7.2.2.1. The third part was discussions with the evaluators about their answers and comments about the evaluation questions. The main purpose of this part was to clarify their opinions on the Framework, such as why they agreed or disagreed with the proposed statements.

7.3 The Key Findings and Analysis of the Industry Evaluation

7.2 Background of Evaluation	7.3 Key Findings and Analysis of the Framework Evaluation
7.4 Summary	

7.3.1 Results of Section I: Appropriateness of the Framework

As described in Section 7.2.2.1, the appropriateness of the Framework was inspected at two levels: a high level investigation and a detailed level investigation. This

section examines the appropriateness of the Framework at the high level and includes the five previously introduced high level evaluation concepts: instructions, phases, activities, roles/responsibilities and factors.

The findings indicated that the evaluators rated the Framework as highly appropriate in general. A high average rating of 4.1 was given to the five questions (Table 7.2). In addition, the evaluators indicated that the Framework properly presents the set of instructions for e-business strategy development. In fact, evaluators 1 and 3 commented that the instructions were very close to their current practices. Moreover, the evaluators were highly satisfied with the provision of phases, included activities in each phase, and the factors considered for categorising the activities. They gave ratings of 4.0, 4.2 and 4.3 for these questions respectively (see Table 7.2).

Table 7.2 Appropriateness of the Framework

	Average Rating Given by Evaluators (1=SD, 2=D, 3=N, 4=A & 5=SA)
Presented an appropriate set of instructions for e-business strategy development	4.0
Identified the appropriate provision of phases needed	4.0
Defined the activities at appropriate level	4.2
Specified the appropriate roles and responsibilities for the activities	4.0
Considered the appropriate factors	4.3
Average	4.1

In rating whether or not the Framework specified the right roles and responsibilities for the activities, the score given was 4.0. Evaluators highlighted the critical role of the Senior Management Board for the successes in e-business strategy execution.

7.3.2 Results of Section II: Clarity of the Framework

Section 7.2.2.1 explained the effectiveness of the Framework was probed mainly in two areas: clarity and applicability. This section addresses the evaluation of clarity. As previously discussed, the evaluation is based on three clarity investigation aspects:

industry specific e-business solutions, specific industry needs, and specific industry requirements.

The findings indicated that the evaluators rated the Framework high in terms of clarity. An average rating of 3.7 was given to the three statements (see Table 7.3). The evaluators also highly agreed with the statement that the Framework has defined a solution for consistent e-business strategy development with lucidity. The score given for this statement was 4.2.

Table 7.3 Clarity of the Framework

	Average Rating Given by Evaluators (1=SD, 2=D, 3=N, 4=A & 5=SA)
Clearly defined a solution for consistent e-business strategy development	4.2
Clearly addressed the strategic e-business needs of the industry	3.4
Clearly delivered the strategic e-business requirements of the industry	3.4
Average	3.7

When having structured interviews with the evaluations, a presentation was carried out to introduce the specific industry e-business needs and requirements and how they were addressed in the Framework. As discussed in Section 6.2.1 in Chapter Six (rationale for developing the Strategic e-Business Framework), the Framework was developed mainly address the construction industry's strategic e-business needs and requirements specifically in four areas: 1) advising organisations in the industry on how to review their e-business strategies after execution, which made the continuous improvement of e-business implementation possible, 2) switching the focuses of their e-business strategies from the project level to the organisational level, 3) linking technological systems, people and processes within e-business implementation, and 4) including external organisations, such as the business partners of the supply chain or collaborators in a project, into their e-business implementation. The findings of the evaluation showed that the evaluators confirmed that the Framework has clearly addressed all these strategic e-business needs and requirements. A rating of 3.4 was given to the relevant statements (also see Table 7.3). However, respondents further commented that how well the Framework addressed these needs and requirements was

difficult to measure at this stage, and it can only be proved after its implementation in practice.

7.3.3 Results of Section III: Review of the Six Phases of the Framework

This section considers the appropriateness of the Framework in depth. The investigation focuses on inquiring into the roles of the main activities in delivering the final outcomes of the associated phases. As mentioned in Section 6.4 of Chapter Six, the Strategic e-Business Framework defined six phases for planning, executing and reviewing e-business strategies. They are: 1) Analyse Situation, 2) Establish Vision, 3) Define Critical Success Factors (CSFs), 4) Develop Action Plan, 5) Implement Action Plan and 4) Review Strategy. Five of the above phases were reviewed in the framework. The Implement Action Plan phase was not included.

Overall, the evaluators reported that the applicability of the main activities was high and confirmed that those activities were appropriate in delivering the final outcomes of the associated phases. The sub-sections 7.3.3.1 to 7.3.3.5 will introduce the findings of the evaluation based on each phase.

7.3.3.1 Analyse Situation Phase

The findings of the evaluation indicated that the main activities included in the Analyse Situation Phase were appropriate to deliver the final outcomes. Ratings of 3.4 and 3.6 were given to the related statements (see Table 7.4).

Table 7.4 Review of the Analyse Situation Phase

	Average Rating Given by Evaluators (1=SD, 2=D, 3=N, 4=A & 5=SA)
Assessing the e-business development stage enables the determination of the level of e-business in future	3.4
Analysing the internal IT capabilities and the external constraints enables the positioning of the e-business situation	3.6

At the Analyse Situation Phase, the evaluators confirmed that assessing the e-business development stage would enable them to determine the level of e-business development in future. Evaluators 2 and 4 both mentioned that it was difficult for them to assess their e-business development stages. One major reason they pointed out was

that the current e-business development within their organisations was a mixture: it was characterised by advanced and mature implementation in some departments or functions, along with slow and recent implementation in other departments or functions. The evaluators also agreed that analysing the internal IT capabilities and external constraints would enable them to complete the situation scanning and reveal their current e-business situation. Evaluator 6 commented that considering external factors at this phase is really important because the external analysis enabled organisations to define the external drivers, address the needs, determine the investment requirement and business risks, and finally decide how affordable and achievable the e-business strategy was.

7.3.3.2 Establish Vision Phase

The findings of the evaluation indicated that the main activities included in the Establish Vision Phase were appropriate for delivering the final outcomes of the Phase. Ratings of 4.4, 4.2 and 4.4 were given to the related statements (see Table 7.5).

Table 7.5 Review of the Establish Vision Phase

	Average Rating Given by Evaluators (1=SD, 2=D, 3=N, 4=A & 5=SA)
Assessing the corporate strategic vision ensures e-business vision aligns with corporate vision	4.4
Agreeing the e-business vision amongst Senior Management Board ensures the awareness of the vision from top-down	4.2
Appointing the e-business champion ensures the champion fully understand the organisation's e-business aim and scope	4.4

At the Establish Vision Phase, the evaluators emphasised the importance of aligning the e-business vision with the corporate business vision. Evaluator 2 stated that:

The corporate business vision is the baseline vision for the overall organisation. All the other visions need to align and support that vision.

Moreover, evaluators agreed that appointing an e-business champion was crucial for the success of e-business implementation. However, three of the evaluators,

Evaluators 1, 3 and 6, noted that it was difficult for them to appoint an e-business champion. Evaluator 1 commented that the e-business champion should be a full-time position because it would be hard for a person to be fully devoted to the champion role if she/he had other responsibilities. Evaluator 6 recommended that in the SMEs, the IT Directors or Senior IT Managers might be the appropriate people to be the e-business champions.

Evaluators also highlighted the significance of communicating the e-business vision across the entire organisation, because this would help ensure that all employees, specifically the management staff, were clear about their roles and responsibilities in e-business implementation. Evaluators 3 and 4 further commented that organisations should have a particular plan for communicating the e-business vision according to the organisational culture and structure.

7.3.3.3 Define CSFs Phase

The findings of the evaluation indicated that the activities included in the Define CSFs Phase were appropriate most for producing the final outcomes of the Phase. Ratings of 4.0 and 4.4 were given to the related statements (see Table 7.6).

Table 7.6 Review of the Define CSFs Phase

	Average Rating Given by Evaluators (1=SD, 2=D, 3=N, 4=A & 5=SA)
Identifying the strategic objectives based on the vision statement ensures the alignment of short-term objectives and long-term vision	4.0
Determining the critical success factors (CSF) enables the definition of the essential measures to assess performance	4.4

At the Define CSFs Phase, the evaluators agreed that identifying the strategic objectives based on the vision statements would ensure the alignment of short-term objectives and long-term vision. Evaluator 2 commented that establishing short-term objectives was crucial for them because e-business development varied across different sections and regions within the corporation. Additionally, evaluators stated that determining the CSFs enabled the definition of the essential measures to assess performance. However, Evaluators 1 and 4 both stated that it was currently difficult to

define CSFs of processes because many of their business processes have not been standardised. Evaluator 6 commented that it was laborious to identify the CSFs of technology precisely. For example, in order to measure the transaction with external business partners, an organisation would need to simulate a range of transaction volume from its suppliers, which is particularly difficult to do.

7.3.3.4 Develop Action Plan Phase

The findings of the evaluation indicated that the activities included in the Develop Action Plan Phase were also very appropriate for producing the final outcomes of the Phase. A rating of 4.2 was given to the related statements (Table 7.7).

Table 7.7 Review of the Develop Action Plan Phase

	Average Rating Given by Evaluators (1=SD, 2=D, 3=N, 4=A & 5=SA)
Defining actions, timescales and responsibilities enables the delivery of a complete and well-defined Action Plan	4.2

At the Develop Action Plan Phase, evaluators stated that defining actions, timescales and responsibilities enabled the delivery of the complete Action Plan. Moreover, Evaluators 2 and 6 commented that it was crucial to consider the engagement and support from the external organisations, such as supply chain partners or project collaborators.

7.3.3.5 Review Strategy Phase

The findings of the evaluation indicated that the activities included in the Review Strategy Phase were appropriate for producing the final outcomes of the Phase. Ratings of 4.6, 4.2 and 3.8 were given to the relevant statements (see Table 7.8).

At the Review Strategy Phase, the evaluators were in agreement that reviewing the effectiveness of the e-business strategy against CSFs enables organisations to deliver feedback on CSFs. This feedback is crucial for the future definition of new CSFs for measuring e-business performance and for eliminating any inappropriate CSFs. The evaluators also concurred that sharing the success of the e-business strategy is important for future success in e-business implementation.

Table 7.8 Review of the Develop Review Strategy Phase

	Average Rating Given by Evaluators (1=SD, 2=D, 3=N, 4=A & 5=SA)
Reviewing the effectiveness of the e-business strategy against CSF enables organisations to deliver feedback on CSF	4.6
Sharing the success of e-business strategy ensures success in future e-business implementation	4.2
Reviewing the e-business situation if the review against CSF fails enables realistic check of the e-business strategy	3.8

Furthermore, evaluators acknowledged that reviewing the e-business situation again if the review against CSFs fails, would provide a realistic check of the e-business strategy. Evaluator 3 noted that the second review of the e-business situation should focus on in-depth strategic scanning and positioning.

7.3.4 Results of Section IV: Applicability of the Framework

This section attempts to review the applicability of the Framework. The investigation includes determining the user-friendliness, usefulness and strengths of the Framework.

7.3.4.1 User-Friendliness of the Framework

This section examines the user-friendliness of the Framework. The findings of the evaluation showed that the Framework was easy to read and understand. The findings also revealed that the Framework was easy to use. Ratings of 4.0 and 3.0 were given to the relevant statement (see Table 7.9).

Table 7.9 User-Friendliness of the Framework

	Average Rating Given by Evaluators (1=SD, 2=D, 3=N, 4=A & 5=SA)
The framework is easy to read and understand	4.0
The framework is easy to use	3.0

7.3.4.2 Usefulness of the Framework

This section investigates the usefulness of the Framework. The findings of the evaluation suggested that the Framework was relevant to the current practices within the evaluators' organisations. Ratings of 4.0 and 3.8 were given to the relevant statements (see Table 7.10). Evaluators 1, 3 and 5 noted that the Framework was very close to the steps they were currently following in implementing e-business. In addition, the evaluators confirmed that the Framework could be easily applied to their organisations. Evaluators 1, 3 and 5 stated that they would consider using the Framework for their e-business strategy development. Evaluator 6 stated that he would recommend the Framework to the Senior Management Board for consideration.

Table 7.10 Usefulness of the Framework

	Average Rating Given by Evaluators (1=SD, 2=D, 3=N, 4=A & 5=SA)
The framework is relevant to your current practices in e-business	4.0
The framework can be easily applied to your organisation	3.8

7.3.4.3 Strengths of the Framework

This section investigates the strengths of the Framework. The investigation is focused on how the Framework can benefit the evaluators' organisations.

The Strategic e-Business Framework provided guidance for organisations in the industry to utilise their available IT resources and maximise the benefits of e-business through strategic practices. The findings of the evaluation revealed that the Framework would benefit the evaluators' organisations in several ways. A rating of 3.2 was given to the relevant statements (see Table 7.11).

Table 7.11 Strengths of the Framework

	Average Rating Given by Evaluators (1=SD, 2=D, 3=N, 4=A & 5=SA)
The framework will benefit to your organisation	3.2

Evaluator 6 commented that the six phases and five factors identified in the Framework could help his organisation consider the appropriate elements for e-business strategy development. Other evaluators commented that the hard gates and soft gates could enable the review of outcomes at the end of each phase. In summary, the evaluators reported that the Framework could benefit their organisations in the following areas:

- Helping them to recognise the attributes of their organisations in e-business practices, specifically by means of the strategic scanning or positioning at the Analyse Situation Phase;
- Providing a useful business case for organisations to evaluate the risks and requirements of e-business;
- Assessing the awareness and commitment of the Senior Management Board in e-business strategies and implementation;
- Helping them to establish a culture that is conducive to e-business implementation by including People as one main factor in the Framework and identifying associated activities;
- Guiding them to perform decision-making on technological issues by including Technology as one main factor in the Framework and identifying associated activities:
- Helping them carefully consider the e-business practices of external business partners by including External Environment as one main factor in the Framework and identifying associated activities.

7.3.5 Results of Section V: Reviewing the Five Factors of the Framework

This section studies the appropriateness of the Framework in detail. The investigation focuses on determining the importance of the five factors in the Framework. As described in Section 6.3 (Chapter Six), the Strategic e-Business Framework has defined five factors for categorising all the main activities: 1) Management, 2) People, 3) Process, 4) Technology and 5) External Environment. All of these five factors were reviewed in the framework evaluation.

The findings of the evaluation indicated that Management was considered the most important and Technology the least important among the five factors of the Framework (see Figure 7.1). All six evaluators ranked Management as more important

than the other four factors, while only one evaluator ranked Technology as more important. The evaluators emphasised the critical importance of management because management must consider how to utilise people, process, technology and external environment to implement e-business in the first place. In contrast to this, , the evaluators noted that technology was less important compared to the other five factors because technology was no longer a big issue and the available technologies were mature enough for them to conduct e-business.

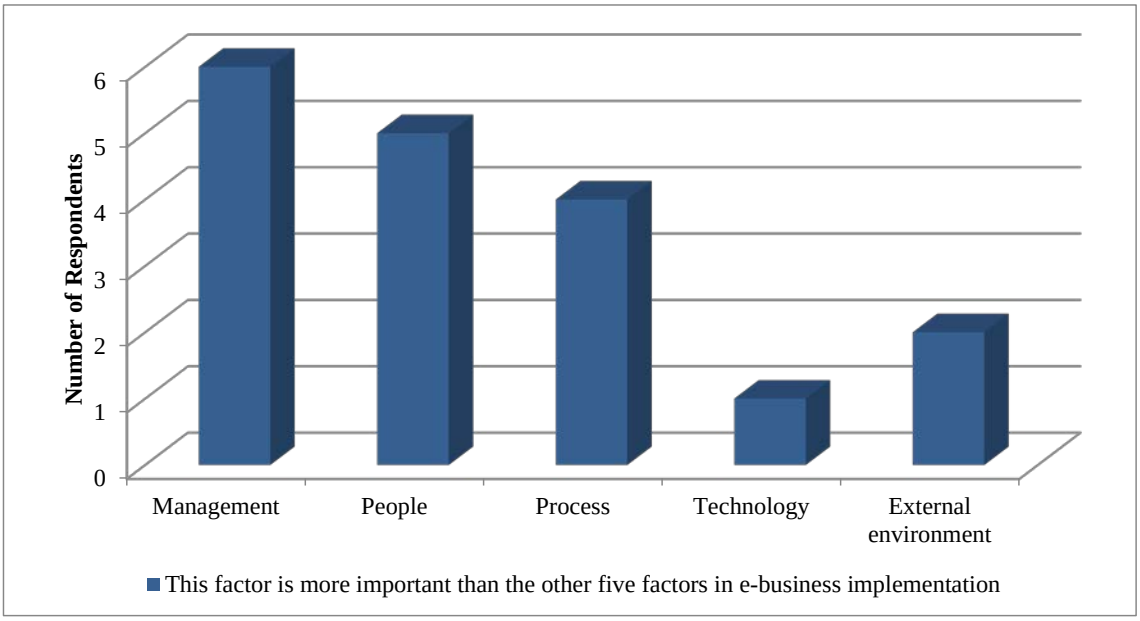

Figure 7.1 Review of the Five Factors in the Framework

Moreover, the evaluators also commented on the importance of People, Process and External Environment. Evaluators 1, 3 and 6 commented that the People factor was crucial for the success of the e-business strategies, specifically at the Implementing Action Plan Phase. Evaluators 4 and 6 suggested that Process and its rationalisation were crucial at the current stage of e-business implementation in the construction industry because many companies have yet to develop structured or standardised processes. Evaluator 2 stated that External Environment was extremely important for their organisation because their businesses and commitments to e-business were dependant on numerous supply chain organisations.

7.3.6 Suggestions for Improvement

This section discusses the comments with regard to the Framework implementation and suggestions on how to improve the Framework. Overall, the findings of the evaluation revealed that the evaluators gave positive about the ease with which the framework could be implemented and also provided valuable suggestions for the future development of the Framework. The following suggestions were made to further enhance the Framework:

- *The user-friendliness of the Framework*: The evaluators commented that the Framework was easy to read and understand. The evaluators also commented that using different colours and graphics to present the various elements of the Framework was necessary and appropriate. Moreover, according to evaluators, the use of colour or graphics could easily be lost on some individuals if they were not clearly defined. Therefore, the use of colour or graphics was one area that they thought could be enhanced to improve the user-friendliness of the Framework. This issue was considered valid. As a result, clear descriptions of graphics/colours that presented various elements of the Framework were included in the Framework Figure. The Framework at pre-evaluation is attached in Appendix 11.
- *The usefulness of the Framework*: The evaluators were not able to give a conclusive response when asked whether the Framework was easy to use. Some commented that the demonstration of the Framework could be enhanced to improve the usefulness of the Framework. For instance, one evaluator suggested that the Framework could be presented online, using dynamic links to content that described activities that were necessary to be undertaken at each phase. Currently the Framework is presented in Microsoft Visio. Users can read it on computer or print it out for reading. According to the evaluators, presenting the Framework online would further enhance the user experience. This improvement requires implementing Web design and other computer skills in presenting the Framework. This is currently beyond the scope of the research, but the next version of the Framework can be designed to allow users to review the Framework online.

- *The implementation of the Framework:* Evaluators also gave suggestions for the implementation of the Framework in practice. It was suggested that the detailed explanation of each activity (e.g. associated lower-level actions, tools and techniques) might be required when implementing the Framework. For example, Evaluator 3 commented some lower-level actions associated with the activity of 'identifying key technological systems and criteria based on the CSF of technology, such as the decision-making on selecting the appropriate approach to integrate the different e-business applications, and the decision-making on selecting the right standards for electronic invoice. This issue currently is out of the research scope, but it can be implemented in future as part of the continuous improvement plan that includes periodic reviews of the Framework for its appropriateness and regular updates (whenever necessary) to meet the changing industry needs and to keep abreast with the technological developments.

7.4 Summary

7.2 Background of Evaluation	7.3 Key Findings and Analysis of the Framework Evaluation
7.4 Summary	

This chapter presented the framework evaluation process and its findings. An evaluation questionnaire was used to gauge the appropriateness and effectiveness of the Strategic e-Business Framework from the industry's perspective. The findings from the evaluation indicated that the Framework was appropriate, effective and useful in identifying an e-business strategy and developing the Action Plan. The Framework provided an appropriate set of instructions for organisations in the construction industry to utilise the available IT resources and maximise the benefits of e-business in strategic practices. The findings of the evaluation also helped the researcher to determine the strengths and weaknesses of the Framework. The Framework had the potential to benefit organisations in several ways, including helping organisations to recognise the attributes of organisations in e-business practices, providing a useful business case for organisations to evaluate the risks and requirements of e-business, and assessing the awareness and commitment of the Senior Management Board regarding to e-business

strategies and implementation. The limitations to implementation of the Framework have also been highlighted and these included difficulties in performing some activities (e.g. assessing e-business development stage, and appointing an e-business champion), and lack of flexibility to address organisational culture and structure issues. The next chapter will present the conclusions drawn from the current thesis research.

CHAPTER EIGHT CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

This chapter presents a summary of the research, reviews the aim and objectives and discusses how each of them was achieved. The chapter also highlights the main contributions of the current study to knowledge and to the research domain. It also makes recommendations to construction industry practitioners on how to implement e-business strategically and how to effectively implement the proposed Strategic e-Business Framework. It identifies potential work for future research and discusses the limitations of the current research. The chapter ends with the concluding remarks.

8.2 Context

Electronic business (e-business) has transformed most industries and, despite its short history, has become a key component of business operations (Schneider, 2010). In the construction industry, the implementation of e-business has advanced from the basic activities to more complicated e-business solutions (DTI, 2004). However, the wider uptake of those e-business solutions in the construction industry has been relatively limited and ineffective. Many firms fail to realise that if they install an IT system without considering the strategic implications, they are likely to end-up with a software installation rather than an implementation of a comprehensive solution to business problems (Ruikar, et al., 2006). A successful company-wide rollout includes more than simply buying and installing technological e-business applications. The current research has considered different perspectives of an organisation and developed a Strategic e-Business Framework for organisations in the construction industry to help them continuously improve their e-business implementation through strategic practices.

8.3 Achievement of Research Aim and Objectives

The aim of the thesis research was *to develop a framework for implementing e-business*. The following six specific objectives were introduced in Section 1.4:

1. Review the main issues faced by the construction industry when implementing e-business;
2. Establish the level of penetration of e-business in the sector;
3. Assess how much understanding industry members have about implementing e-business strategically;
4. Explore the units of measurement that the sector members used for evaluating e-business implementation and strategies;
5. Determine the required elements of a strategic e-business framework; and
6. Develop a strategic e-business framework for organisations in the sector.

Investigating the actual practices of industry members in implementing e-business, determining the industry-specific needs and requirements, and identifying a holistic approach to address those needs and requirements would help achieve the aim. The following sections discuss these objectives and summarise how each was fulfilled.

8.3.1 Achievement of Objective 1

The first objective was to *review the main issues faced by the construction industry when implementing e-business*. This objective was achieved using a review of literature on the subject of e-business and its implementation within the construction industry (Sections 2.2 to 2.3). The review also included an examination of the different research efforts that have been employed in an attempt to help organisations in the construction industry to improve their e-business implementation (Section 2.4). The review highlighted the fact that e-business has the potential to change the fundamental structure of the industry through reengineering the workflow and the methods of sharing information, and therefore can benefit all organisations across the various construction disciplines (Sections 2.3.1 to 2.3.4). The review showed that the current barriers to the effective use of e-business in the construction industry are mostly related to management, human resources, organisational policies, and organisational culture (Section 2.3.5). The review also suggested that strategic practices are better than other approaches in improving e-business implementation because an e-business strategy can provide a comprehensive business solution that can be used to: a) define the future direction and actions of an organisation in carrying out internal and external communications, b) identify how an organisation should connect with external partners and link management activities, processes and systems, and c) enable an organisation to promote the business and IT infrastructure alignment to derive maximum benefit from

its investment in technology (Sections 2.4.1. to 2.4.4). The findings of review also identified research gaps and areas for further empirical investigation.

Four research questions were defined to guide the accomplishment and achievement of the other five objectives.

8.3.2 Achievement of Objective 2

The second objective was to *establish the level of penetration of e-business in the construction industry*. An industry-wide survey was designed and administered and the statistical descriptive analysis of the survey results was used to establish the level of penetration of e-business in the industry. The results revealed that e-business has penetrated the sector in many ways and that its greatest impacts have been felt in terms of productivity, efficiency of business processes, revenues, and management and control (Sections 4.3.1 to 4.3.4). The industry members participating in the survey recognised the competitive advantages provided by e-business and strived to implement e-business into their daily business activities and processes (Section 4.3.4). They have established communication networks for both internal and external communications (Section 4.3.2). They also have set up in-house IT training to develop the e-skill of their organisation's staff. Many of the organisations participating in the survey have invested in IT continuously over the last five years and their IT departments have played a critical role in their IT investment decision-making (Section 4.3.3). The research also revealed problems in the current implementation of e-business. One significant problem was that the continuous IT investment among the industry members did not resolve their limited and ineffective usage of e-business enabled advanced activities (Section 4.3.6). A need for further in-depth investigation was identified to determine the issues that prevented industry members from leveraging their IT investments and having better e-business implementation.

8.3.3 Achievement of Objective 3

The third objective was to *assess how much understanding industry members have about implementing e-business strategically*. The investigation of this objective was accomplished using the aforementioned industry survey and the analysis of its findings. The findings of the investigation revealed that the industry members were aware that the improvement of e-business implementation was associated with internal resources and capabilities, business processes, and organisational culture. Staff training

and senior management buy-in were crucial for improving e-business implementation (Section 4.3.5.1). Changes related to business processes, such as automation of processes, and integration of processes, also played an important role in improving the e-business implementation (Section 4.3.5.2). Recognising the benefits of using e-business through effective benefits realisation planning and good case studies would set a solid basis for establishing an e-business culture to motivate staff to implement e-business positively and confidently, which would improve e-business implementation dramatically (Section 4.3.5.3).

The findings also indicated that the industry members believed that e-business practices could be improved effectively if e-business implementation policies or strategies were properly related to the overall business goal (e.g. e-business strategy is incorporated into the overall business goal) (Section 4.3.5.4). The investigation of this objective also revealed problems in the current implementation of e-business. One major problem was that the industry members implemented e-business without long term strategic planning (Section 4.3.6). A need for further in-depth exploration was identified to study the actual practices of industry practitioners in e-business implementation.

8.3.4 Achievement of Objective 4

The fourth objective was to *explore the units of measurement that the sector members used for evaluating e-business implementation and strategies*. Case studies were designed to address this objective. The studies investigated the implementation of e-business at both the organisational and project levels. The evaluation of e-business implementation at organisational level was seldom done across the construction industry. The evaluation at the project level was conducted in three ways: calculating the cost savings at the different phases of projects, calculating the ROI of the applied e-business tools/applications in projects, and measuring the efficiency of e-business applications/tools following their implementation in projects (Section 5.3.3).

In the construction industry, the practices used in evaluating e-business strategies were still in the very early stages of development (Section 5.3.3). Units of measurement of the suitability, acceptability and feasibility of e-business strategies were limited and incomplete. The results of the case studies also indicated that industry innovators believed that e-business was the way of the future for conducting construction business

(Section 5.3.2). Driven by this belief, they were working on clarifying the future directions for strategic e-business implementation. From a technological perspective, they were attempting to arrive at a comprehensive solution for integrating different e-business applications (Section 5.3.2). From a strategic perspective, they were trying to establish a vision for directing long-term e-business implementation (Section 5.3.1). The needs and requirements for e-business strategy and its development process were defined based on an analysis of the case studies.

8.3.5 Achievement of Objective 5

The fifth objective was to *determine the required elements of a strategic e-business framework*. The results of the first four objectives were reviewed in order to address the needs and requirements in e-business strategy and its development process, and determine the elements of a strategic e-business framework (Sections 3.4.4, 6.2.2, and 6.2.3). The review suggested that an e-business strategy should include multiple elements and that collaboration between partners and information systems lies at the heart of a successful e-business strategy (Sections 2.4.5 and 6.2.4). An e-business strategy must consider both internal and external factors in order to engage with players from both inside and outside of the organisation. The research also indicated that: a) management buy-in is the driver of any e-business strategy; b) people (i.e. the active involvement of a cross-section of an organisation's staff) are crucial for the success of executing the strategy, c) process and technology set the infrastructural basis for operating the strategy, and d) another key factor in successful e-business strategy is that external environment supported the full utilisation of strategic actions, collaborations and benefits.

The review also indicated that the development of e-business strategy involved different phases. For example, situation analysis is a way of understanding the strategic position of an organisation implementing e-business. It helped organisations to scan their internal strategic drivers including capabilities, resources and culture, and also helped them to seek external, attractive opportunities in the marketplace (Sections 2.4.5.5 and 5.3.1). Strategic purpose is concerned with the most fundamental decision in e-business strategy development, which is, determining the purpose of the strategy. Defining a strategic purpose enabled organisations to identify long term business aspirations and identify the specific outcomes that they wanted to achieve in the short-term (Sections 2.4.5.5 and 5.3.1). Strategy implementation is about the practices and

execution of the defined e-business strategy. Successful implementation was assured by appointing the right people to take the right actions in the right way (Sections 2.4.5.5 and 5.3.2). Strategy evaluation is refers to evaluating the e-business strategy both before and after its implementation. It enabled organisations to define the main criteria for determining the success of the strategy and to define consistent methods for pursuing those criteria (Sections 2.4.5.5 and 5.3.3).

8.3.6 Achievement of Objective 6

The sixth objective was to *develop a strategic e-business framework for organisations in the sector*. The Plan-Do-Study-Act (PDSA) model was applied as the key principle to develop the Strategic e-Business Framework (Section 6.2.3). The Construction Process Protocol Framework was used to structure the contents and layout of the Framework (Section 6.2.4). A Strategic e-Business Framework was developed for organisations in the construction industry, to allow them to plan, execute and review their e-business strategies. The Framework includes six phases: Analyse Situation, Establish Vision, Determine Critical Success Factors (CSFs), Develop Action Plan, Implement Action Plan and Review Strategy (Section 6.4). By working through the six phases, industry practitioners can develop a complete e-business strategy and an implementation plan (the Action Plan). The Framework also included five factors by which to categorise the main activities involved in each phase. By addressing each of the five factors, industry members can make their organisations ready for immediate implementation of e-business (Section 6.3). The Framework also specifies the roles and responsibilities pertaining to each of the defined activities. Through investigating each activity, the industry organisations can utilise their available IT resources and maximise the benefits of e-business (Section 6.2.5).

The Framework was evaluated using structured interviews with industry practitioners (Section 7.2). Evaluators gave positive feedback about the appropriateness and effectiveness of the Framework and provided valuable suggestions for its future development (Section 7.3). The generalisation and analysis of their comments and recommendations also set the stage for the future research work.

8.4 Conclusions

The research has investigated the implementation of e-business in the construction industry with the aim of specifying a holistic approach that members of this sector can

use to continuously improve their e-business implementation. Subsequent to conducting the research, the following conclusions have been formulated:

- Industry members have recognised the competitive advantage of e-business and have made efforts to unlock the benefits and value that e-business can create. However, the full realisation of substantial e-business benefits can only happen within those organisations that have carefully considered e-business and its development through strategic scanning, positioning and planning.
- The uptake of advanced e-business activities, such as product/service promotion, project management and collaboration, e-procurement, SCM and CRM, is still limited. The adoption of construction-specific e-business solutions has grown and this suggests a potential large increase in adoption over the next 10 to 15 years.
- Industry members were aware that the improvement of e-business implementation was associated with internal resources and capabilities, business processes, and organisational culture. The industry practitioners attempted to manage changes related to these factors, and made efforts to reduce the risks and gaps in e-business implementation. Nevertheless, their progress in such practices varied between the different organisations. Staff e-skill development and senior management buy-in have been emphasised widely across the industry as important factors in improving e-business implementation. Process transformation was slow because the current practices still focused on adjusting technological solutions to fit into the current business activities. More effort was required aimed at process standardisation and integration. Finding the right people with both professional and IT skills was crucial for helping organisations to improve e-business implementation and establish an e-business culture.
- Industry practitioners were aware that their e-business plans or policies for implementation needed to be integrated with the overall business goals of their organisation. The industry practitioners have developed a variety of technology strategies to support corporate business goals, but most of these strategies were defined according to different e-business applications or were focused on project execution. A successful, company-wide,

comprehensive, strategic e-business solution was missing. As a result, the long-term direction for e-business implementation was not clear and the defined strategies could only address current organisational needs.

- A Strategic e-Business Framework was developed to provide a holistic approach to help organisations in the industry implement e-business. The Framework was developed from an IT Director or Senior IT Manager's perspective based on a concept of harnessing the abilities and commitment of other staff within the organisation. The Framework addresses all factors necessary for developing and implementing an e-business strategy, such as advising organisations to review e-business strategies after execution, linking technological systems, people and processes within the strategy, and including external organisations in the strategy.
- The Framework enables IT Directors or Senior IT Managers to include multiple elements in their e-business strategies and carry out consistent e-business planning. The Framework facilitates a sequential approach for industry practitioners to review their e-business strategy planning and implementation through examining phase gates (hard gates or soft gates) and phase outcomes. The Framework also makes the continuous improvement of e-business implementation possible by incorporating feedback loops. The Framework can prepare organisations for immediate e-business implementation. The Framework can also assist organisations in the construction industry to better utilise their available IT resources and maximise the benefits of e-business through strategic practices.
- The analysis of the evaluation of the Framework by practitioners have demonstrated the intense interest of industry practitioners in implementing the Framework to improve their current strategic practices in e-business and remain diligent in e-business strategy development.

8.5 Contribution to Knowledge

The main contributions to knowledge of this research are detailed below:

- This research identified the research approaches that have employed in an attempt to help construction organisations to improve their e-business implementation. It indicated that strategic practices are better than other

approaches in improving e-business implementation because an e-business strategy can provide a comprehensive business solution for construction organisations to define the future direction and actions in carrying out internal and promote the business and IT infrastructure alignment to derive maximum benefit from its investment in technology.

- This research established the level of penetration of e-business among the surveyed members of the construction industry. It indicated and confirmed that e-business practices in more complicated business activities (e.g. customer relationship management (CRM) and supply chain management (SCM) among construction organisations were still limited and more effort is required to improve their implementation.
- The research identified how aware industry members were of the added value of e-business with regard to business process operations, e-business capabilities and resources. It indicated that industry members were aware that the implementation of e-business could be improved through better staff training, more involvement of senior management, improved process rationalisation (e.g. process automation and process reengineering), and recognition of e-business benefits by all the staff within an organisation.
- The research identified the mixed e-business development stage among the specific end-user companies involving in the case studies and defined gaps and problems existing in their e-business practices. It indicated that changes must be assessed in order to enhance the e-business development in the case study organisations. All these changes must be specified in the organisations' e-business strategies and managed through project management approach in line with operational plans.
- The research identified the issues that organisations in the industry must address in order to develop a complete and robust e-business strategy. A good e-business strategy should consider the medium term (three to five years), the long-term (over five to ten years), and emergent needs to derive business value.
- The research developed a Strategic e-Business Framework to help industry practitioners (e.g. IT Directors or Senior IT Managers) to define, execute and review their e-business strategies. It provided recommendations for

industry practitioners regarding how to use and benefit from the Strategic e-Business Framework.

- The research identified potential targets for future research work, and gave recommendations for other researchers to execute further research work built upon the current study.

8.6 Recommendations

The current research has defined a holistic approach and presented a Strategic e-Business Framework that organisations in the construction industry can use to improve their e-business implementation through strategic practices. The investigation and evaluation of the Framework have suggested several possible avenues for future development of the Framework and for further research work to build upon the current study. Overall, this research provides recommendations for future work in two main areas:

- Recommendations regarding the strategic implementation of e-business in the construction industry; and
- Recommendations on future research.

8.6.1 Recommendations on Strategic Implementation of e-Business in the Construction Industry

The following recommendations are made on strategic implementation of e-business in the construction industry:

- The industry should consider a comprehensive business solution addressing both the organisation's current needs and its future emerging needs in order to make full utilisation of their existing investment in e-business including effective benefits realisation planning.
- The industry should consider their e-business solutions in a collaborative environment. Organisations must give serious thought to the engagement and support of external organisations. This includes linking e-business systems with the information set that is collected from the clients and submitted by suppliers. This is crucial because secure, transparent information exchanges and transfers along the whole supply chain are

necessary to ensure the effective implementation of e-business and unlock the full substantial benefits that e-business has to offer.

- Organisations in the construction industry should consider the appropriate and effective staff training and skill assessment programmes in order to motivate employees to use e-business tools and applications, build their confidence in using new e-business technologies, and create a good culture to e-business practices.
- The industry should revise the measures and methods used for evaluating their level of success in implementing e-business. The current measures are limited and ineffective. The measures for evaluating e-business implementation should include performance metrics for implementation at both the organisational level and the project level. The measures used to evaluate e-business strategies should include criteria that ensure the success of strategy implementation. The evaluation of e-business strategies should define consistent methods for pursuing those success criteria.

8.6.2 Recommendations on the Future Research Work

The following recommendations were made on the future research work:

- Extend the research to investigate the commitment of a wider range of management staff (i.e. Senior Management, Middle Level Management, Lower Level Management, and other End-users) in implementing the Strategic e-Business Framework.
- Replicate the case study to other construction firms (e.g. M&E contractors, suppliers and manufacturers) to examine their approach and to study good practice.
- Explore the strategic e-business practices of industry end-user companies via quantitative methods within a much larger sample of construction firms. It would provide interesting points of comparison to the conclusion derived from the interpretation of the qualitative data. The findings could strengthen or appropriately limit the generalisability of this research.
- Compare and contrast the findings with organisations in other project-based industries to identify similarity and difference.

- Explore the impact of newly emerging technologies and hardware, such as smart phones and handheld devices (i.e. Apple® iPads, Android® tablets, Windows® tablets and others), on construction organisations' strategic e-business practices.
- Explore the impact of newly emerging e-business combined-solutions, such as Collaboration-BIM and Mobile-BIM, on construction organisations' strategic e-business practices.

8.7 Limitations

Although strategic planning and management have been abundantly explored in other areas and domains, research of strategic implementation of e-business within the context of construction industry is quite new. This research is a pioneer study in this area and contributed to the knowledge and the research domain. As with any research, this study has some limitations, which are identified as follows:

- The industry survey was conducted with the members of Construct IT. Although the members of Construct IT are appropriate representatives of the construction industry there were questions over the generalisation of the data to a broader set of construction industry organisations.
- The survey questionnaire was delivered through the Internet and results were collected electronically. Personal contacts were made to ensure the right informants were reached. Informant bias still exists according to the survey participants' experience in using e-business applications and their knowledge about e-business and the associated strategic factors, such as internal resources, business processes and organisational culture.
- The multiple-case studies were conducted with four organisations that have participated in the industry survey and expressed their interests in the follow-up study. Altogether, two contractors (main contractors) and two consultants were involved in the case studies. Organisations from other construction disciplines, such as suppliers and manufacturers, were not included in the case studies. Although these organisations are appropriate representatives of the construction industry there were questions over the generalisation of the data to a broader set of construction industry organisations.

- The evaluation of the Strategic e-Business Framework was carried out using only IT Directors or Senior IT Managers of contractors and consultants. Although the findings have not shown any significant differences between the opinions of contractors and those of consults, it might have been very useful to include a broader representation including a greater variety of disciplines and also participants from organisations that were not included in the case studies.

8.8 Concluding Remarks

There are four key findings of this research. First, a complete and robust e-business strategy is defined as an essential to the improvements of e-business practices. Organisations that install an IT system without considering the strategic implications, are likely to end-up with a software installation not an implementation of a comprehensive solution to business problems. Secondly, a complete e-business strategy should consider the medium term (three to five years), long-term (over five to ten years), and emergent needs to derive business value. The most effective technology strategy is the one that closely supports its owner's strategic business goals. The result is the ability to capitalise on the full potential of the technology investment both, in short- and long-term. Considering this, it is essential to develop short-term and long-term strategies for the effective deployment of technologies. Thirdly, a complete e-business strategy should address every facet of an organisation and produces substantial changes not just from a technology perspective, but also from the internal organisation’s perspective of its management practices, people (culture, attitudes, behaviour), and processes. Fourthly, it is also important to recognise that e-business is a collaborative effort; therefore any strategy that is developed needs to take into account both, the internal and the external environments.

In conclusion, a holistic approach is required to address the strategic needs and requirements of construction organisations in e-business. A Strategic e-Business Framework was developed to address these comprehensive needs and requirements. The Strategic e-Business Framework can assist organisations in the construction industry to define, manage and review their e-business strategies. The Framework provides guidance for them to utilise their available IT resources and maximise the benefits of e-business. The Framework also provides an approach that manages changes and makes

process continuous improvement effectively, and it also provides a learning and feedback loop that enables lessons learned from the past. The Framework is a positive step towards e-business management. Organisations in the industry can enhance their e-business development and plan proactively when new technologies emerge.

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APPENDICES

APPENDIX 1 ARCOM CONFERENCE PAPER

ELECTRONIC PROCUREMENT BENCHMARCHING EXERCISE IN THE AEC INDUSTRY SECTOR

Chen, Y, Ruikar, K and Carrillo, P M (2008) Electronic procurement benchmarking exercise in the AEC industry sector. *In:* Dainty, A (Ed) *Processing of 24th Annual ARCOM Conference*, 1-3 September 2008, Cardiff, UK, Association of Researchers in Construction Management, 647-654. Available from: http://www.arcom.ac.uk/-docs/proceedings/ar2008-647-654_Chen_Ruikar_and_Carrillo.pdf.

ABSTRACT

In spite of recognising the potential of electronic commerce (e-commerce), a majority of the architecture-engineering-construction (AEC) industry participants still adopt a 'wait-and-see' approach in their investments of information technologies. Quantitative study and benchmarks can help the industry to have a better understanding and implementation of e-commerce. Research work that focuses on electronic procurement (e-procurement) benchmarking in the Canadian AEC sector makes headway in evaluating the value of e-commerce quantitatively. The initial findings of the research suggest the need for a conceptual e-procurement model. Literature is synthesised to highlight the issues while proposing to take this by undertaking further benchmarking studies of e-procurement in the UK AEC sector.

KEYWORDS:

Benchmarking, construction industry, electronic commerce, electronic procurement

APPENDIX 2 SUMMARY OF THE PILOT STUDY FOR THE INDUSTRY SURVEY

Respondent	Position	Construction Disciplines	Experience
A	Planning Engineer	M&E Contractor	9
B	Site Manager	Main Contractor	3
C	Planning Manager	M&E Contractor	20
D	Project Manager	Designer	11
E	IT Engineer	Consultant	2
F	IT Engineer	Consultant	3
G	Research Student	Research Institution	3
H	Research Student	Research Institution	2
I	Research Student	Research Institution	2
Recommendations:			
Time taking for completing	Average 7 to 8 minutes, at most 10 minutes		
Format of questionnaire	1. Adding university logo and make the questionnaire more formal 2. Labelling the copyright at the end of questionnaire 3. Identifying the check boxes and forbidding non-effective results caused by respondents unintended mistake 4. Changing the format of some questions and making them easy to be completed for respondents. 5. Making the survey aim and objectives in the same page with the questionnaire.		
Wording of questionnaire	1. Rewording some of the questions for better understanding. 2. Changing a few titles 3. Removing some choice options because they are repetitive.		
Limitation of questionnaire	1. Suggesting targeting respondents on both IT working staff and end-users, or there will be limitations. 2. Suggesting improvements of e-business implementation not limited to hard issues, but soft issues. So the questions about organisational culture were added.		

APPENDIX 3 SURVEY QUESTIONNAIRE

Survey: e-Business in the Construction Industry

Introduction:
The purpose of this survey is to collect the opinions of the construction industry in implementing electronic business (e-business) strategically: to support a research program in the adoption and implementation of e-business within the construction industry at Department of Civil Engineering in Loughborough University.

Definition:
In this survey, e-Business is defined as automated business processes (both intra-and inter-firm) over computer mediated networks and also the integration of all business activities that include redesigning of business process or reinventing of business model through information and communication technologies.

1 Background Information

Please provide some information about your company and responsibility.

1.1 Type of Organisation

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

Main Contractor	Architect	Building Material Supplier	Developer
M&E Contractor	Engineer	Plant Hire (with operators) Supplier	Facility Manager
Trade Contractor (Speciality)	Designer	Manufacturer	Consultant
Other (please specify)			

1.2 Areas of Work

Please **select** the type of construction work that your organisation undertakes:

Building work	Civil work	Refurbishment
Other (please specify)		

1.3 Job Title

Please **select one** option that best describes your role:

Senior Management Staff	Middle Management Staff	IT Working Staff
Other (please specify)		

1.4 Size of Organisation (annual turnover)

Please **select one** range of annual turnovers to indicate the volume of business conducted by your **organisation**:

0~£1 million	£1million~£5 million	£5 million~£10 million
£10 million~£50 million	£50million~£100 million	Over £100 million

2 e-Business in Your Organisation

Please provide some information about the application of e-Business in your organisation.

2.1 e-Business Activities

Please **state the degree** to which the following activities/documents are computerised and exchanged electronically:

Activities/Documents	None	A small amount	Most	All
Design Drawings				
Specifications				
Tendering Documents				
Project Programming				
Estimating Documents				
Purchase Orders/Invoices				
Administration Documents				
Other (please specify)				
Other (please specify)				

2.2 Communications Network

A. Please **identify** the type of the network you use:

Intranet	Extranet	Both	Neither

B. Please **identify the degree** to which you communicate **electronically** internally and externally:

Activities	None	A small amount	Most	All
Internal Communications				
External Communications				

2.3 Level of e-Business Usage

If Internet technology is used in your organisation, please **state the degree** to which the following activities are undertaken:

Activities	None	A small amount	Most	All
Product/Service promotion				
Electronic procurement (purchase material & equipment)				
Bidding and tendering online (whole project delivery)				
Project collaboration and management				
Customer relationship management				
Supply chain management				
Other (please specify)				
Other (please specify)				

3 IT Investment Advice and e-Skill Development

Please provide some information about how your organisation operates and maintains your e-business systems.

3.1 IT Investment Advice

Please **select all** statements that apply to your organisation:

Obtain advice on IT investment from professional IT providers
Obtain advice from own IT department or IT practitioners

Learn through university or other research parties
Implement IT investment through government/third party recommendations
Other (please specify)
Other (please specify)

3.2 IT Expenditure

What is the **average annual** share of your IT budget, including hardware, software, services and personnel, as percentage of your total company costs in last 5 years?

0~5%	5~10%	10~15%
Other (please specify)		

3.3 e-Skill Development

A. Do you provide in-house IT training to your staff?

Yes	No

If yes, please answer the following questions. If no, please go to question 4.1.

B. Please **select all** statements that best reflects your organisation's situation:

Staff learn new computerised skills through self-learning
Hire IT practitioners to train your staff
Staff attend training courses outside your organisation
Other (please specify)
Other (please specify)

4 Drivers, Impact and Barriers of e-Business

Please provide some information about the drivers, impact and barriers of applying e-business in your organisation.

4.1 Drivers

Please indicate the reasons that your organisation engages in e-business:

Your competitors also engage in e-business
Your customers expect it from you
Your suppliers expect it from you
You believe the competitive advantage of e-business
Other (please specify)
Other (please specify)

4.2 Impact

Please **identify the level** the following influences would have on the decision of implementing e-business by clicking buttons provided :

Impact	**H** (high)	**M** (medium)	**L** (low)
Growth of revenue			
Efficiency of business processes			
Procurement cost of supplied goods			
Quality of products			
Quality of customer service			
Productivity			
Management and control			
Accounting and administration			
Internal organisation relationship			
Staff training			
Market reach			
Innovation			
Research and development			
Other (please specify)			

4.3 Barriers

Please **identify the level** the following barriers of implementing e-business by clicking buttons provided:

Barriers	**H** (high)	**M** (medium)	**L** (low)
Cost of investment			
Resistance to change			
Confidence in using new technology			
Lack of technical skills			
Legal barriers			
Interface with other systems			
Security of data transaction and submission			
Changeable IT technical needs of an organisation			
Modification of legacy systems			
Other (please specify)			

5 Improvement of e-Business

Please provide some information about potential improvement of e-business in your organisation.

5.1 Internal Resources

Please **select all** the statements below that best describe your organisation's belief in improving e-business implementation with regard to internal resources:

More IT investment funds
More expenditure in IT infrastructure
Increase IT working staff or hire professionals to help
More senior involvement
Better training for working staff
Other (please specify)
Other (please specify)

5.2 Business Processes

Please **select all** the statements below that best describe your organisation's belief in improving e-business implementation with regard to business processes:

Automation of business processes
Integration of different business processes
Reengineering business processes
Connect e-business value to business performance
Other (please specify)
Other (please specify)

5.3 Organisational Culture

Please **select all** the statements below that best describe your organisation's belief in improving e-business implementation with regard to organisational culture:

Recognise the benefits and importance of using e-business
Encourage staff to use e-business tools
Commit to address issues/inhibitions when using e-business
Change organisation culture to suit for e-business adoption and use
Other (please specify)
Other (please specify)

5.4 Business Goal

Please **select one** statement below that best describes your organisation's belief in improving e-business implementation with regard to business goal:

Sell-side e-business policy, no need to integrate with the overall business goal
e-Business policy integrated with the overall business goal
e-Business policy incorporated as part of the overall business goal
Other (please specify)
Other (please specify)

6. Future of e-Business in Your Organisation

Please provide some information about the future of e-business with your organisation.

6.1 Future Investment in e-Business

Please **select one** statement below that best describes your organisation's commitment to e-business:

Plan to make an investment in 0~ 6 months	Plan to make an investment in 6 months ~ 1 year	Plan to make an investment in 1 ~ 1.5 years
Plan to make an investment in 1.5 ~ 2 years	No plans to make an investment	Other (please specify)

6.2 Launch of e-Business Policy

If your organisation has a plan for launching an e-business implementation policy, please indicate its type:

Short-term (up to 2 years)	Medium-term (3~5 years)	Long-term (over 5 years)
Don't know yet		

7 Survey Results

If you would like a summary of the results of this survey please provide your name and e-mail address below:

Name:

Email:

If you would be willing to be contacted as a follow up on the survey please provide your contact information below:

APPENDIX 4 RAW DATA OF THE QUESTIONNAIRE

Part 1 of 6: Information Background

1.1 Type of Organisation

Main Contractor	37%
Architect	2%
Developer	10%
M&E Contractor	6%
Engineer	6%
Trade Contractor	4%
Consultant	14%
Other	20%
Total	100%

1.2 Areas of Work

Building work	76%
Civil work	41%
Other	29%

1.3 Job Title

Senior management staff	50%
Middle Management staff	17%
IT working staff	11%
Other	22%
Total	100%

1.4 Size of Organisation (annual turnover)

£1million~£5 million	9%
£5 million~£10 million	11%
£10 million~£50 million	15%
£50million~£100 million	17%
Over £100 million	48%
Total	100%

Part 2 of 6: e-Business in Your Organisation

2.1 e-Business Activities

	None	A small amount	Most	All
Design drawings	2%	9%	47%	43%
Specifications	2%	9%	52%	37%
Tendering documents	0%	17%	53%	30%
Project programming	2%	7%	44%	47%
Estimating documents	2%	13%	53%	32%
Purchas orders/invoices	4%	33%	39%	24%
Administration documents	4%	21%	60%	15%
Other	0%	50%	50%	0%
Other	0%	100%	0%	0%

2.2 Communications Network

Communication Network

Intranet	16%
Extranet	0%
Both	82%
Neither	2%
Sum	100%

	None	A small amount	Most	All
Internal communications	0%	4%	75%	21%
External communications	2%	6%	81%	10%

2.3 Level of e-Business Usage

	None	A small amount	Most	All
Product/Service promotion	4%	38%	56%	2%
Electronic procurement	17%	45%	30%	9%
Project collaboration and management	4%	29%	54%	13%
Customer relationship management	15%	56%	21%	8%
Supply chain management	21%	51%	21%	6%
Other	0%	50%	50%	0%
Other	0%	100%	0%	0%

Part 3 of 6: IT Investment Advice and e-Skill Development

3.1 IT Investment Advice

Advice from professional IT providers	67%
Advice from own IT departments	83%
Learn from universities or research parties	26%
Learn through government/third party	17%
Other	9%

3.2 IT Expenditure

Average Annual Share of IT Budget in Last 5ys

0~5%	50%
5~10%	33%
10~15%	7%
Other	11%
Total	100%

3.3 e-Skill Development

IT In-house Training

Yes	77%
No	23%
Total	100%

External Sources for e-Skill Development

Learn computer skills through self-learning	77%
Hire IT practitioners to train your staff	60%
Attend training course outside	60%
Other	21%

Part 4 of 6: Drivers, Impact and Barriers of e-Business

4.1 Drivers

Competitors also engage in e-business	54%
Customers expect it from you	76%
Suppliers expect it from you	43%
Belief of competitive advantage	76%
Other	35%

4.2 Impact

	High	Medium	Low
Growth of revenue	51%	36%	13%
Efficiency of business processes	78%	17%	4%
Procurement cost of supplied goods	26%	43%	31%
Quality of products	21%	35%	44%
Quality of customer service	45%	39%	16%
Productivity	67%	23%	9%
Management and control	51%	42%	7%
Accounting and administration	49%	42%	9%
Internal organisation relationship	29%	49%	22%
Staff training	16%	52%	32%
Market reach	23%	42%	35%
Innovation	37%	33%	30%
Research and development	37%	33%	30%

4.3 Barriers

	High	Medium	Low
Cost of investment	59%	30%	11%
Resistance to change	39%	32%	30%
Confidence in using new technology	23%	61%	16%
Lack of technical skills	11%	52%	36%
Legal barriers	9%	30%	61%
Interface with other systems	32%	55%	14%
Security of data transaction and submission	20%	59%	20%
Changeable IT technical needs of an organisation	16%	55%	30%
Modification of legacy systems	16%	57%	27%

Part 5 of 6: Improvement of e-Business

5.1 Internal Resources

More IT investment funds	40%
More expenditure in IT infrastructure	35%
Increase IT working staff or hire professionals to help	28%
More senior involvement	50%

Better training for working staff	68%
Other	15%

5.2 Business Processes

Automation of business processes	75%
Integration of different business processes	75%
Reengineering business processes	65%
Connect e-business value to business performance	53%
Other	10%

5.3 Organisational Culture

Recognise the benefits of using e-business	64%
Encourage staff to use e-business tools	69%
Commit to address issues/inhibitions	50%
Change organisation culture	47%
Other	8%

5.4 Business Goal

One-side e-business policy, not integrated with the overall business goal	7%
e-Business policy is integrated with the overall business goal	49%
e-Business policy is incorporated as part of the overall business goal	32%
Other	12%
Total	100%

Part 6 of 6: Future of e-Business in Your Organisation

6.1 Future Investment in e-Business

Plan to make an investment in 0~ 6 months	23%
Plan to make an investment in 6 months ~ 1 year	12%
Plan to make an investment in 1 ~ 1.5 years	12%
Plan to make an investment in 1.5 ~ 2 years	14%
No plans to make an investment	16%
Other	23%
Total	100%

6.2 Launch of e-Business Policy

Short-term (up to 2 years)	32%
Medium-term (3~5 years)	27%
Long-term (over 5 years)	2%
Don't know yet	39%
Total	100%

APPENDIX 5 CONSTRUCT IT REPORT

Chen, Y., Ruikar, K.D., Carrillo, P.M., Khosrowshahi F. and Underwood, J. (2011) E-business in the Construction Industry. An Industry Report Produced for the Construct IT Autumn Event held in conjunction with Oxford Brookes University and buildingSMART. Available from http://www.construct-it.org.uk/

EXECUTIVE SUMMARY

This report was produced based on an industry survey delivered electronically among construction organisations. The survey was part of a three-year research project that was undertaken at the Department of Civil and Building Engineering in Loughborough University focused on the strategic implications of e-business in the AEC sector. Industry practitioners were invited to answer questions about the current status of e-business and strategic implementation of e-business in the construction industry. The survey results were then analysed to establish the level of penetration of e-business and assess the understanding of industry practitioners towards strategic implementation of e-business. The survey results indicated that the industry organisations have implemented e-business in their business activities and processes. However, they were still slow in adopting sophisticated e-business applications. The organisations have acknowledged the competitive advantage of e-business. They had a full understanding about current challenges of e-business implementation, and knew how to improve their e-business practice by leveraging the internal resources, business processes, organisational culture, and overall business goal. After presenting the achievable from the survey, the conflicts between the understanding of organisations and their actual practices in e-business were discussed for the future research.

This study elicits the opinion of construction industry practitioners to identify strategic issues associated with the implementation of electronic business (e-Business) In this study, e-Business is defined as automated business processes (both intra-and inter-firm) over computer mediated networks and also the integration of all business activities that include redesigning of business process or reinventing of business model through information and communication technologies.

APPENDIX 6 CASE STUDIES: SEMI-STRUCTURED INTERVIEW QUESTIONS WITH INDUSTRY EXPERTS

Section 1: Introduction Question

1.1 What is your understanding of e-business?

Section 2: e-Business Tools and Applications for Further Investigation

2.1 Many e-business tools and applications have adopted in the construction industry. Which ones do you think require further investigation about their roles of transforming the industry (i.e. industry processes or business activities)?

Section 3: Strategic e-Business Practices in the Construction Industry

3.1 According to your experience, how the construction industry has involved in strategic e-business practices?

Section 4: Recommended Organisations for Case Studies

4.1 Do you know any organisations that are good for carrying out an in-depth investigation on their e-business practices?

APPENDIX 7 CASE STUDIES: STRUCTURED INTERVIEWS QUESTIONS (FOR IT MANAGERS)

Section 1: Introduction Question

1.1 What is your understanding of e-business?

Section 2: The stage of e-business use in your organisation

2.1 What e-business enables you to do currently? (Service Available)

2.2 How e-business help you to transfer information and communication across departments or beyond? (Organisational scope)

2.3 How would you define e-business to fit into your organisation currently business activities (e.g. just a part of technological infrastructure or innovation, or part of your internal processes, or something else)? (Transformation)

Section 3: Strategy

3.1 What is your e-business strategy?

3.2 What does it cover?

3.3 How did you work it out?

3.4 When did you have it?

3.5 What's your future consideration of the strategy?

3.6 When will you apply it?

Section 4: Implementation

4.1 What kinds of risks do you need to deal with when implementing e-business in your organisation? (Risk)

4.2 What do you usually do if you find a need to change in the organisation (such as the systems, working practices, and processes) when do the implementation? (Change)

4.3 How do you manage the gap if the change is not possible? (Managing the gap)

4.4 What else do you do to improve the e-business implementation? (Improvement)

Section 5: Units of measurement

5.1 How do you measure the benefits of e-business implementation?

5.2 Do you usually connect the benefits to your organisation's performance?

5.3 How do you measure the risks of e-business implementation?

5.4 How do you measure your e-business strategy?

APPENDIX 8 CASE STUDIES: STRUCTURED INTERVIEWS QUESTIONS (FOR PROJECT MANAGERS)

Section 1: Introduction Question

1.1 What is your understanding of e-business?

Section 2: Project Information

2.1 Type of project

2.2 Contract type

2.3 Contract value

2.4 Project location

2.5 Project size

2.6 Project start and completion

Section 3: e-Business Tools Used in the Projects (Implementation)

3.1 What kinds of e-business tools have you implemented in your projects (e.g. CAD, BIM, other design software, planning tools, collaboration tools, project management tools, knowledge management tools, e-procurement tools, CRM, SCM, and etc.)?

3.2 At what phase did you implement the tools (e.g. project initiation, project planning, project execution, and project closure)?

3.3 How did the e-business tools help you with the delivery of the final product (the final product refers to the final output of the project is targeted to complete, such as a building, infrastructure, and etc.)?

3.4 How did the e-business tools help you with the working processes (the working process refers to all the processes that involved in the delivery of the final product)?

3.5 How did the e-business tools help with the interaction with other participants/parties/disciplines in the projects?

Section 4: Units of measurement

4.1 How do you measure the efficiency of using the electronic tools after they have implemented?

Section 5: Strategy

5.1 Do you have a particular strategy for this project to implement the e-business tools?

APPENDIX 9 EXAMPLE OF INTERVIEW RESULT ANALYSIS

Issues Related to People Factor

1) Each office has an e-business leader. The leader is to help promote wider management of e-business tools to access their potentials, usually a specialist who understands technologies well (*e-business leader or champion*).

2) Another change is much more skill requirement of people (*new skill requirements*).

3) Also we try to find new blood. We try to find the best designer, and best skills. It was hard five years ago, but it is easy now (*new skill requirements, new blood*).

4) Another gap is the lack of digital assemblers in the industry as whole, which refers to the people who knows how to take the digital concepts and turn them into something build-able (*new roles and new responsibilities*).

5) I do a lot of training and build confidence. We do a lot of seminar and introduction programme, and across board training (*building confidence, organisational culture; awareness*).

6) It's difficult to persuade everyone this is the best way to do it (*changing people's mind set, organisational culture).*

7) I use training and building confidence of people using the main features of the tools to improve the efficiency. We do test and we use testing facility called knowledge smart. It is online service. It examines the people through multiple choices and accomplishing certain drawing tasks. It is the base for the training concept (*skill assessment*).

8) The biggest challenge is not the technologies, but the training people to use it. Everyone in the project had to buy in to the BIM database and use it. A good proportion of people need to change of their mind-set of using 3D modelling (*changing people's mind-set and behaviour, organisational culture*).

9) We identify the people who are capable of being open-minded enough to adopt new technologies. It's not an age thing, and some people are more resistant than the others. It will start from the bottom up. Because our graduates coming through are far more IT ligature and capable (*identifying e-business leader or innovator, improving the IT capability, new roles and new responsibilities, new blood*).

10) If you got bad process and procedures, but really good people, that turns to be OK. The emphasis is to school with the people, not the processes (*people focused*).

11) We are trying to small bit of things at a time, for example, could be people, the willingness of people, and some specific changes for the particular project (*changing people's mind-set and behaviour*).

12 People are generally engineers, and they do not feed of the information or data that created during the design phase (*new roles and new responsibilities*).

13) People are the most part to be managed (see the diagram of people, process, and technology). We invest massive in communications such as workshops rather than buying a new piece of software, new server or other infrastructure (*good communication*).

Main Issues Related to People	**Frequency**
New roles and new responsibilities	**3**
New skill requirements	**2**
New blood	**2**
Skill Assessment	**1**
People focused	**1**
Changing people's mind-set and behaviour	**4**
Identifying e-business leader or innovator	**2**
Good communication	**1**
Organisational culture	**3**
Improve IT capabilities related to people	**1**

APPENDIX 10 QUESTIONNAIRE FOR THE STRATEGIC E-BUSINESS FRAMEWORK EVALUATION

Evaluator's role and responsibility:
Company:
Experience:
Date:
Please read the accompanied attachment on *Strategic e-Business Framework for the Organisations in the Construction Industry* and kindly answer the following questions by giving them the appropriate scores (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree).

Section I: Review the appropriateness of the framework *Do you agree that the proposed framework:*	**Ranking (1=strongly disagree & 5=strongly agree)**				
	1	**2**	**3**	**4**	**5**
Presents an appropriate set of instructions for developing e-business strategies at organisational level					
Identifies the appropriate provision of phases needed					
Defines the activities at appropriate level (e.g. three activities included in the Analyse Situation Phase)					
Specifies the appropriate roles and responsibilities for the activities					
Considers the appropriate factors (e.g. management, people, process, technology and external environment)					

Section II: Review the clarity of the framework *Do you agree that the proposed framework:*	**Ranking (1=strongly disagree & 5=strongly agree)**				
	1	**2**	**3**	**4**	**5**
Clearly defines a solution for consistent e-business strategy development					
Clearly addresses the strategic e-business needs of the industry					
Clearly delivers the strategic e-business requirements of the industry					

Section III: Review the Six Phases of the Proposed Framework *To what degree, do you agree with the statement that:*	**Ranking (1=strongly disagree & 5=strongly agree)**				
	1	**2**	**3**	**4**	**5**
Assessing the e-business development stage enables the determination of the level of e-business in future					
Analysing the internal IT capabilities and the external constraints enables the positioning of the e-business situation					
Assessing the corporate strategic vision ensures e-business vision aligns with corporate vision					

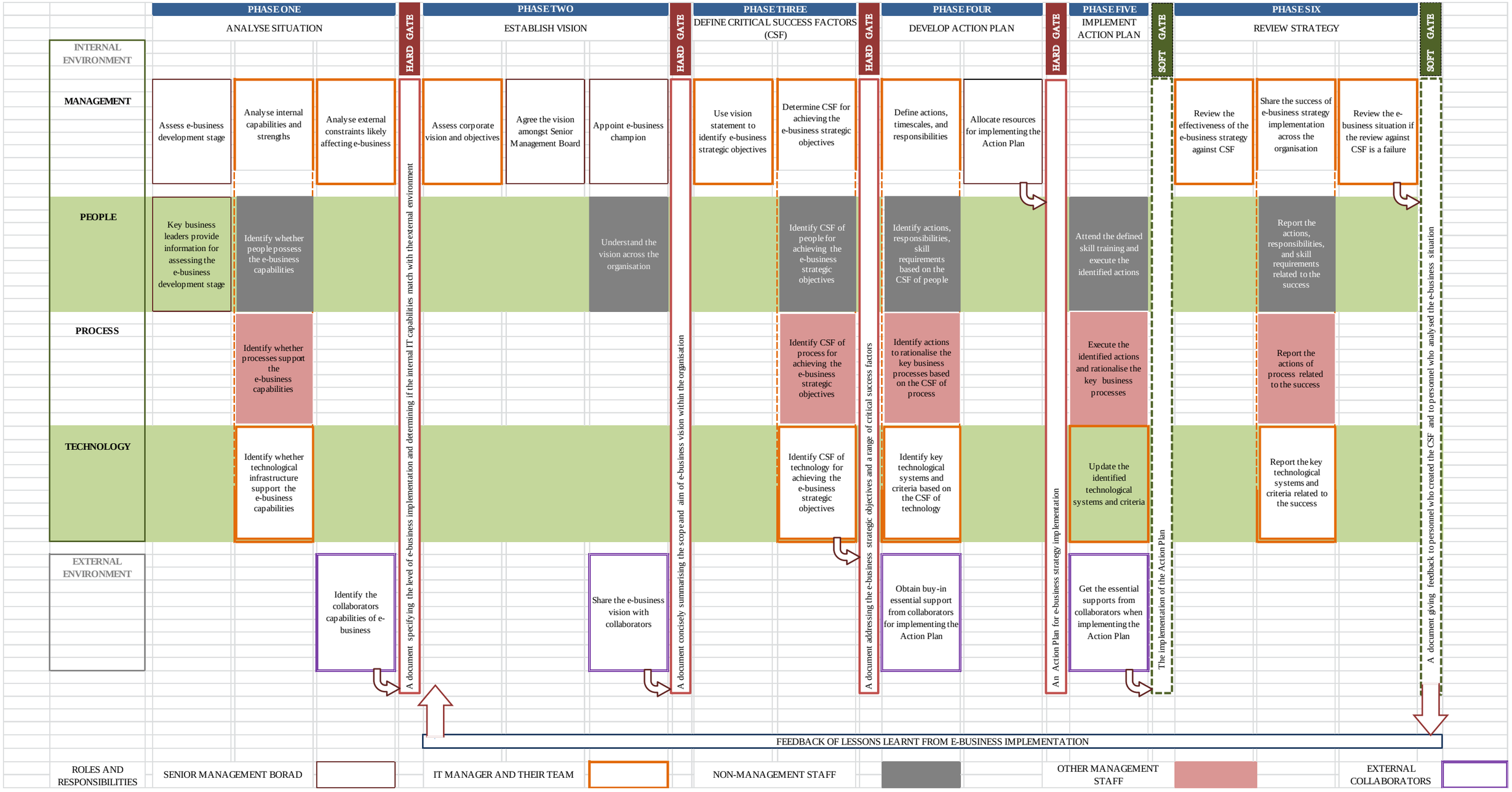
Agreeing the e-business vision amongst Senior Management Board ensures the awareness of the vision from top-down					
Appointing the e-business champion ensures the champion fully understand the organisation's e-business aim and scope					
Identifying the strategic objectives based on the vision statement ensures the alignment of short-term objectives and long-term vision					
Determining the critical success factors (CSF) enables the definition of the essential measures to assess performance					
Defining actions, timescales and responsibilities enables the delivery of a complete and well-defined Action Plan					
Reviewing the effectiveness of the e-business strategy against CSF enables organisations to deliver feedback on CSF					
Sharing the success of e-business strategy ensures success in future e-business implementation					
Reviewing the e-business situation if the review against CSF fails enables realistic check of the e-business strategy					

Section IV: Review the applicability of the framework *To what degree, do you agree with the statement that:*	**Ranking (1=strongly disagree & 5=strongly agree**				
	1	**2**	**3**	**4**	**5**
The framework is easy to read and understand					
The framework is easy to use					
The framework is relevant to your current practices in e-business					
The framework can be easily applied to your organisation Explain reason for the response:					
The framework will benefit to your organisation Explain reason for the response:					
It is easy for you to assess your current e-business development stage					
It is possible to appoint an e-business champion in your organisation					
It is possible for you to share the success of e-business strategy across your organisation					

Section V: Review the Factors of the Proposed Framework *It is crucial to include the factors (management, people, process, technology and external environment) in an e-business strategy. Please indicate the importance of each factor as comparing to the other four:*	**Ranking 1=more important, 2=equally important, 3=less important**		
	1	**2**	**3**
Management			

People			
Process			
Technology			
External environment			

Are there any changes/improvements you would suggest to the *Strategic e-Business Framework*?

Would you use this *Strategic e-Business Framework*? Please explain your answer.

APPENDIX 11 THE STRATEGIC E-BUSINESS FRAMEWORK AT PRE-EVALUATION