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Title Study of internet usage in the fresh produce supply chain in the UK and China

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STUDY OF INTERNET USAGE IN THE FRESH PRODUCE SUPPLY CHAIN IN THE UK AND CHINA

BY

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ABSTRACT

Fresh produce supply chain management faces a high level of complexity and uncertainty and a number of challenges due to fresh produce's perishable, seasonal and fragile characteristics. It is argued that effective implementation of Information and Communication Technologies (ICTs) has great potential for improving efficiency and reducing wastage within the fresh produce (fruit and vegetable) supply chain. While the Internet is used by many small and medium-sized enterprises (SMEs) in the fresh produce industry, the extent to which it is applied and further developed after the initial adoption varies widely. Much research has been carried out to investigate Internet adoption and usage, but very limited effort has been focused on the identification of the current level of technology integration and development and the factors affecting the level of the development after the adoption, especially in the context of SMEs in the fresh produce supply chain.

This research attempts to address this issue by developing a theoretical framework to illustrate the evolutionary process of Internet adoption and diffusion and to identify factors affecting the development of Internet-based supply chains by following the Technological-Organisational-Environmental (TOE) framework. First, five development levels of post-adoption of Internet technologies in the supply chain were defined, and factors from the technological, organisational and environmental contexts were identified according to literatures and exploratory interviews. Second, questionnaire surveys were conducted in the UK and China to investigate the current situation of Internet technologies used by SMEs in the fresh produce supply chains in the two countries. Finally, factors in the proposed framework were validated and discussed.

The empirical findings show that the Internet is no longer a new technology for most fresh produce SMEs in the UK and China. However, a large proportion of SMEs surveyed are still using basic functions of the Internet, and there is little difference between the UK and Chinese SMEs when comparing the use of complex applications in the supply chains. The results also show that most of the factors in the

organisational and technological contexts are positively related to the current development levels of the Internet-based supply chain, whereas, in the environmental context, pressures from customers in the UK and mutual trust among partners in China have a significant impact on current development levels. Additionally, in both countries, companies in a better development level of Internet-based supply chain would achieve a higher degree of integration in their supply chain in five years.

Overall, the research has made a number of important contributions to knowledge, current debate and practice in an under-researched sector. The five-level post-adoption framework can be adapted to identify ICT development levels and key factors in other sectors. The empirical data collected has added value to and sheds lights on the current applications of the Internet in the supply chain in general, and in the fresh produce SMEs in China and the UK in particular. The key factors identified as impeding the further development of the Internet, such as factors related to the business environments in the UK and China, will help government policy-makers, supply chain facilitators and IT service providers to be more focused in their efforts to improve the situation and to stimulate the further diffusion of emerging Internet technologies. The research has certain limitations due to the time constraints and sample selections. These limitations provide a platform for directing future research.

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Chapter 1 Introduction

The study is to investigate the post-adoption of Internet technologies by SMEs in the fresh produce supply chain. This chapter begins with a presentation of the research background and boundaries to provide the justification for this study. Research aims and objectives are therefore presented and, finally, an overview of the thesis' structure is provided.

1.1 Research background

This research focuses on studying the use of Internet technologies by SMEs in the fresh produce supply chain in the UK and China. To better understand the research rationale and focuses, the research boundaries are presented at the beginning. The chapter then identifies three reasons for this empirical study of SMEs' post-adoption in the context of the fresh produce supply chain. First, current research about Internet usage in supply chain management will be reviewed to prove the value of an empirical investigation. Second, the significance of studying SMEs in the supply chain is justified. Third, supported by the VEGNET project, this study is set within the Chinese and British fresh produce industry. An overview of the project is provided and the importance of studying the fresh produce industries in both countries will be demonstrated.

1.1.1 Research boundaries

This research is restricted in scope to an investigation of the development of Internet usage in supply chain management for SMEs in the fresh produce

industry. To properly carry out this investigation, several boundaries, definitions, and key assumptions need to be clarified. This section presents the concepts and boundaries which are used in this research.

Fresh produce refers to fruit and vegetables, which includes fresh potatoes, fresh green vegetables, other fresh vegetables and fresh fruit. The core sectors of the processed market are canned fruit and vegetables, and frozen fruit and vegetables.

The fresh produce supply chain involves the key players related to the production, distribution, manufacture and selling of the fresh produce, such as growers/farmers, importers/exporters, food manufacturers, transporters, wholesalers, retailers and other agents. As this study focuses on SMEs in the fresh produce supply chain, individual consumers are not included.

SMEs (small and medium sized enterprises) are defined as companies with 10-250 employees, adopting the SME definition given by the UK Department for Business, Enterprise and Regulatory Reform (BERR, formerly DTI). Although SMEs are defined differently in China, this research follows BERR's definition throughout, in order to produce comparable results.

Internet usage in the supply chain involves both the use of basic Internet functions, such as online searching, e-mail, etc., and advanced use, such as using the Internet to connect databases or software between partners. Thus, Internet usage may be associated with the use of independent software packages, such as EDI, ERP, RFID, etc. This research focuses on the post-adoption stage, which examines how companies further use the technologies in other functional areas or

how they increase the frequency of usage. Thus, unlike in other research, Internet usage is not a dichotomous ("Yes" or "No") question, but it can be seen to contain different levels for the whole process.

1.1.2 Internet usage in supply chain management

Supply chain management (SCM) aims to shorten cycle times, transform purchasing from a tactical operation to strategic sourcing, reduce inventories, decrease logistics costs, and streamline communication processes across a total network, from initial supplies to final consumption, and for after-sale service. In order to fulfil seamless supply chain operation, speedy communication between all the links within the supply chain is critical. Recent technological developments in the Internet and information technologies have the potential to facilitate supply chain coordination, resulting in a higher level of integration in the entire supply chain.

The Internet has had and is still having a significant impact on the way businesses operate. With the rise of Internet technologies, the focus of traditional business operation has gradually switched to Internet-based operation, starting from marketing and sales functions to supporting functions in the "back-office". For example, a company may start using the Internet with a static website containing marketing information. Later, the business may attempt to market its products and services using a wider range of Information in e-marketplaces like eBay.com and Alibaba.com. As business operation becomes more complex, other functions such as the ordering and payment process are connected to the initial website. Various back-office systems such as enterprise resource planning (ERP), customer

relationship management (CRM) and warehouse management systems (WMS) are integrated with the website, to achieve internal supply chain integration. As the business involves more transactions with partners, external supply chain integration is formed when companies connect their databases with suppliers and customers by using an extranet. The Internet creates the opportunity to share information across the supply chain in a faster and more reliable way. The fluent flow of information enables companies to improve productivity, increase efficiency and achieve better collaboration within the company and with their supply chain partners.

With the continuous development of Internet technologies, the Internet has become a ubiquitous tool in common business communications, fulfilling functions like online searching and sending e-mails. The use of the Internet has attracted a great amount of interest from researchers into IS implementation. For example, the works of Lancioni *et al.* (2000, 2003) are considered as the pioneering effort in investigating Internet use in the supply chain. They conducted two surveys of over 1000 companies about their Internet usage in supply chain management in 1999 and 2001. The questions covered how the Internet was being used in managing the major operational functions of supply chains, including transportation, purchasing, inventory management, customer service, production scheduling, warehousing, and vendor relations. After comparison of these two surveys, they found that Internet usage within supply chains was maturing, as evidenced by enhanced and increased productivity, reduced costs and increased profit for participating firms. However, this ubiquitous impact of the Internet on supply chains can raise questions as to the range of its application, as well as the

extent of its integration with other software packages. For example, Poirier and Bauer (2000) argued that, with further integration of supply chain management, the Internet is expected to connect stand-alone software packages in each company to achieve seamless connectivity. This trend prompted the researchers to view Internet usage in supply chain management as a complex phenomenon, from basic applications, like email or the website, to advanced applications, to integrate with different supply chain software packages.

Electronic Data Interchange (EDI) and the Enterprise Resource Planning system (ERP) are among the popularly used software packages. Leonard and Davis (2006) compare the manual supply chain and supply chain operations using EDI, and find that the EDI supply chain is more effective than the manual supply chain in terms of: shorter order cycles, greater availability, lower (purchase) price, and lower (transaction) cost. When researching ERP implementation, Wu and Wang (2006) emphasise the importance of ERP in modern business as the price of entry for running a business and for being connected to other enterprises in a value chained or networked economy. However, given the fact that some companies use more than one software package in their supply chain, focusing on only one of the software packages used in the chain may not be enough to reflect the real impact of the software upon it.

In summary, the research into Internet use in supply chain management not only involves the adoption of the Internet, but also needs to investigate how the Internet connects different software packages. This complex process involves different stages, as software packages are integrated to specific supply chain functions by the Internet. Since the Internet has become widely used by

companies (Europa, 2006), the Internet use situation varies in terms of post-adoption after initial Internet adoption. This study, therefore, needs to focus on the use of Internet technologies during post-adoption.

From a theoretical perspective, according to Roger's (1983) theory, the complex processes of innovation diffusion within an organisation involve initiation (agenda-setting and matching) and implementation (redefining/restructuring, clarifying, and routinising). Many researchers stress that research on the stages after adoption is as critical as the study of the initial adoption itself, but it has not received enough attention (Boynton *et al.*, 1994; Dewett *et al.*, 2007). Cooper and Zmud (1990) argue that "although adoption is necessary for infusion [implementation] to occur, factors affecting adoption may actually have the opposite effect upon infusion". These arguments fit the research aim of Internet use in the supply chain management. As the Internet is widespread in many companies, it is far more significant to research its further use in different functions of the supply chain management, rather than simply initial adoption.

Recent research about e-business and Internet technologies used in supply chain management follows this trend. For example, Ranganathan *et al.* (2004) considered post-adoption as the assimilation of Web technology systems into internal supply chain functions and their external diffusion into inter-organisational supply-chain networks. Aguila-Obra and Padilla-Mellendez (2006) recognised that the adoption of Internet technologies involves different stages, which can be linked with different organisational factors. A common feature of recent studies is that their objects are not limited to one specific technology like the Internet, ERP or EDI. Instead, they choose Internet

technologies or web technologies as a general name for the technologies related to supply chain management. Therefore, the study of Internet technologies use in supply chain management has to take a process view, and previous dichotomous studies about initial adoption are not suitable.

Moreover, previous research into adoption and post-adoption is often restricted to the individual level (Carter and Bélanger, 2005) and organisational level (e.g. Mehrtens, 2001). In the context of supply chain management, the research about post-adoption is enlarged to not only the organisational, but also the inter-organisational level (Teo *et al.*, 2003). In addition, in supply chain research, researchers (Quayle, 2003; Arend and Wisner, 2005) argue that the process of implementing supply chain technologies within an organisation or between organisations is poorly understood. Therefore, this research attempts to explain the complex process of the use of Internet technologies in supply chain management at organisational and inter-organisational levels, and to provide a theoretical contribution in the post-adoption development of Internet use in supply chain management.

1.1.3 SMEs' Internet use in the fresh produce supply chain

Fresh produce is perishable, seasonal and fragile, and these characteristics generate great complexities in managing the fresh produce supply chain. Fresh produce deteriorates easily and its shelf-life is often very short. Prices for fresh produce are time-sensitive, which means that the price decreases dramatically as the shelf-life of the product nears its end. On the other hand, a shortage of saleable agricultural products at any given point in time may result in significant loss of revenue because the demand is not carried forward (Du *et al.*, 2009). Therefore,

the management of the fresh produce supply chain requires a quick response to market conditions, to ensure that the right products are supplied with the right quality, in the right quantity and to the right marketplace. Previous research has indicated that real-time information provided by Internet technologies can help large fresh produce companies reduce communication time, increase accuracy, enable collaboration between trading partners, and provide a quick response to customer demand (Jones and Clarke, 2002). However, in terms of SMEs in the fresh produce supply chain, fewer studies have been conducted with regard to the use of Internet technologies, and the main approaches in this area are analytical modelling (Cadilhon *et al.*, 2003; Georgiadis *et al.*, 2004) and practitioner case studies (Blundel and Hingley, 2001; Fearne *et al.*, 2006). Three reasons enable the researcher to conduct an empirical study of SMEs' Internet usage in the fresh produce supply chain.

First, the majority of the fresh produce companies are SMEs. They are considered as the main forces of the economy, as SMEs make up a significant percentage of the local economy (Cabinet Office, 2008). Though small in size, SMEs may be critical within a supply chain, and lack of their full participation may result in inefficiency of the supply chain. In particular, SMEs contribute a large proportion of the fresh produce industry (Zhang *et al.*, 2001; Kidd, 2006), and have become an essential player in supply chain integration. However, recent research in supply chain management and the Internet has been mainly conducted from the viewpoint of large companies, and SMEs seem to be neglected when considering supply chain integration and technology use (Vaaland and Heide, 2007).

Even though in the UK multi-retailers have played a leading role in the fresh produce supply chain, 70% of the companies in this industry are still SMEs. 85% of fresh produce is sold in leading supermarkets, which have extensively implemented information technologies and the Internet along their supply chains (Kidd, 2006). These implementations put significant pressures on their suppliers, most of whom are SMEs, to provide a quick response to customers' demands. Consequently, SMEs in this type of supply chain are under considerable pressure to apply corresponding technologies. However, the process of implementing Internet technologies by SMEs seems to be neglected by empirical studies, apart from several anecdotes, for example, as contained in Blundel and Hingley (2001).

Chinese publications indicate that most agribusiness companies are SMEs, and recognise the importance of SMEs from a macro-economic point of view (Li, 2000). However, there is no clear indication of the percentage of agribusiness SMEs in the industry. Zhang (2003) criticises the inconsistency in statistics on SMEs between different departments of the central government. More ironically, China SMEs Online, the official SMEs department of China, did not cover the SMEs in agriculture in its national 'Survey Report of Informatisation in Chinese SMEs' (China SMEs Online, 2006). This demonstrates that agribusiness SMEs have largely been ignored by previous research in terms of their "informatisation", although they are believed to be important for the agriculture industry. Previous research analyzing the role of the Internet in agriculture is mostly based on anecdotal evidence (Wang and Liu, 2005), such as the benefits that the Internet can bring to farmers (Wan, 2007), the difficulties for farmers in accepting it, and suggestions to promote Internet usage by farmers (Tian and Chen, 2006). These

studies may serve as a good foundation to propose ideas, but further empirical investigations are needed to find out the situation with SMEs' acceptance of the Internet, what factors enable them to use it, and what factors discourage them from using it.

Hence, SMEs in both the UK and China play an important role in supplying fresh produce to larger companies, but not enough research attention has been given to them.

Second, the supply chain operations of SMEs are different from the operations of large companies. Increasingly, SMEs play key roles in supply chain management as they participate in value-creating activities, such as supplying raw materials, producing products and distributing finished goods to customers. However, much of the research in supply chain management focuses on the practices of large companies (Ballou *et al.*, 2000; Lambert and Cooper, 2000). Hong and Jeong (2006) argue that SMEs and large companies are different in terms of their strategic and operational choices, such as competitive priorities, key strategies, external control structure, internal control structure and the goals of supply chain management. These differences are summarised in Table 1.1.

Moreover, Quayle (2003) argues that SMEs in the supply chains benefit less than large companies because they are more likely to be managed by large companies. If SMEs want to survive in business, they have to follow the norms stipulated by the large buyer. In addition, SMEs are easily replaced if they fail, having less power and uniqueness compared with large companies. Consequently, buyers are reluctant to form partnerships with SMEs, although the benefits of aligning buyers

and suppliers are obvious.

Table 1.1 Comparison of SCM practices: large enterprises versus SMEs

Category	SCM by large enterprises	SCM by SMEs
Competitive priorities	• Market dominance through sustaining large market share	• Market niches through sustaining profitable market position
Key strategies	• Exert influences in supply chain - both upstream and downstream • Strategic alliances with suppliers and distributors	• Focus on specialised market • Build on unique competencies • Effective customer/supplier management
External control structure	• Command and control of their small suppliers and distributors • Collaborate with more dominant suppliers and distributors	• Either accept command and control by OEM or 1st tier suppliers or utilise their negotiation strengths • Pursue collaboration with other SMEs
Internal control structure	• Decentralized, structured and highly specialised • Multiple core competencies development	• Centralized, semi-structured and moderately specialised • Specific core competencies development
Goals of supply chain management process	• Operational effectiveness with multiple performance outcome requirement (e.g. cost, quality, delivery, time, customer value, and disposal), bigger scopes of information flows and product flows	• Operational effectiveness with focused performance outcome requirement (e.g. specific definition of order qualifiers and order winners) • Small scopes of information flows and product flows.

Source: Hong and Jeong (2006).

Third, the research about SMEs' use of Internet technologies in the fresh produce supply chain is limited, despite the importance of SMEs and their special features which differ from large companies in managing the supply chain. These differences between SMEs and large companies in supply chain management determine different characteristics of applying technologies to facilitate supply chain operation for SMEs. Recent studies have indicated that SMEs and large enterprises differ in performance after the introduction of SCM technologies (Arend and Wisner, 2005), and SMEs perform less actively than large enterprises. Possible explanations are (1) SMEs do not implement SCM appropriately, (2) SMEs do not use SCM to complement strategic focus, and (3) SMEs are not freely choosing to pursue SCM. Moreover, recent studies have indicated that SMEs give low priority to electronic commerce and new technology in their supply chain management (Quayle, 2003). Given the fact that the Internet is

widespread among SMEs in the UK (Europa, 2006), Quayle's study further calls for an investigation of factors influencing the low priority given by SMEs to electronic commerce and new technologies, which is part of the post-adoption development of Internet technologies in the supply chain.

1.1.4 The fresh produce supply chain and the VEGNET project

Funding from the Europe Asia IT&C programme by the European Commission was granted to a project called VEGNET: "Enhancing Vegetable Supply Chain Management with Internet Technologies" (http://vegnet.beds.ac.uk/vegnet). The aim of this project was to transfer managerial and technological know-how to Chinese SMEs from Europe and to introduce supply chain management (SCM) concepts and the use of Internet technologies to support SCM in Chinese agri-businesses. The main objectives of the project were to:

- Investigate the current situation of vegetable supply chain operations and the adoption of Internet technologies in support of vegetable supply chain activities in Europe and China;
- Search for ideas, know-how, expertise and experience in SCM - especially Internet-supported SCM - from Europe and Asia and transfer them into China by establishing a knowledge transfer framework, developing a web-based knowledge base and conducting various dissemination activities;
- Increase managerial awareness of SCM approaches and tools by introducing concepts of SCM and Internet-enabled SCM in Chinese agribusiness and educating agribusiness managers in the development and

use of e-learning systems, workshops and seminars;

- Pilot an Internet-based vegetable supply chain management system in a selected Chinese region;
- Test and evaluate the effectiveness of the pilot implementation and identify the bottlenecks and barriers to the future deployment of Internet-enabled SCM in Chinese agribusiness;
- Establish an effective network of communication and exchange of information between European and Asian ITC experts and develop a strong link between European and Chinese organisations for long-term collaboration.

This research project sought to increase the mutual understanding of the complexity of transferring ICT-related knowledge from Europe to Asia and hence to help improve technology cross-flow and the quality of long-term Euro-Asia partnerships. The research reported in this thesis formed a critical part of the project and provided an empirical basis for better understanding and new insights.

In summary, after defining the research boundaries, this research is justified by three rationales. First, with prevalent usage of Internet technologies, it is imperative to investigate post-adoption development of Internet technologies on an organisational level and inter-organisational level. Second, research on supply chain management reveals that SMEs possess different characteristics compared with large companies, which indicates the inappropriateness of applying theories for large companies to SMEs. Moreover, the fresh produce industry seems to be neglected by IS researchers, despite the strong requirement to implement Internet

technologies. Finally, supported by VEGNET, this research provides a well-established basis for studying the use of Internet technologies in the fresh produce supply chains in the UK and China.

1.2 Research aims and objectives

This research aims to investigate the post-adoption of Internet technologies by SMEs at an intra-organisational and an inter-organisational level. The research targets the fresh produce industry in the UK and China. To achieve the research aim, the research has the following specific objectives:

- Researching relevant studies in Internet-based supply chain operations and management, the characteristics of the fresh produce supply chain, and the technology adoption theories and models;
- Developing a theoretical framework for analysing the development levels of post-adoption of Internet technologies in supply chains and the key influential factors;
- Investigating the current situation of Internet usage by SMEs in China and the UK fresh produce supply chain, with a view to understanding the differences between the two countries;
- Evaluating factors affecting the post-adoption of Internet technologies by SMEs in the fresh produce supply chains in the UK and China.

1.3 Outline of thesis

The thesis consists of seven chapters. The structure of the thesis is shown in Figure 1.1.

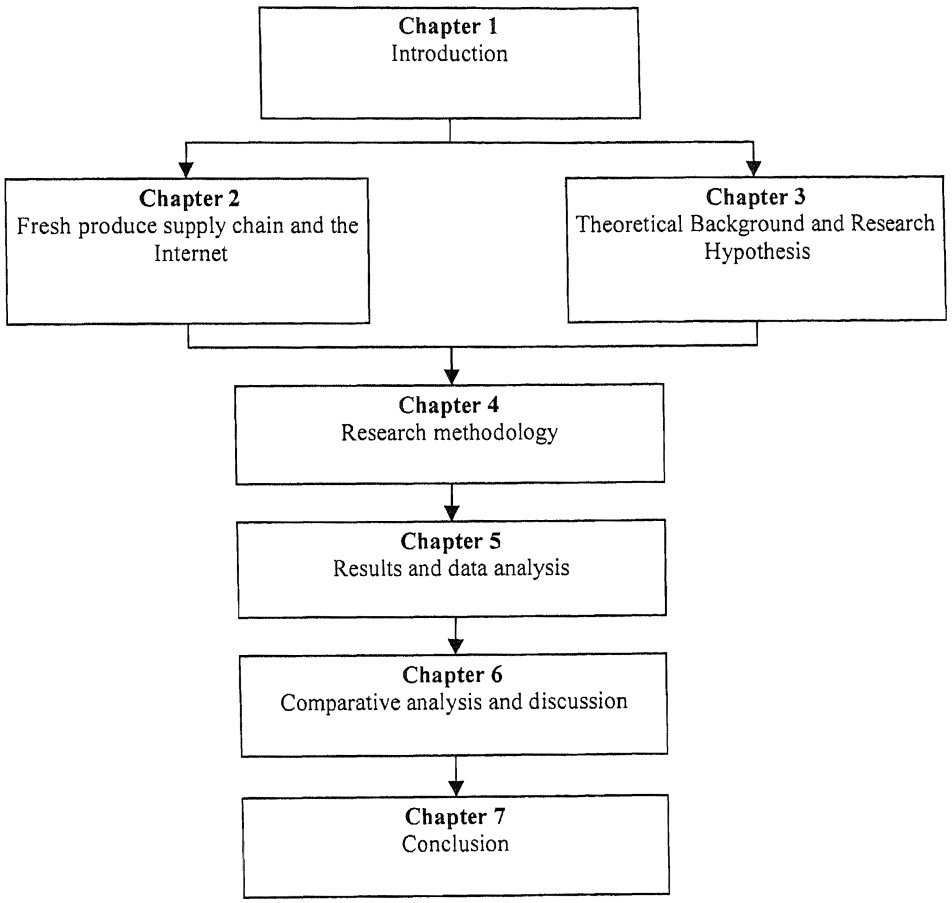

Figure 1.1 Structure of the thesis

Chapter 1 provides an introduction to the thesis. The background to the research and other related issues are presented. The research aim and objectives are defined. The structure of the thesis is outlined.

Chapter 2 reviews the current development of supply chain management and the Internet in the fresh produce industry in the UK and China. It covers basic concepts of supply chain management, technology and Internet usage in the supply chain, and the situation of the fresh produce supply chains in the UK and China.

Chapter 3 provides a literature review of the theories of innovation, adoption and

post-adoption, and discusses the development of supply chain management. Influential factors in the technology use are also considered.

Chapter 4 discusses the research methods used in this study, including qualitative studies, quantitative studies, and computer-assisted telephone interviews, which combines both approaches. Procedures of the survey are then described, and strategies for data analysis are presented.

Chapter 5 presents the survey results in the UK and China, and discusses the data analysis and hypotheses tests. Challenges and problems are identified for both countries, and barriers and motivators are identified.

Chapter 6 discusses the results on Internet use by SMEs in the fresh produce supply chain in the UK and China, and highlights key findings.

In Chapter 7, the conclusions and contributions of this research are presented. Its limitations are discussed. The thesis then closes with a section on further research.

Chapter 2 Supply Chain Management and the Internet in the Fresh Produce Industry

This chapter starts with a discussion of the concept of supply chain management and the role of Internet technologies in supply chain management. It then continues with a review of the fresh produce industries in the UK and China, the two countries in which the data has been collected. The characteristics of the fresh produce supply chain are then discussed and Internet technologies used in the chains are identified. The chapter finishes with a review of previous research in the food industry that is related to Internet technologies and supply chain management. In this way the chapter provides the background for the study.

2.1 Supply chain management and Internet technology

2.1.1 Supply chain management

The concept of supply chain management (SCM) can be traced back to 1958, when Forrester tracked the effects of delays (material flow lead times and information flow lead times) and decision policies within the manufacturing process (Porter and Millar, 1985). It became popular in the 1990s, and has been a "hot topic" since then (Mentzer *et al.*, 2001). Modern business management has shifted the focus from solely individual business to the effectiveness of the supply chain, in order to reduce operation and transaction costs, and to achieve a competitive position in the marketplace. This shift has made research in supply chain management more significant in current business studies.

Recently developed, the concept of SCM has been defined by various researchers from different angles. Based on Porter's value chain (Porter and Millar, 1985), Coley *et al.* (2003) demonstrated the logistics supply pipeline. They explained that "supply chain management can be viewed as a pipeline or conduit for the efficient and effective flow of products/materials, services, information and financials from suppliers through various intermediate organizations to customers. It manages the sequence of all supplier-to-customer material flow activities that add value to the final product" (Coyle *et al.*, 2003). The diagram of the logistics supply chain is presented in Figure 2.1(Ee 2001).

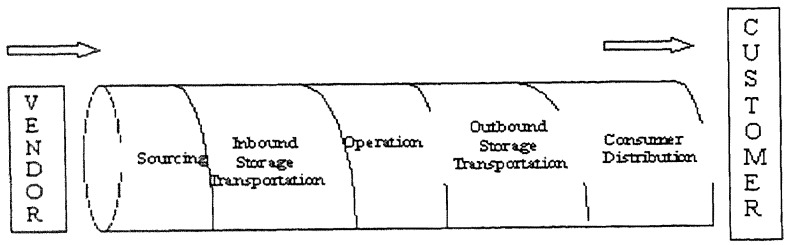

Figure 2.1 Logistics supply chain

A widely accepted definition of SCM is produced by the Global Supply Chain Forum (GSCF): Supply Chain Management is the integration of key business processes from original suppliers through to end users, which provides products, services, and information that add value for customers and other stakeholders (Lambert and Cooper, 2000). This integration involves not only the intra-functional and inter-functional level within an organization (intra-organizational), but also inter-organizational integration (Ballou *et al.*, 2000).

To achieve these types of integration, the Internet and information systems play a pivotal role in supply chain management. The following section introduces different types of Internet technology used in supply chain management.

2.1.2 The role of Internet technology

The Internet can enhance SCM decision making by providing real-time information and enabling collaboration between trading partners (Giménez and Lourenço, 2004). The Internet integrates the networks of suppliers, manufacturers, warehouses, retailers, and other players along the supply chain, through which the entire supply chain is managed so that faster and more flexible coordination can be achieved between a company and its customers and suppliers.

Technically, the Internet refers to the world's largest internetwork, which consists of hundreds of thousands of interconnected networks worldwide and has associated with it a certain culture. The Internet also implies a collection of computer networks based on a specific set of network standards (TCP/IP, Transmission Control Protocol/Internet Protocol), which describe how the computers of each individual network are to communicate with each other (Gallo and Hancock, 2002, pp.9, 10, 56). In supply chain management, the Internet is viewed as one of the most important sources of commercial information. Companies can search online, exchange information, and also send messages via e-mail or other communication tools.

Intranets and extranets are a form of Internet technology that has certain security controls in terms of the way they are used. An intranet is a private computer network designed to securely share part of an organization's information or operations with its employees. Sometimes the term refers only to the most visible service, the internal website. In summary, an intranet is an internal company

network that implements a traditional Internet service (Gallo and Hancock, 2002, p. 10). It can be used in supply chain management to improve communication between departments, functions and business units, in order to achieve a functional integration or intra-organisational integration.

An extranet is a private network designed to securely share part of an organization's information or operations with suppliers, vendors, partners, customers or other businesses. An extranet can be viewed as part of a company's Intranet that is extended to users outside the company (normally over the Internet). In other words, an extranet is a network connection to non-company entities which is not being accessed via an Internet connection (Gallo and Hancock, 2002, p. 10). This type of private network enables the privileged information to be shared among key partners, so that a company can align with network partners. As a result, inter-organisational integration is formed with the connection of less expensive but more pervasive Internet technology.

The intranet, Internet and extranet are enabling tools to connect various supply chain information technologies in order to achieve wider information sharing across the whole supply chain (Poirier and Bauer, 2000). The rise of e-commerce creates a shift from traditional business models, and companies restructure their supply chains by using Internet technologies. For example, to obtain real-time information, the Internet is used to connect back-office software packages within the company (by intranet), and to electronically connect the database with trading partners (by extranet) along the supply chain. These supply chain technologies are inevitably designed to be connected to the Internet for information management,

data transfer, and quality control, such as barcodes, EDI (electronic data interchange), ERP (enterprise resource planning), etc. Patterson *et al.* (2003) provide an extensive list of commercial supply chain software. After investigating the online directory of freshinfo.com, the UK's largest fresh produce magazine, Table 2.1 lists the software packages which are applicable in the fresh produce supply chain (Freshinfo.Com, 2007).

Table 2.1 List of software packages in the fresh produce supply chain

Type of software packages	Explanations	Examples
Barcode systems	Systems or products that are used in conjunction with any of the above systems to produce barcodes for any purpose.	KTEC group, PRISYM
Radio Frequency Identification (RFID)	Technology or tools that support wireless communication to read and transmit data from data points such as barcodes.	PRISYM NORAND, Intermec, Symbol
Electronic Data Interchange (EDI)	The computer-to-computer exchange of business information using a standardised data format. Standardised EDI messages are based on common business documents such as purchase orders, invoices and bills of lading and are sent from one computer application to another over telecommunications links without human intervention or interpretation.	Freeway, Transalis
Enterprise Resource Planning system (ERP)	ERP offers a centralised system to control information flow through a manufacturing environment. ERP covers functions such as capacity planning, cost and accounting, order entry, production management, inventory, and finance. Examples: SAP, Oracle, JD Edwards, PeopleSoft.	COMiT, De Facto, Fresh Dynamic, Freshware, Linkfresh, Prophet, Protrak, Rubicon, Tectura, WIZDOM
Customer Relationship Management (CRM)	CRM is an intelligent relationship management tool that can offer Web-based analytic and operation systems to unify all inbound and outbound sales, service, and marketing customer interactions with a single enterprise-wide view of each customer; CRM solutions analytically help a company better understand and proactively serve customers in real time.	Siebel, Tectura, Vantive.
Automated Quality Control Systems (AQC)	AQC systems help monitor the quality assurance process, inspection procedures, specifications, and gauge calibration statistics.	Q-SYS, QMS, Power Way, Pilgrim Software
Warehouse Management Systems (WMS)	WMS track and control the movement of inventory through the warehouse, from receiving to shipping. WMS manage utilization of resources such as space and personnel. They also offer systematic management of material handling to optimise and shorten fulfilment cycle time, reducing cost.	Catalyst, EXE, Manhattan, Optum.
Transportation Management Systems (TMS)	TMS are intended to achieve enterprise-wide load control centres by allowing companies to address the complex requirements of transportation between channel partners. TMS solutions can offer sophisticated planning algorithms to optimise different shipping scenarios.	i2, Manugistics, Descartes, nPassage, Capstan.
Geo-coded Tracking Systems	Geo-coded Tracking systems: Satellite or cellular tracking devices most commonly used in trucks or trailers to identify position and feed the information to ancillary systems such as TMS, Routing or WMS.	Qwset

2.2 The fresh produce supply chain

The fresh produce supply chain has a high level of uncertainty due to the special features of fresh produce: perishability, fragility, and seasonality. Perishability and fragility are the most significant features of fresh produce, so sales and procurement procedures in the fresh produce industry are considerably more dynamic than in most other commodity-based industries (Mclaughlin, 1995, Du *et al.*, 2009). In addition, as a commodity, fresh produce also features considerable supply variation due to seasonality of agricultural production, weather conditions and the biological nature of agricultural products, which result in input variation and unpredictability (Mangina and Vlachos, 2004).

Due to the perishable nature of fresh produce, its supply chain tends to be short, and needs minimal effort for processing. Even for more processed fruit and vegetables, the chains are relatively short with often very close relationships between producers and processors. Those special features of fresh produce attract more attention in supply chain management. For example, McLaughlin (1995) recommended the vertical co-ordination issue as a critical research area in the fresh produce industry. He hypothesised that "the shift of certain functions and costs formerly assumed by produce buyers further back in the distribution system increases system-wide efficiency". This idea can be applied to supply chain management today. Several empirical studies prove that Internet technologies improve the efficiency of the whole supply chain. For example, Du *et al.*'s (2009) case study finds that EDI can improve the efficiency of the replenishment of the agriculture supply chain through accurate collaborative demand forecasting among partners in the supply chain so that the products can be sold in perfect condition. Manthou *et al.* (2004)

surveyed 24 fruit companies and found that Internet-based applications enhanced the flexibility, information visibility, and efficiency of the supply chain management.

The following sections will review the fresh produce supply chains in the UK and China, and introduce Internet technologies used in this industry.

2.2.1 The UK fresh produce industry

The fresh produce industry in the UK is a mature industry with a per capita consumption of 2,448 grams per week out of 3,290 grams for all food in 2006 (Gower, 2007). Consumer expenditure on fruit and vegetables totalled £15.47bn at current prices in 2006, having grown by 19.3% since 2002 (Gower, 2007). However, the production of fresh produce in the UK was only 2.8 million tonnes in 2004, which amounted to only 0.21% of world production (Kasnakoglu, 2005). The UK has become increasingly dependent on international trade to meet customers' demand, especially for fruit. FAO (Food and Agriculture Organization of the United Nations) statistics show that the UK ranked as the 10th major country to import fresh fruit (Kasnakoglu, 2005). The situation of the production and consumption in the UK influences the formation of the supply chain, which involves more importers and wholesalers, but fewer growers and farmers.

The supply chain and SMEs

The fresh produce supply chain in the UK involves farmers/growers, importers/exporters, food processors/manufacturers, wholesalers, retailers, and transporters(Duffy, Fearne, & Hornibrook 2002)(Figure 2.2). Although larger companies are playing an increasingly important role within the fresh produce

sector, the majority of businesses in the UK belong to small business. In terms of growers, in 2005 only 90 companies (1.8%) had turnovers exceeding £5million, but they represent the majority of the sector's turnover (Kidd, 2006). As for importers and wholesalers, they source from a number of countries to purchase fresh vegetables and fruits to meet the demand of customers. Food services, like processors/manufacturers, work closely with wholesalers to meet the growing demand for fresh produce from public-sector employee canteens, school meals, hospitals, etc.

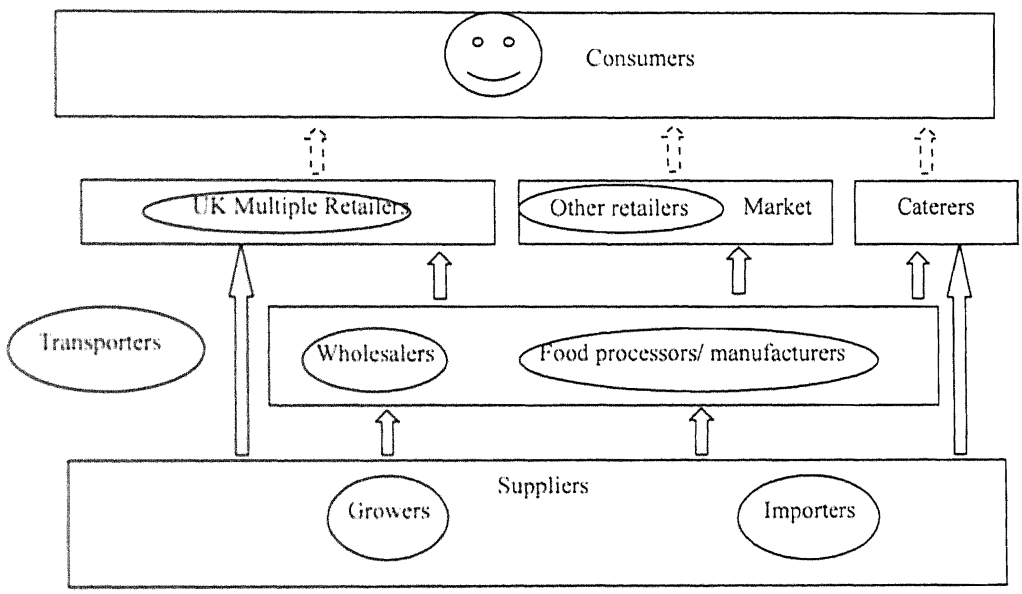

Figure 2.2 UK fresh produce supply chain

Of these players, retailers might be the most important players. Over 83% of the fresh produce by value is sold by supermarkets, such as Tesco, Asda and Sainsbury's (Gower, 2007). Researchers (Wilson, 1996, Fearne and Hughes, 1999) suggested a decade ago that the UK fresh produce supply chain has been the most sophisticated in Europe or even in the world. The British food retailers continued their innovation and collaboratively aligned with their supply chain partners,

which meant that the UK fresh produce supply chain remained at the leading edge of the development in vertical co-ordination (O'Keeffe and Fearne, 2002, Maruyama and Hirogaki, 2007). Supermarkets use their buying power and scouring channels to manage the supply of the fresh produce from wholesalers, growers, and food processors, many of whom are categorised as SMEs. As supermarkets possess more power in selling fresh produce, there is a steady decline in the number of local fresh produce retailers (Gower, 2007), most of whom belong to SMEs.

Use of Internet technologies

The Internet has been extensively used in searching and exchanging market information, and some local growers have launched online ordering systems, particularly for organic produce or local food (Groves, 2005). Business-to-business opportunities also exist for wholesalers or food services in trading with private and public canteens, schools or hospitals. For example, the National Health Service (NHS) launched the NHS PASA website to source a large variety of products including food (NHS PASA, 2007). The National Audit Office also released a report on purchasing food for the public sector, highlighting the increasing opportunities for SMEs in e-auction (National Audit Office, 2006).

Other Internet-related software packages are also available in the UK fresh produce industry. In the web directory of the UK's major fresh produce website, freshinfo.com, there are six categories of supply chain software packages offered by 16 IT or E-business companies, such as EDI, ERP, RFID, barcode system, CRM, etc. (Freshinfo.Com, 2007). Based on online investigation of the web directory, a list of software packages is collected and used by the survey in the UK

fresh produce supply chain (see Table 2.1). However, the situation of the usage by SMEs is still unclear and needs further investigation.

In the UK, the giant multi-retailers are the main drivers of using the technologies in the fresh produce supply chain. Aiming to build "fresher, simpler and closer" supply chains, multiple retailers work closely with their suppliers using the Internet to facilitate communication. For example, Tesco encourages their fresh produce suppliers to communicate via the Internet, in order to achieve a leaner supply chain (Jones and Clarke, 2002). Tesco launched Tesco farming websites for local farmers (http://www.tescofarming.com/v2/farmer-profiles.asp), and also helped some of them to establish company websites, such as http://www.tescowatercress.com. Supported by the Tesco technology team, SMEs are able to work collaboratively with Tesco to provide value-added service, such as online tracking of a particular product (http://www.tescowatercress.com/trace1.php).

In summary, the fresh produce supply chain in the UK has a high degree of vertical integration influenced by multi-retailers, and technologies are extensively used to build a closer relationship with suppliers, especially between retailers and SMEs. The next section demonstrates the situation of the fresh produce supply chain and Internet technology in China, which is different from the one in the UK.

2.2.2 The Chinese fresh produce industry

China is the biggest agricultural country in Asia and its entry into the WTO has further increased its influence (World Trade Organization, 2001). In 2004, China produced 506.6 million tonnes of fruit and vegetables, which accounted for 36.62% of world production. China is also a major country which operates a tremendous

amount of exports in fresh produce. China is ranked in first place in exporting prepared vegetables and fruits by value (Fao, 2004). As a highly populated country, China also increases the consumption of fresh produce every year, with the influence of rising incomes and changes in the dietary habits of local residents (Asia Access Limited, 2004). Hundreds of categories of fruit and vegetables are available in almost every province all year round. The huge amount of trading in different types of fresh produce makes the fresh produce supply chain extremely dynamic in China.

The supply chain and SMEs

Unlike the highly integrated supply chain in the UK, fragmentation is the significant feature of the Chinese fresh produce supply chain (Asia Access Limited, 2004). Although China's fruit and vegetable market is the largest sector in the country's retail food market, it largely remains tied to traditional ways of production and selling. Similar to the UK, the major players in China include farmers/growers, importers/exporters, food processors/manufacturers, wholesalers, retailers, and transporters, but they function differently from the players in the UK.

Generally, farming for fresh produce is mostly on miniscule plots based on family production, and a large proportion of produce is consumed locally (Asia Access Limited, 2004). Farmers also work together as an association to manage the selling of similar types of produce in the same village. Due to vast geography and the under-developed transport infrastructure in remote rural areas, transporters work like agents or middlemen to purchase large amounts of produce from farms, and then resell them to food processors, wholesalers or supermarket chains, who supply

to urban areas. They profit from buying at an extremely low price, and selling high to urban residents, due to information asymmetry between rural farmers and the market (Vegnet, 2006).

With growing demand for fresher and more convenient foods from urban residents, food manufacturers/processors are formed in small groups locally. They process the raw produce into pieces or slices, and pack them according to Chinese recipes. They also produce prepared meals that are supplied to supermarket chains. However, the majority of produce is sold in the local wholesale markets or open-air street markets, which have existed for hundreds of years in China (Datamonitor, 2006). Being organised by the local government or reformed from street markets, wholesale markets play a pivotal role in supplying rural produce to urban residents because of the convenience and the freshness of the produce (Missiaen, 2006). There were more than 4,150 wholesale markets in 2002 nationally, and sellers in the markets were mainly operated by small-sized family enterprises (Li, 2000, Vegnet, 2006). Therefore, Chinese scholars categorise most agri-businesses as SMEs, including local retailers, growers, food processors, transporters, and importers/exporters (Li, 2000, Jiang and Wang, 2008).

However, with the influence of international multi-retailers, such as Carrefour and Walmart, fresh produce is increasingly being sold through the sales channels owned by supermarkets. There is also a call from the government to facilitate this change, as customers can benefit from food safety traceability, guaranteed produce quality, honest weights and measures and a relatively clean shopping environment (Ministry of Agriculture of the People's Republic of China, 2006). As a result, local

retailers of fresh produce face increasing competition with supermarkets, and most of the local retailers are believed to be SMEs.

Use of Internet technologies

The Chinese government has put tremendous effort into so-called "informatisation" to enable people in agriculture to obtain in-time information from the market, especially for those in remote rural areas. As a result, government-sponsored agricultural websites developed rapidly from 1998, including government, educational, and commercial websites (Xiang *et al.*, 2006). Fresh produce companies are gradually accepting the usage of the Internet in managing their supply chains. Most importantly, the state government promoted the use of the Internet for farmers to get in-time information from the market, because many farmers complained about receiving asymmetric information when scheduling the production plan and selling their produce (Yan, 2006).

It is noticeable that the online marketplace developed fast in the Chinese fresh produce sector. The biggest business-to-business (B2B) website is alibaba.com, which hosts more than 30,000 fresh produce companies selling domestically and abroad. The website also provides users with communication tools (trademanager) for communication between clients. Online orders and transactions are operated based on this platform.

However, software packages are relatively new for Chinese agribusinesses, especially for SMEs. Only a few leading agribusinesses utilised ERP for internal integration, and a very small number of them achieved external integration with

clients (Sina.Com, 2007). Similar to the UK, the situation for SMEs still needs to be further explored.

In summary, the Chinese fresh produce sector is still very traditional, although it is influenced by modern supply chain management and technologies. There is still a long way to go before Chinese SMEs develop and progress to a leaner supply chain.

2.2.3 Research in SMEs about Internet usage in the food sector

The fresh produce sector seems to be neglected in terms of the use of Internet technology. The empirical studies about SMEs' use of Internet technology are rare. To obtain more evidence about this particular area, the researcher had to trace back almost a decade (to 1998) in the literatures to search for the trend of the studies about SMEs' use of Internet technologies in the food industry. It is hoped that previous studies with a broader geographic range and for a larger industry would provide useful insights for this study. Therefore, this section will start from a general discussion of Internet usage in the food sector worldwide, and then focus on the situation in the UK and China.

The pioneering study on the use of Internet technologies in agri-food supply chains was conducted by Salin (1998), though he mentioned information technology instead of Internet technology. Salin proposed that IT used among close partnerships in agribusiness "can generate information that serves as a strategic resource to the chain" (Salin, 1998, p. 332). Later, Dresner *et al.* (2001) investigated Internet usage across the food industry supply chain in the US. Their survey revealed a low level of Internet usage in the food industry, and within this

industry, larger firms had a higher rate of Internet usage than smaller ones. Hill and Scudder (2002) further explored the usage of EDI in the food industry, and their results suggested that companies tended to be much more accommodating of the desires of their customers than of their suppliers when using EDI. Manthou *et al.* (2004) surveyed the Greek fruit canning sector, and revealed the fact that Internet technologies were considered as new communication tools in the food industry. Their usage was still at a primary stage for marketing and accommodating customers' requirements, and their usage by suppliers and other logistics functions was still limited. However, those studies did not pay special attention to SMEs in terms of the usage of Internet technologies.

It was suggested that the fresh produce industry in the UK is the most sophisticated one in Europe (Wilson, 1996), and at the leading edge of the development in vertical co-ordination (O'Keeffe and Fearne, 2002, Maruyama and Hirogaki, 2007). In order to provide value-added service to customers and incorporate the trend of "fresher, simpler and closer", top retailers began to switch their focus to managing their fresh produce suppliers. For example, Tesco uses the Internet and other information technologies to work more closely with farmers and provide fresher produce to the customers. However, little is known about how SMEs use the Internet to compete or to collaborate with those multi-retailers in the fresh produce sector.

In the Chinese literature, anecdotal evidences are more common in technology usage in the fresh produce sector. Studies have looked at the role of the Internet in agriculture (Wang and Liu, 2005), the benefits that the Internet can bring to farmers

(Wan, 2007), and the difficulties of farmers in accepting the Internet and suggestions for promotion (Tian and Chen, 2006). Those literatures may serve as a good foundation to propose ideas, but empirical investigations still need to be conducted to find out about the situation of SMEs' acceptance of the Internet, what factors motivate them to use it, and what factors discourage their usage.

In summary, SMEs are becoming critical in the UK fresh produce industry, whereas they dominate the Chinese fresh produce supply chain. However, SMEs in the food supply chain have been neglected in the literature when discussing the usage of Internet technology.

2.3 Chapter summary

This chapter reviewed the context of the research, supply chain management and the Internet, and the fresh produce supply chains in the UK and China, where data had been collected. It highlighted the role of SMEs in the fresh produce supply chains, and identified the gap in the literature about Internet usage.

Chapter 3 Theoretical Background and Research Hypotheses

Chapter 3 presents a detailed review of theories and models that serve as the theoretical foundation of this study, and progresses to research hypotheses. This research is based on the theory of diffusion of innovation. Researchers in IT implementation have emphasised the similarity between IT adoption and innovation adoption/diffusion, and borrowed heavily from the diffusion of innovation literature (Rogers, 1983; Swanson, 1994). Internet technologies were considered as new technology adoptions in supply chains, and the field of diffusion of innovation adoption provided a rich set of theories and findings that could be directly applied to study the adoption and diffusion of Internet technologies.

Section 3.1 presents the theoretical basis of the research, by firstly identifying that the use of Internet technologies in supply chain management is an innovation, then reviewing Rogers' diffusion of innovation theory, and finally summarising the categories of information technology/information system (IT/IS) implementation research that use the diffusion of innovation theory. Section 3.2 firstly reviews the process of diffusion of innovations in IT/IS implementation research; secondly, it summarises the diffusion of Internet technologies within supply chain management; and, finally, it identifies the development levels of the use of Internet technologies in supply chain management, which serve as the dependent variable in this research. Section 3.3 attempts to identify factors, independent variables,

influencing this development level, and follows Tornatzky and Klein's (1990) technological-organisational-environmental (TOE) framework. Finally, Section 3.4 raises research hypotheses.

3.1 Diffusion of innovation

3.1.1 Internet technology as an innovation

In an era of revolutionary new developments in the Internet and information technologies, the implementation of new technologies has been considered as an innovation by many literatures (Mehrtens *et al.*, 2001; Patrick and Miller, 2004). In particular, Kwon and Zmud (1987) commented that information system (IS) implementation in business had become an important managerial concern, focusing on the effective diffusion of information technologies through organisations, business units, and work groups. Swanson (1994) further identified three types of innovation of this usage among organisations: type I confined to the IS task, type II supporting administration of the business, and type III being embedded in the core technology of the business.

Researchers have borrowed diffusion of innovations theories as a tool to analyse the diffusion of Internet and information systems (Thong, 1999; Mehrtens *et al.*, 2001; Dholakia and Kshetri, 2004; Fillis *et al.*, 2004; Zhu *et al.*, 2004), where diffusion is defined as the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 1983: p.10) As a borrowed theory, diffusion of innovation theories have brought concepts and empirical studies to the research in information systems (Fichman, 1992). Theories of diffusion of innovation are, therefore, borrowed in this research.

3.1.2 Diffusion of innovation theory

Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 1983, p. 34). After the systematic study of innovation diffusion studies, Rogers began his research in diffusion of innovation studies from the perspective of the individual. He further addressed four main elements in the diffusion of innovation: 1) an innovation, 2) communication channels, 3) time, and 4) a social system. From these four elements, characteristics of innovations are most frequently used by many IT/IS researchers (Russell and Hoag, 2004; Carter and Bélanger, 2005), in terms of relative advantage, compatibility, complexity, trialability, and observability (Rogers, 1983).

Rogers' focus shifted from individual-level studies of diffusion of innovation to the organisational level in the 1970s, because he later realised that organisational decisions are different in important ways from innovation decisions made by individuals (Rogers, 1983). The innovation process in organisations is much more complicated, and involves a number of individuals, each of whom plays a different role in the innovation decision (Rogers, 1983, p. 348). Instead of identifying the characteristics of innovations, Rogers (1983) looked at organisational characteristics, and associated them with organisational innovativeness, such as individual characteristics, internal characteristics of organisational structure, and external characteristics of the organisation. Rogers' theory provided an appropriate framework to explain the innovation adoption process in organisations and to describe what factors influence it, as well as to identify the phases within this process (Ranganathan *et al.*, 2004).

However, another group of researchers (Gibbs and Kraemer, 2004; Zhu *et al.*, 2006) argue that Rogers' theory may not be suitable for studying Internet technology adoption for business, because adoption may be influenced as much or more by the environment in which the company is embedded. In the study of Internet technology adoption in supply chains, the environment consists of suppliers and other trading partners, competitors, customers, and regulatory agencies such as government, which may create incentives and barriers to adoption and use. Hence, they recommended that Tornatzky and Klein's (1990) Technological-Organisational-Environmental (TOE) framework is more appropriate when studying e-business adoption, and Internet adoption and diffusion by an organisation. This framework brought broader areas into consideration in the area of organisational diffusion of adoption, and identified that the context in which technological innovation takes place can have a significant influence on the outcome of the process. While the context almost never determines the process, it does serve to constrain or facilitate it.

As discussed in 3.1.1, the use of Internet technologies in supply chain management is an innovation. Researching the diffusion of Internet technologies therefore falls right into the area of diffusion of innovations. The categorisation of IT diffusion research will be discussed in 3.1.3.

3.1.3 Categorisation of IT diffusion research

Rogers (1983) categorises the research in diffusion of innovation into individual-level and organisational-level studies. As an innovation, Internet technologies create connections between organisations, which are considered as an

inter-organisational-level study (Teo *et al.*, 2003; Bhattacherjee and Sanford, 2006). As a newly developed dimension, theories in inter-organisational-level studies are mainly rooted in the studies about the organisational level. In the area of IS/IT implementation research, researchers have developed various frameworks according to different types of diffusion of IS. Fichman (1992) identified two loci of adoption: individual versus organisational. As Internet technologies have been extended to use between organisations, such as EDI, a new level of locus developed: the inter-organisational level (Bhattacherjee and Sanford, 2006).

The individual level

As previously mentioned, Rogers' theory is mainly developed from an individual level of adoption. He identified five characteristics of innovation which are perceived by individuals, and which help to explain different rates of adoption: relative advantage, compatibility, complexity, trialability, and observability (Rogers, 1983). His theory has been extensively used to examine the adoption of technologies by individuals, such as e-mail (Premkumar, 2003), the Internet (Carter and Bélanger, 2005), computers (Jarvis, 1990) and online portals (Shih, 2008).

The Technology Acceptance Model (TAM) (Davis, 1989) is also a widely used framework in IS research. This theory is developed from Fishbein and Ajzen's Theory of Reasoned Action (TRA) (Anandarajan *et al.*, 2000). In TAM, an individual's motivating factor for using computer technology can be categorised in two groups: extrinsic motivators, such as perceived benefits and social pressure, and intrinsic motivators, such as enjoyment and fun (Anandarajan *et al.*, 2000). This model has also been applied to a variety of IT technologies, for instance,

e-mail (Davis, 1989), Internet (Anandarajan *et al.*, 2000), and online banking (Jaruwachirathanakul and Fink, 2005). Though TAM is mainly an individual-level theory, it is also applicable in studies that concern individual users within an organisation (Bhattacherjee, 2001; Olson and Boyer, 2002).

Jeyaraj *et al.* (2006) provide a good summary of the difference between the above two types of individual-level study models. The TAM and TRA models explain an individual's behavioural intention to adopt, whereas Rogers' innovation diffusion theory predicts an individual's adoption behaviour. At times, behavioural intention and actual behaviour have been used interchangeably.

Regarding the factors of IT adoption by individuals, Jeyaraj *et al.* (2006) summarise six dependent variables – perceived system use, adoption, intention to use, diffusion, outcomes, and actual system use – and the five most frequently used independent variables: perceived usefulness, ease of use, attitudes, relative advantage, complexity, and subjective norms. However, the best predictors of IT adoption by individuals are: top management support, computer experience, perceived usefulness, behavioural intention, and user support. Since this research does not concern itself with the individual level of diffusion, the literature review will not get into detailed analysis of the above-mentioned factors, but will focus on the factors used in the organisational and inter-organisational levels.

The organisational and inter-organisational levels

Different theories have been formulated to examine the diffusion process in the organisational and inter-organisational levels. Different from the theories in the individual level, theories in these levels consider a larger picture, including impacts

from the organisation and the environment. In the context of supply chains, the diffusion of technologies involves the performance within an organisation, as well as the interaction between organisations.

In the process of diffusion of technologies by organisations, Tornatzky and Fleischer's (1990) Technology-Organisation-Environment (TOE) mode is recognised as a well-accepted one. The TOE model is presented in Figure 3.1, and posits three aspects of an organisation's context that influence the process of implementing a technological innovation: technology, organisation, and external environmental context (Tornatzky and Fleischer, 1990, p. 152-4).

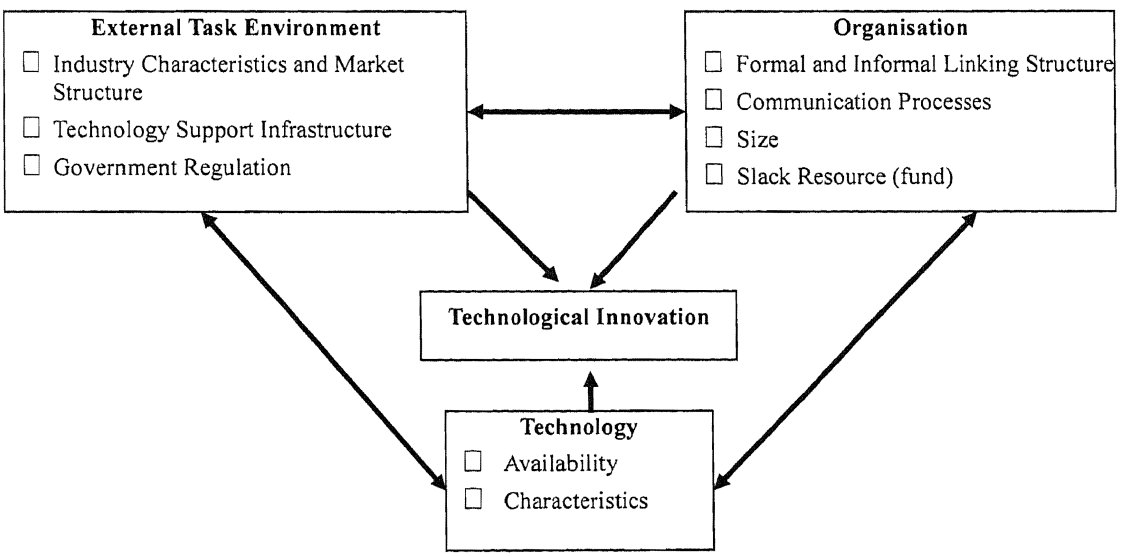

Figure 3.1 TOE model

Technology, organisation, and environment are three common contexts that IS/IT researchers in organisational studies always seek factors from. For example, Zhu *et al.* (2003, 2004) have applied the TOE model in research into e-business adoption

in a cross-country study. Chau and Tam (1997) investigate factors affecting the adoption of open systems. Thong (1999) finds that the extent of IS adoption is mainly determined by organisational characteristics. Iacovou *et al.* (1995) suggest that environmental impacts are more critical influences for SMEs in deciding whether to adopt EDI. Mehrtens *et al.* (2001) apply Iacovou's model when researching Internet adoption by SMEs.

It is noticeable that the TOE model is also applicable in diffusion and post-adoption studies. Zhu and Kraemer (2005) explore post-adoption variations in e-business by applying the TOE framework. Hsu *et al.* (2006) apply the TOE framework to investigate e-business use in US firms, and identify pressure on companies to use e-business from trading partners. Therefore, for the purpose of this study, the TOE model is believed to be suitable for identifying factors influencing the diffusion of the Internet in supply chains.

Based on the TOE model, the dependent variable is the diffusion process of Internet technologies in supply chains (discussed in Section 3.2), and the independent variables are the factors from the technological, organisational and environmental contexts that influence the diffusion of Internet technologies (discussed in Section 3.3). However, in Section 3.3, emphasis is put on the post-adoption process at the organisational and inter-organisational levels.

3.2 The diffusion process of Internet technologies in supply chain management

With the development of Internet technologies, the evolution of supply chain management involves various integration levels assisted by the Internet. It is

important for this research to clarify the evolution of supply chain management, because the Internet plays different roles in different levels of supply chain management, and factors that influence the adoption and implementation may vary. Combining the Internet and supply chain management, researchers fall into two major streams: IT supporting supply chain management and e-business. As research in IT supporting supply chain management generally relates to large companies (Lee and Billington, 1995; Muzumdar and Balachandran, 2001), the study of SMEs' supply chain evolution could borrow the studies of the process of IT diffusion, as well as the studies of e-business evolution processes, and apply them to supply chain functions. This section clarifies these two streams, in order to theoretically outline the development levels of Internet-based supply chains.

3.2.1 Process of diffusion of Internet technologies

The process of diffusion is a complex one, which Rogers (1983) conceptualises as having five steps: knowledge, persuasion, decision, implementation and confirmation. The five-step process is mostly applicable to individuals. When an individual is exposed to an innovation and has some idea of how it functions, the knowledge step occurs. The individual then forms a favourable or unfavourable attitude toward this innovation, which is called the persuasion step. The decision step occurs when an individual decides to accept or reject the innovation. Implementation occurs when an individual puts the innovation into use, and finally confirmation occurs when an individual seeks reinforcement of an innovation decision.

In an organisational setting, Rogers (1983) simplifies this complex process into two

main stages: initiation (agenda-setting and matching) and implementation (redefining/restructuring, clarifying, and routinising). Based on Rogers' stages, Kwon and Zmud (1987) develop a broader perspective of the IS implementation process: initiation, adoption, adaptation, acceptance, use (performance, satisfaction), and incorporation. Cooper and Zmud (1990) further refine the stages after adoption and define a widely-accepted model of the IT implementation process: initiation, adoption, adaptation, acceptance, routinisation and infusion. Fichman (2000) outlines the process of diffusion with the following stages: earliness of adoption, aggregated adoption, internal diffusion, infusion, routinisation, and assimilation. Clearly, researchers have agreed that adoption is a critical turning point in the whole process of IS diffusion, where "adoption is a decision to make full use of an innovation as the best course of action available" (Rogers, 1983, p. 21).

Most of the empirical studies in information system research focus on the adoption process, which contains a dichotomous (adopter or non-adopter) dependent variable (Premkumar *et al.*, 1997; Thong, 1999). However, another school of researchers argue that the stages after adoption are as critical as the study of the adoption, and have not received enough attention compared to adoption (Cooper and Zmud, 1990; Premkumar *et al.*, 1994; Dewett *et al.*, 2007). As a more complicated process, the stages after adoption are named differently. Boynton *et al.* (1994) name the process "use", and define "IT use" as the application of IT within an organisation's operational and strategic activities. Cooper and Zmud (1990) and Premkumar *et al.* (1994) name the process "diffusion", which starts with an initial "adaptation" stage and ends with a final "infusion" stage. However, their definition

contradicts Rogers', whose "diffusion" progresses from initiation (knowledge), via adoption, through to Cooper and Zmud's "infusion" stage. For the purpose of clarification, this research sticks with Rogers' definition, and considers "diffusion" as a whole process from "initiation" to "infusion", and names the stages after adoption as "post-adoption". In summary, the whole diffusion process includes "adoption" and "post-adoption".

Researchers consider that diffusion and adoption are two distinct perspectives in analysis. "While studies using the adoption perspective evaluate the characteristics of an organisation or society that make it receptive to innovation and change, studies using the diffusion perspective attempt to understand why and how an innovation spreads and what characteristics of the innovation lead to widespread acceptance" (Premkumar *et al.*, 1994, p. 160). A full list of studies in adoption and diffusion are provided in Table 3.1. For example, Cooper and Zmud (1990) follow a classification of MRP (material resource planning) implementation, and compare the significance of the same factors in adoption and post-adoption. Premkumar *et al.* (1994) define the post-adoption process of EDI implementation as adaptation, internal diffusion, external diffusion and implementation success. They further examine the significance of various innovation characteristics for each stage. In summary, many of the empirical studies divide the complex post-adoption stage into sub-stages, and examine factors influencing the post-adoption stage.

Additionally, the diffusion and post-adoption process is more frequently adopted in some research on the inter-organisational use of IT. In several instances, researchers of inter-organisational systems (IOS) and EDI have differentiated the

diffusion internally and externally, discussing the permeation of the post-adoption

Table 3.1 List of research in adoption and diffusion theories

Adoption theories			
Theories	*Type of users*	*Elements*	*Empirical examples*
Diffusion of innovation (Rogers, 1983)	Individuals	Relative advantage Compatibility Complexity Trialability Observability	IT and Supply chain (Russell and Hoag, 2004) e-government (Carter and Bélanger, 2005)
TAM (Davis, 1989)	Individuals OR Individuals in an organisation	Perceived usefulness Perceived ease of use	Internet purchase* (Bhattacherjee, 2001; Olson and Boyer, 2002) Online banking (Jaruwachirathanakul and Fink, 2005) Internet (Anandarajan *et al.*, 2000)
TOE (Tornatzky and Klein, 1990)	Organisation	Technology Organisation Environment	e-business (Zhu *et al.*, 2003; Gibbs and Kraemer, 2004; Xu *et al.*, 2004; Zhu *et al.*, 2004; Zhu and Kraemer, 2005; Hsu *et al.*, 2006) Internet* (Mehrtens *et al.*, 2001) IT (Internet, email, EDI) (Premkumar, 2003) Open system (Chau and Tam, 1997) Telemedicine (Hu *et al.*, 2002) EPC in Supply chain (Huber *et al.*, 2004)
Diffusion and post-adoption theories			
Theories	*Type of users*	*Elements*	*Examples*
TOE (Tornatzky and Klein, 1990)	Organisation	Technology Organisation Environment	EDI* (Iacovou *et al.*, 1995) e-business (Zhu and Kraemer, 2005; Zhu *et al.*, 2006) IT adoption* (Thong, 1999) e-marketplace* (Gengatharen and Standing, 2005) EDI (Premkumar *et al.*, 1994)
Theories	*Type of users*	*Elements*	*Examples*
Zmud (Cooper and Zmud, 1990; Boynton *et al.*, 1994)	Organisation	Technology characteristics Technology complexity	MRP (Cooper and Zmud, 1990) IT (Premkumar, 2003)
Others	Organisation	IT knowledge, Internet strategy Cost, concern	E-business, knowledge management (Lin and Lee, 2005) IT skill, management skill (Piccoli and Ives, 2005) Internet (Doherty *et al.*, 2003; Dewett *et al.*, 2007)
Inter-organisational studies	Inter-organisation	Knowledge and competence, cost privacy-security	Inter-organisational systems (Soliman and Janz, 2004) Internet (Dholakia and Kshetri, 2004)

* refers to the studies about SMEs

process in the extended value chain of a company (Iacovou *et al.*, 1995; Premkumar *et al.*, 1997; Ranganathan *et al.*, 2004). This study is focused on the SCM function, which encompasses a range of internal organisational activities as

well as inter-organisational processes that stretch beyond company boundaries. In line with earlier research by IOS/EDI researchers, the post-adoption in this study would include internal diffusion as well as external diffusion. The next section moves on to the discussion of research on the diffusion of Internet technologies in SCM.

3.2.2 Development of Internet technologies diffusion in business

To better illustrate the development levels of Internet technologies in supply chain management, the evolution of e-business and the evolution of supply chain management is discussed in this section.

Evolution of e-business

Researchers in e-business studies clarify several stages of e-business development for SMEs (Daniel and Wilson, 2002; Rao *et al.*, 2003; Mendo and Fitzgerald, 2005). Generally, four stages are agreed by researchers, as in Figure 3.2(Rao *et al* 2003).

In the "presence stage", SMEs are typically characterised by gaining access to the Internet, followed by the use of relatively basic technologies (e.g. e-mail or online searching) to share and gather information. During the "portals stage", SMEs establish a simple static homepage containing basic information. Later, a wider range of information is published and products are marketed online with some after-sales support. In the "transactions integration stage", B2B or B2C transaction allows the users of the site to order and/or pay for products and services. In the "enterprises integration stage", the company website is fully integrated with the various back office systems such as ERP, CRM, and integrated supply chain

management applications.

With similarity of depth and width in Internet technology usage within the

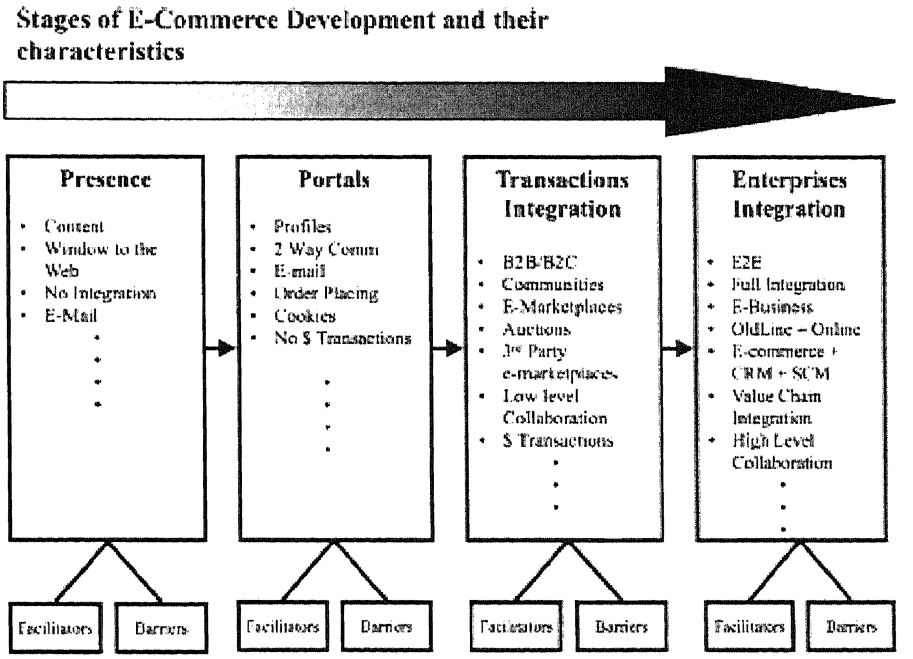

Figure 3.2 Stages of e-commerce development

company, e-business/e-commerce evolution considered basic applications of the Internet in supply chain management, which may be characteristic of many SMEs in the fresh produce industry in the UK and China. Therefore, it would be wise to combine these two approaches to identify the development levels of Internet-based supply chains of SMEs.

Evolution of supply chain management

As a newly developed subject, the evolution of supply chain management has not achieved agreement between researchers. However, researchers attempt to explain the evolution from an integration perspective, which represents the key feature of supply chain management.

Muzumdar and Balachandran (2001) review the industrial trend of supply chain management from a historical perspective, and describe the transformation of supply chain management in three phases (Table 3.2).

Table 3.2 Phases of evolution of supply chain management

	Phase 1: Functional or Departmental	Phase 2: Integrated	Phase 3: Value Networked
Supply Chain Planning	*Done in functional silos * Ineffective due to limited information visibility and standardisation across the enterprise	* Shift to a business process focus * Increase in effectiveness due to standardisation of information across the enterprise * Integrated supply chain planning: demand forecasting, planning & scheduling	* Collaborative planning * Extension of the planning process beyond the enterprise including contract manufacturers, key customers and suppliers
Supply Chain Execution	*Silo-based execution—often in a reactive mode * Decisions often made by functional managers and key associates	* Integrated cross-functional decisions, still primarily in a reactive mode * Limited collaboration	* Decisions taken at the most appropriate level in the organisation * Greater proportion of collaborative, pre-emptive decisions
Procurement	*Leverage purchasing knowledge to procure at the lowest price * Minimal interaction with other functional areas	* Make integrated cross-functional decisions to minimise enterprise costs (e.g. focus on impact of raw material on total "cost-to-make") * Use MRP and long-range planning to better negotiate with suppliers	* Strategic sourcing *Supplier segmentation—long-term relationships/contracts for key raw materials, reverse auctions for MRO
Planning	* Develop supply plan based on historical production data * Minimal linkages between business planning and production planning	* Integrated demand forecasting, planning and scheduling * Sales and operations planning	* Collaborative planning forecasting and replenishment (CPFR) * More frequent and granular sales and operations planning
Scheduling	* Maximise asset utilisation and minimise manufacturing costs * Minimal linkage with supply chain planning	* Minimise cost-to-serve customer base—greater cooperation with customer service * Strong linkages to supply chain planning	* Dynamic constraint-anchored scheduling in a capable-to-promise environment * Collaborative scheduling
Inventory Management	* Minimise inventory within one's four walls * Inventory treated as an "independent business variable"	* Customer segmentation—align inventory policies with customer service levels * Inventory viewed as an artefact of incomplete supply chain information	* Dynamic network optimisation * Collaborative replenishment and vendor-managed inventory
Logistics Planning and Execution, Warehouse Management	* Manual-labour intensive * Limited visibility	* Increased warehouse management & automation—pick, pack & ship * Logistics network optimisation	* Transactional logistics—real-time track and trace, multimodal shipment delivery and visibility * Multi-modal logistics scheduling optimisation
Sales/ Customer Service	* Reactive customer service * Minimal interaction with manufacturing	* Customer segmentation—align customer service levels with segment characteristics * Available-to-promise	* Proactive customer relationship management * Capable-to-promise
Skills and Focus	* Narrow and functionally focused in	* Increased breadth of inter-functional knowledge spanning multiple	* Broad-based collaboration around business processes

	a reactive mode * Soft skills not viewed as critical	business processes * Soft skills—the ability to lead and work in cross-functional teams, effective communication is increasingly important	that extend beyond the enterprise to key customers and suppliers

Phase 1 represents the transformation from the post-World War II era up to the late 1980s. Each functional area or department planned and operated separately. Phase 2 represents the incremental changes that occurred from the late 1980s through to the late 1990s. Some information systems were adopted, which assisted the integration of supply chain planning and operation. With the advent of Internet technologies, Phase 3 describes a linear supply chain, with collaborations from suppliers and customers. Moreover, real-time information is available to supply chain partners, and a more proactive supply chain is achieved.

Taking a different approach, Poirier and Bauer (Poirier and Bauer, 2000) view the evolution of supply chain management in five levels (Table 3.3). They believe that

Table 3.3 Supply chain development framework

Progression / Business Application	Level I/II: Internal Supply Chain Optimisation	Level III: Network Formation	Level IV: Value Chain Constellation	Level V: Full Network Connectivity
Information technology	Inform—point solutions	Interaction—linked intranets	Transact—Internet-based extranet	Deliver—Full network communication system
Design, Development Product/service introduction	* Internal only	* Selected external assistance	* Collaborative design-enterprise integration and PIM	* Business functional view—joint design and development
Purchase, Procurement, sourcing	* Leverage business unit volume	* Leverage full network through aggregation	* Key supplier assistance, web-based sourcing	* Network sourcing through best constituent
Marketing Sales, customer service	* Internally developed programs, promotions	* Customer-focused, data-based initiatives	* Collaborative development for focused consumer base	* Consumer response system across the value chain
Engineering, planning, scheduling, manufacturing	* MRP * MRPII * DRP	* ERP—internal connectivity	* Collaborative network planning—best asset utilisation	* Full network business system optimisation
Logistics	* Manufacturing push—inventory intensive	* Pull system through internal/ external providers	* Best constituent provider—dual channel	* Total network, dual-channel optimisation

Customer care	* Customer service reaction	* Focused service—call centres	* Segmented response system, customer relationship management	* Matched care—customer care automation
Human resources	* Internal supply chain training	* Provide network resources, training	* Inter-enterprise resource utilisation	* Full network alignment and capability provision

the accomplishment of Level 1 and 2 is the starting point of e-business, where Level 1 is defined as sourcing and logistics improvement, and Level 2 is internal excellence within supply chain functions. After Level 2, supply chain functions are integrated in Level 3 by an Intranet, and advanced supply chain technologies are connected by the Internet. Level 4 starts the value chain constellation by using extranet to share information with supply chain partners. In Level 5, full network connectivity is achieved, as use of the Internet is pervasive and the network is fully connected to the Internet.

After reviewing numerous approaches regarding the evolution and type of supply chain management, Folinas *et al.* (2004) summarised an integrated evolution model of supply chain management (Figure 3.3). The evolution of supply chain management is divided into four types: 1st Type, Core logistics activities efficiency; 2nd Type, Coordination of internal organisational processes; 3rd type, Inter-enterprises of business exchanges; and 4th Type, establishment of dynamic networks between virtual organisations.

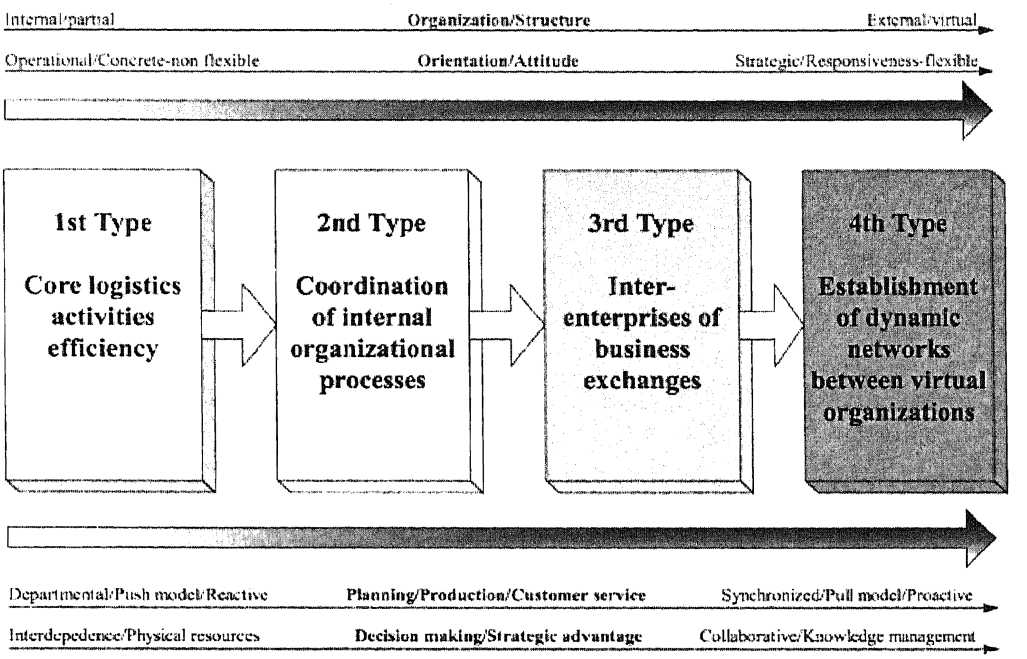

Figure 3.3 The evolution of supply chain

It is not hard to see the similarity of these three evolution models. Generally, the supply chain integration starts with functional integration, departmental integration, and internal integration, and progresses to external integration, and even full network integration. However, the advantage of Poirier and Bauer's supply chain development framework is that it recognises the roles of Internet technologies and other supply chain technologies in the progression of supply chain development. It also follows the trend recognised by the other two models. Additionally, it draws a clear line between each stage, such as highlighting the process of integration from internal integration to external integration, and also indicates the final possible trend, full network integration, which is not foreseen by the other two models. Therefore, Poirier and Bauer's supply chain development framework is more appropriate for this research.

3.2.3 The development levels of Internet-based supply chain

Considering that SMEs may be familiar with basic Internet technologies, Poirier and Bauer's (2000) framework is modified. It is argued that a per-integration level ought to be positioned, due to the fact that a great amount of SMEs in the fresh produce supply chain may only use basic functions of Internet technologies, such as sending e-mails or searching information. For Level 2, internal integration within supply chain functions, supply chain software packages are considered as the landmark. The later levels follow the characteristics of information technologies for each level, such as Intranet for Level 3 and Extranet for Level 4. The development levels of Internet-based supply chains for SMEs are shown in Figure 3.4.

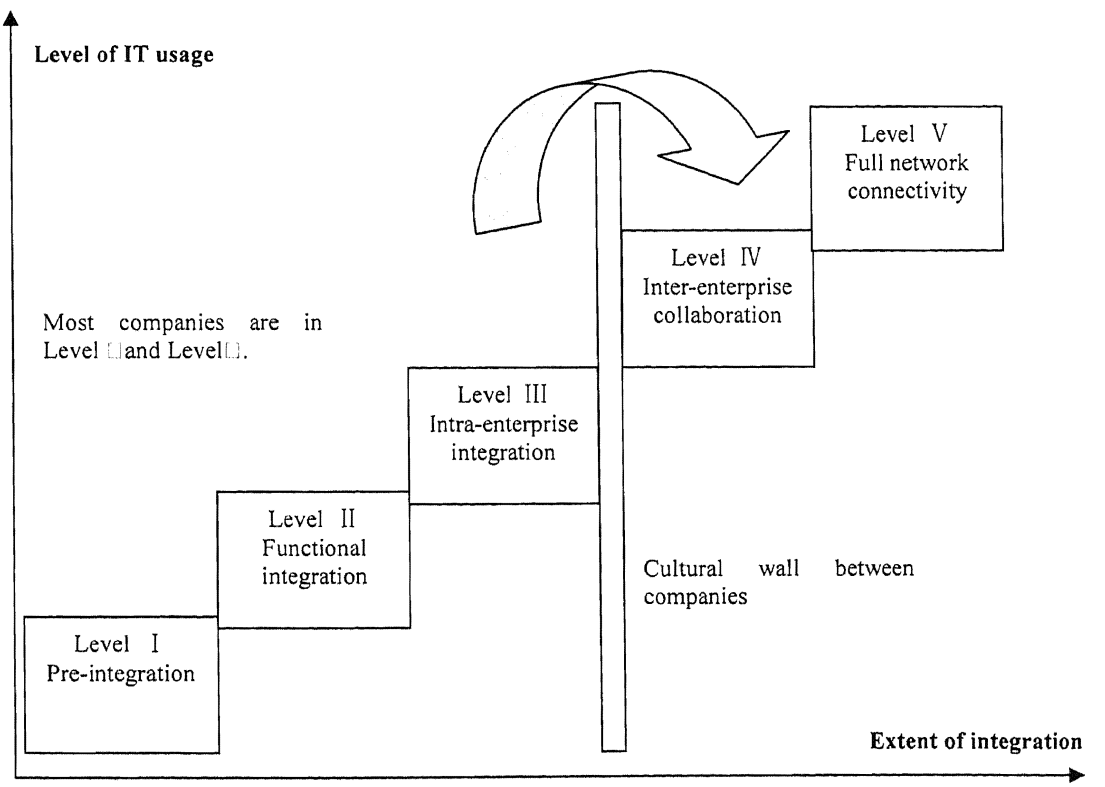

Figure 3.4 Development levels of Internet-based supply chains

In summary, these five development levels of Internet-based supply chains are

identified as the dependent variable in this research, and they are:

- ✓ Level 1 Pre-integration: The supply chain activities are mainly operated manually, with phone, fax, personal contacts, and e-mails. Additionally, online searching has been used for searching market information.
- ✓ Level 2 Functional integration: Software packages are used to assist the management of individual functions, such as barcode systems, RFID, EDI, ERP, CRM, AQC, WMS, TMS, and geo-coded tracking systems.
- ✓ Level 3 Intra-enterprise integration: Companies not only use software packages, but also set up the Intranet as the internal interface of the software packages to share timely information between departments.
- ✓ Level 4 Inter-enterprise collaboration: Extranet is extensively used between the company and important partners to share information and to facilitate transactions.
- ✓ Level 5 Full network connectivity: This is the world of full network collaboration and the use of technology to gain positions of market dominance. Information is shared electronically between network members, with the application of e-commerce, e-business and cyber-communication techniques to enable end-to-end visibility across the value chain network.

3.3 Factors influencing IT diffusion

As discussed in section 3.2, the diffusion of innovation theory has been widely applied to assess the adoption and diffusion of the Internet and information systems, including, Internet (Mehrtens *et al.*, 2001; Doherty *et al.*, 2003; Dholakia and Kshetri, 2004), e-business and e-commerce (Daniel and Wilson, 2002; Daniel

and Grimshaw, 2002), EDI (Angeles *et al.*, 1998; Chwelos *et al.*, 2001), MRP (Cooper and Zmud, 1990), open systems (Chau and Tam, 1997), and ERP (Buonanno *et al.*, 2005; Gattiker and Goodhue, 2005). Tables 3.4 and 3.5 summarised previous research about factors under the TOE framework. From the tables, it can be seen that many diffusion studies are associated with adoption research (Cooper and Zmud, 1990; Iacovou *et al.*, 1995; Mehrtens *et al.*, 2001; Ranganathan *et al.*, 2004; Sanchez and Perez, 2005). Therefore, to find out the factors influencing post-adoption, it is necessary to review the factors tested in adoption and diffusion research. Factors that have appeared in SME research will be discussed in section 3.3.2.

3.3.1 Factors in adoption and diffusion research

In Jeyaraj *et al.*'s study (2006), the five independent variables are the most frequently used factors of IT adoption by organisations: relative advantage, top management support, organisation size, compatibility and complexity. However, from their statistics, four factors are proved to be the best factors: external pressure, professionalism of IS unit, external information source, and top management support. Table 3.4 presents studies about IT/IS adoption by organisations.

In studies of factors in diffusion by organisations, 40 independent variables were examined. Jeyaraj *et al.* (2006) find that an analysis of the best predictor of diffusion is not possible, given the fact that meaningful observation is not possible due to the overwhelming evidence of experimentation with diffusion at the organisational level. Table 3.5 presents the factors found in diffusion by organisations.

Table 3.4 Table of adoption research

	Dependent variable	Technological factors	Organisational factors	Environmental factors	Comments
Premkumar *et al.* (1997)	EDI adoption	Innovation Characteristics Relative Advantage Compatibility Complexity Cost	Top Management Support Product Champion Size	Transaction Climate (Trust) Net-dependence Competitive Pressure Customer support	Size of the firm, competitive pressure, customer support, and top management
Chau and Tam (1997)	Open systems adoption	Perceived benefits Perceived barriers Perceived importance to compliance to standards, Interoperability, and Interconnectivity	Complexity of IT infrastructure Satisfaction with existing systems Formalisation on system development and management	Market uncertainty The market for their company's products The competition for their company's products The demand of their major customers The degree of loyalty of their major customers The frequency of price-cutting in their industry	Extent of perceived barriers, satisfaction with the existing computing systems, and importance level of compliance to standards, interoperability and interconnectivity are significant.
Xu *et al.*, (2004) Zhu *et al.*, (2004)	E-Business Value Impact on Commerce Impact on Internal Efficiency Impact on Coordination	Technology Readiness Technologies in use Website functionality Back-office integration	Firm Size Global Scope Financial Resources IT spending Web-based spending	Competition Intensity Local/country/outside the country Regulatory Environment	
Quaddus and Hofmeyer, (2007)*	Adoption of B2B		Organisational characteristics Manager characteristics Organisational readiness	Vendor support Critical mass Competition Government Trading partners	External influences raise the small business's awareness of an innovation.

Table 3.5 Table of diffusion research

	Dependent variable	Technological factors	Organisational factors	Environmental factors	Results
Cooper and Zmud, (1990)	MRP implementation: adoption, infusion	Technology characteristics Technology complexity			Interactions between task and technology affect the adoption of MRP, but not infusion process, political and learning models may be more useful when examining infusion.
Boynton *et al.*, (1994)	IT use: ● Cost reduction ● Management support ● Strategic planning ● Competitive thrust	Managerial IT knowledge	IT management climate IT management process effectiveness		Management IT knowledge is dominant factor in explaining high level of IT use. IT management process effectiveness found small effect on the influence of IT use.
Premkumar *et al.*, (1994)	EDI diffusion: ● Adaptation ● Internal diffusion ● External diffusion ● Implementation success		Cost Elapsed time	Communicability	Determinants of adaptation: relative advantage technical compatibility and cost Determinants of internal diffusion: relative advantage, elapsed time Determinants of external diffusion: technical compatibility and elapsed time Determinants of implementation success: cost, technical and organisational compatibility
Iacovou *et al.*, (1995)* similarly Mehrtens *et al.*, (2001)*	EDI adoption and integration (Internet)		Organisational readiness ● Financial resources ● Technological recourse	External pressure ● Competitive pressure ● Imposition by partners	Organisational readiness and external pressure are positively related to adoption, integration and impact.
Angeles *et al.*, (1998)	Levels of EDI implementation	IT compatibility training	Top management	Trading partner relationships	Training and trading partner relationships are significant factors for the adoption.
Thong, (1999)	Likelihood of IS adoption Extent of IS Adoption		CEO's Innovativeness CEO's IS knowledge Employees' IS Knowledge Size Information intensity	Competition Ease for a customer to switch to a competitor Levels of rivalry among business Effect of substitutable products and services.	CEO characteristics, innovation characteristics, organisational characteristics influence adoption. The extent of IS adoption is mainly determined by organisational characteristics.
Ranganathan *et al.*, (2004)	Assimilation and diffusion of web technologies in supply chain management	Managerial IT knowledge	Centralisation Formalisation of IT unit structure	Supplier interdependence Competitive intensity IT activity intensity in industry	Managerial IT knowledge and formalisation of the IT unit structure are significant drivers

Zhu and Kraemer, (2005)	E-business usage: percentage of business function conducted online	Technology competence	Size	Competitive pressure Partner readiness	Technology competence, partner readiness and competitive pressure significantly drive e-business usage.
Sanchez and Perez, (2005)	EDI adoption EDI use: functions use EDI in supply chain		Cost difficulties Technical difficulties Organisational difficulties	External pressure Supply dependence Mutual understanding Technological uncertainty	Factors for EDI adoption: operational benefits, external pressure, mutual understanding, Factors for EDI use: proactive management, strategic benefits
Gengatharen and Standing, (2005)	E-marketplace adoption, implementation	E-marketplace characteristics	Participants` characteristics	Environmental factors	Owner innovativeness, ownership structure and governance.
Hsu *et al.*, (2006)	E-business use Diversity Volume		Size, technology resource (to T) Globalisation level	Trading partner pressure, Government, pressure, Regulatory concern, Competition intensity	Diversity of E-business: pressure from trading partners E-business volume: government pressure

*refers to the studies about SMEs

3.3.2 Research in SMEs

The research listed in Tables 3.4 and 3.5 presents the research foci about SMEs by IS/IT researchers. Premkumar (2003) produces an extensive review of IT research in small businesses, and categorises factors into five major domains: individual, task, technology/innovation, organisation and environment. However, several dimensions are arguably not applicable to this research. For example, he argues that factors in the individual domain are considered to have a secondary role in studies dealing with organisational IT implementation. They are more likely to be useful in the design of systems and user-interfaces, so those factors are not suitable for this research. Factors in the task dimension are also not suitable, as they are collected from decision support system research, which mainly concerns the fit between task and technology.

In supply chain literatures, research attention was predominantly placed on large multinational companies (Jones and Clarke, 2002; Ranganathan *et al.*, 2004). Vaaland and Heide (2007) investigate 200 Norwegian companies and find that SMEs give less attention to planning and control methods than large companies, are less focused on system integration with other actors in the supply chain, and are less focused on EDI and e-based solutions. Their findings further demonstrate the importance of researching SMEs' behaviour in the diffusion of Internet technologies in the supply chain.

3.3.3 Factors influencing post-adoption at the inter-organisational level

The technological context

Tornatzky and Klein (1990) defined the technological context as the existing

technologies inside the company, as well as external available technologies in the market. Later researchers in IT/IS adoption defined the technological context as the perceived characteristics of technologies (Chau and Tam, 1997; Thong, 1999). However, in terms of post-adoption, these perceived characteristics are not considered as significant (Kwon and Zmud, 1987; Xu and Duan, 2007), as companies have already adopted technologies and no longer feel unfamiliar with their relative advantages. Consequently, researchers in the area of post-adoption apply IT competence as an indicator of the technological context (Zhu *et al.*, 2004; Aguila-Obra and Padilla-Mellendez, 2006), such as the use of Internet and other supply chain technologies, and managers' and employees' skills.

The organisational context

Factors in the organisational context are firstly associated with the characteristics of the company, which include company size, geographic scope of the business, and operational complexity. Previous studies have found that company size is an important determinant of its involvement with technology. Larger companies tend to have more resources for implementation and further deployment of the technology (Dholakia and Kshetri, 2004). Broader geographic scope may enable companies to use the Internet in communication within departments or with partners (Gibbs and Kraemer, 2004).

Other factors from the point of view of management are also very critical: company knowledge, a company's financial resources, strategies, and operational complexity are all major concerns in supply chain management.

Knowledge and competence are frequently cited as factors by IT usage research

(Boynton *et al.*, 1994). Drawn from absorptive capacity theory, Boynton *et al.* (1994) indicated that business-related knowledge is a major component of an organisation's absorptive capacity of IT. In the area of supply chain management, business-related knowledge is related to the knowledge of supply chain management. It can be further argued that those parts of knowledge are not only processed by managers, but also by employees who are the main operators of the supply chain, especially in the context of small businesses.

For SMEs, limited financial resources are always a barrier when considering the usage of new technologies. Dewett *et al.* (2007) suggest that sufficient financial resources not only determine cost and benefits during the adoption decision, but can also facilitate the post-adoption decisions.

Supply chain strategies will influence the company structure and management, and will influence the role of the Internet in supply chain management in the long term. The alignment of a supply chain strategy with company strategy is becoming vital for many businesses' success (Bowersox and Daugherty, 1995; Patterson *et al.*, 2003). Another influence that may affect the usage of the Internet is operational complexity, because operational complexity encourages companies to continuously use Internet technologies to improve efficiency (Pant *et al.*, 2003).

The environmental context

Environmental factors mainly refer to the companies' supply chain environment, such as the power of trade partners and trust. Pant *et al.* (2003) compared the factors influencing the stage of companies' decisions to adopt the Internet and the stage of diffusion, and concluded that customer service is a significant external factor for

both stages. Premkumar *et al.* (1997) discuss the importance of trust in the supply chain and point out that "trust among the partners reduces the need for extensive control and safeguards". Therefore, trust can be an indicator for Internet-based supply chain operations.

3.4 Research variables and hypotheses

The dependent variable in this research is five development levels of Internet-based supply chain, which are summarised in 3.2.3, as the Internet has different roles among different development levels of the supply chain. Inspired by the TOE framework, factors influencing the diffusion of Internet technologies will be categorised in the technological, organisational, and environmental contexts. Figure 3.5 summarises those hypotheses.

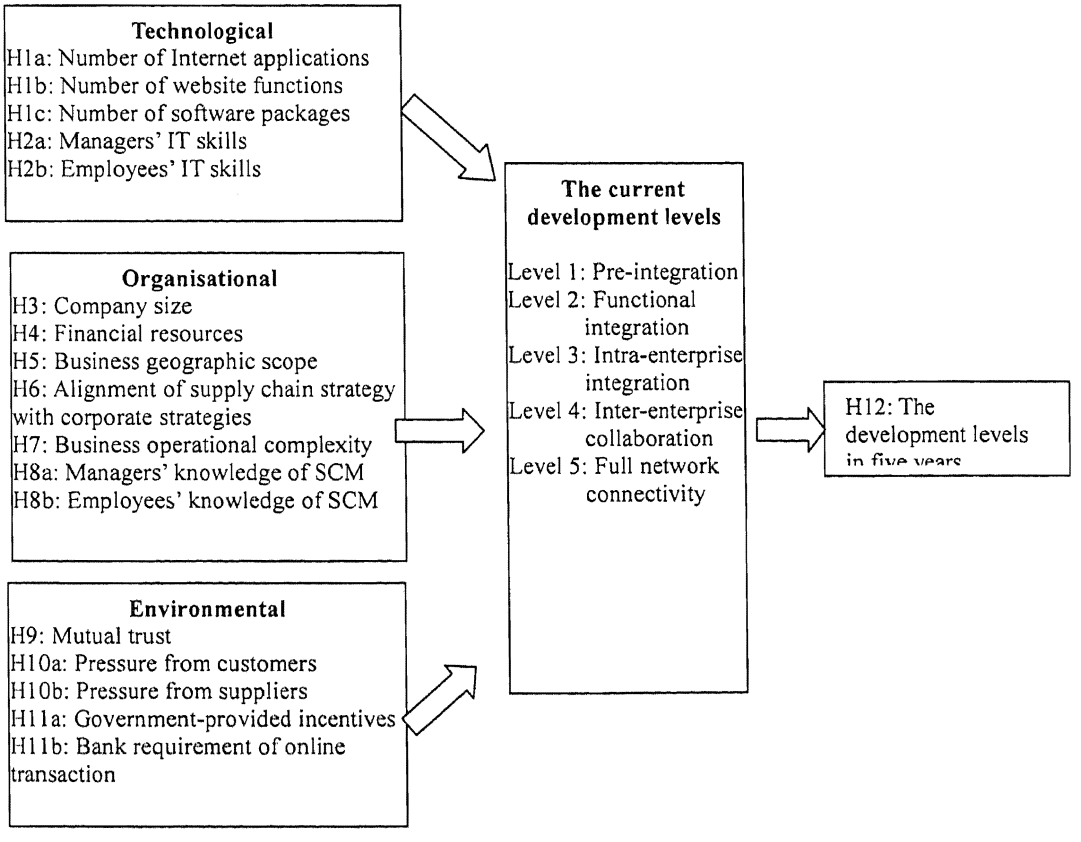

Figure 3.5 Independent variables related to the development levels of Internet-based supply chain

3.4.1 The technological context

Zhu and Kraemer (2005) examine technology competence in the technology context, including IT infrastructures and IT skills. In this study, IT infrastructures refer to the use of supply chain-related technologies, such as e-mail, websites, EDI, ERP and related supply chain software packages. Due to various integration levels of the supply chain, individual technologies can be used separately to support one of the functions in the supply chain, as well as be connected to the Internet to form a platform to achieve a higher development level of the supply chain.

H1a: Companies with a higher number of Internet functions implemented are positively associated with the development levels of Internet-based supply chains.

H1b: Companies with a higher number of website functions are positively associated with the development levels of Internet-based supply chains.

H1c: Companies with a higher number of software packages used are positively associated with the development levels of Internet-based supply chains.

Piccoli and Ives (2005) investigate barriers to IT implementation, and find that IT technical skills and IT management skills are two popular factors examined by researchers. In this research, technical IT skills can be reflected in employees' IT skills, because it mainly refers to how employees use IT technologies. On the other hand, IT management skills refers to managers' IT skills, as managers in SMEs are more likely to make strategic decisions.

H2a: Companies with better managers' IT skills are positively associated with the development levels of Internet-based supply chains.

H2b: Companies with better employees' IT skills are positively associated with the development levels of Internet-based supply chains.

3.4.2 The organisational context

According to the characteristics of Internet technology diffusion in the supply chain, this research brings supply chain factors, like supply chain strategy alignment, operational complexity and knowledge about supply chain management, along with well-cited factors in the organisational context, such as company size and a company's geographic scope, together in the organisational context.

Previous research on the Internet and IT applications identified that company size is positively related to the adoption of the Internet and IT (Hill and Scudder, 2002; Hsu *et al.*, 2006). In terms of usage and diffusion, Dholakia and Kshetri (2004) found that company size does not have a significant effect on e-commerce application. There seems not to be fully conclusive evidence about company size and Internet usage. Nevertheless, it is proposed that:

H3: Companies with more employees are positively associated with the development levels of Internet-based supply chains.

Unlike large companies, SMEs are more limited in terms of their budgets, and have fewer financial resources. Archer *et al.* (2008) indicate that cost requirement is one of the barriers for SMEs in terms of using online supply chain solutions. However, Premkumar (2003) argues that since the prices of software and hardware have dramatically reduced for many years, and the cost for online communication is declining due to the competition among telecommunication companies, Internet technologies are more affordable by SMEs. Therefore, no agreement has been reached in relation to the influence of financial resources upon SMEs' use of Internet technologies, so it is proposed that:

H4: Companies with more financial resources are positively associated with the development levels of Internet-based supply chains.

The geographic scope of business can have an influence on SMEs' development levels of Internet-based supply chains because the Internet can be used to gain visibility across an extended network of trading partners and to help companies respond quickly to a range of business conditions, from changes in customer demand to resource shortages (Hsu *et al.*, 2006). This factor was shown to be significant by Gibbs and Kraemer (2004) when they researched e-business usage by large companies. In the UK fresh produce industry, although the supply of fresh vegetables can be from domestic production, about 96% of fruit is imported. Further, 60% of importers and exporters are SMEs (Kidd, 2006). It is expected that geographic scope will affect the development levels of Internet-based supply chains. Therefore, it is proposed that:

H5: Companies with broader geographic business scopes are positively associated with the development levels of Internet-based supply chains.

Several researchers illustrate the importance of alignment between supply chain strategies and IT usage in the supply chain (Bowersox and Daugherty, 1995; Patterson *et al.*, 2003). The alignment of a supply chain strategy with company strategy is becoming vital for many businesses' success. For SMEs, it is expected that a more aligned supply chain strategy will help SMEs use the Internet technologies in the supply chain to a greater extent. Therefore, it is proposed that:

H6: Companies with a more aligned supply chain strategy are positively associated with the development levels of Internet-based supply chains.

Pant *et al.* (2003) suggest that the internal and external operational complexity decides the level of integration between the website and the off-the-shelf software

solutions. It is possible that operational complexity in SMEs is lower than in larger companies. Some companies may only focus on internal operations, while some may operate more actively in external operations. Less operational complexity may cause SMEs to remain in a lower development level of Internet-based supply chain. Since the research by Pant *et al.* (2003) presents the theoretical illustration of this factor without any empirical support, this factor is further tested during exploratory interviews. Therefore, it is proposed that:

H7: Companies with a higher level of operational complexity are positively associated with the development levels of Internet-based supply chains.

In studying IT implementation, Boynton *et al.* (1994) find that the knowledge of managers and line managers was directly and positively related to the extent of IT usage within an organisation. Nevertheless, apart from IT knowledge, supply chain knowledge would also be critical. The pilot case studies by the authors found that some managers have a limited understanding of the supply chain, which discourages the further use and integration of the Internet. Therefore, this research proposes the following hypotheses:

H8a: Companies with managers who have more knowledge of supply chain management are positively associated with the development levels of Internet-based supply chains.

H8b: Companies with employees who have more knowledge of supply chain management are positively associated with the development levels of Internet-based supply chains.

3.4.3 The environmental context

In the environmental context, pressure from partners, trust, and the regulatory environment are proposed as influential factors.

In general, a trusting relationship between the supply chain partners is a critical factor for the success of Internet usage (Soliman and Janz, 2004; Patterson *et al.*, 2003). However, in a study of the transportation industry, Premkumar *et al.* (1997) found limited evidence to suggest that trust between an adopter and a non-adopter are different, and they presumed that the reason for the low significance of trust is that competitive pressure in the transportation industry is relatively low. However, the fresh produce industry is a highly competitive industry, due to the perishability of the produce. SMEs are concerned with sharing information with their partners at prices, the inventory levels, etc. The pilot study found that, although trust may not be significant in adoption, it is important for the further implementation and integration of the Internet. Therefore, it is proposed that:

H9: Companies with a higher level of trust between partners are positively associated with the development levels of Internet-based supply chains.

Existing research suggests that trading partners have a substantial impact on a firm's decision to adopt supply chain technologies (Iacovou *et al.*, 1995). In terms of further usage and diffusion, the way that trade partners implement supply chain technologies significantly influences the further development of the Internet. Dholakia and Kshetri (2004) found that the power of customers motivated SMEs to move adoption to further diffusion. Son and Benbasat (2007) found that suppliers' adoption continuously influenced companies' adoption, from decision-making to further implementation. Therefore, the hypotheses concerning external factors are proposed as:

H10a: Companies with a higher level of pressure from customers are positively associated with the development levels of Internet-based supply chains.

H10b: Companies with a higher level of pressure from suppliers are positively associated with the development levels of Internet-based supply chains.

The regulatory environment is also proven to be influential in Internet diffusion studies (Zhu and Kraemer, 2005). In the environment of supply chains in particular, companies can be influenced by government incentives of online communication. For example, Xu *et al.* (2004) identified the importance of government incentives for China, compared to their influence in the US. As this research is about a comparison between the UK and China, the hypothesis is proposed as:

H11: Companies with a higher level of government incentives are positively associated with the development levels of Internet-based supply chains.

3.4.4 SMEs' intention for the development levels in five years

The relationship between the current development levels of Internet-based supply chain and the development levels in five years could indicate a company's progress of Internet-based supply chain. Ranganathan *et al.* (2004) have indicated that companies with better internal integration are more likely to succeed in diffusing these technologies and transforming them into external integration. Therefore, it is proposed that:

H12: Companies with better development levels currently are positively associated with their development levels in five years.

3.5 Chapter summary

This chapter presents a detailed review of theories about innovation diffusion. Development levels of Internet-based supply chains are defined and factors affecting the diffusion process are summarised. Ten hypotheses are proposed for empirical research. The next chapter discusses the methodology of the empirical

research.

Chapter 4 Research design and methodology

This chapter presents a detailed description of the research design and methodology used in this study. The main objectives of this study are to investigate the Internet usage by SMEs in the fresh produce supply chain, identify factors affecting SMEs' post-adoption development, and reveal the differences between SMEs in the UK and China. The research design needs to take into account the different demands of collecting, analysing and interpreting data under these circumstances. Following a general discussion of possible research methodologies, this chapter justifies the methods used in this research, which includes the collection and analysis of both qualitative and quantitative data.

This chapter discusses the research paradigm and associated concepts adopted in the study. The chapter then goes into detail about the data collection methods, including exploratory interview and survey techniques. This includes the data analysis methods, which include content analysis for qualitative data, and statistical methods for the survey data.

4.1 Research paradigm

Saunders *et al.* (2007) use the research "onion" to depict the issues underlying the choice of data collection techniques and analysis procedures (Figure 4.1). This research follows Saunders' "onion" framework to justify the research methodology that is used.

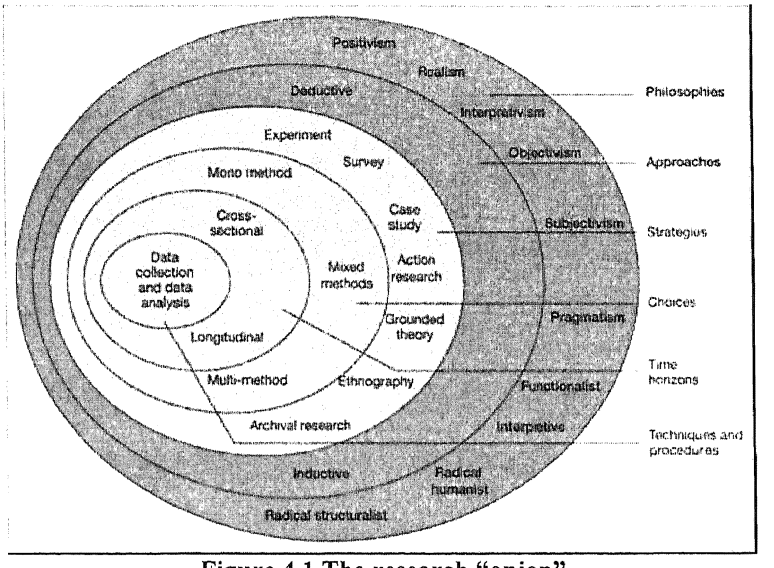

Figure 4.1 The research "onion"

4.1.1 Philosophical considerations

The first outside layer of the "onion" refers to research philosophies, including epistemology (positivism, realism, interpretivism), ontology (objectivism, subjectivism, pragmatism), and axiology (functionalist, interpretive, radical humanist and radical structuralist) (Saunders *et al.*, 2007). From a philosophical perspective, one of the major dichotomies that exists in research is the different approaches represented by positivism and interpretivism (Bryman, 2004; Saunders *et al.*, 2007).

Positivism is an epistemological position that advocates the application of the methods of the natural sciences to the study of social reality and beyond (Saunders *et al.*, 2007). Interpretivism is an epistemology that advocates that it is necessary for the researcher to understand differences between humans in their role as social actors. This emphasises the difference between conducting research among people and conducting research about objects such as trucks and computers (Saunders *et al.*, 2007).

Saunders *et al.* (2007) listed the advantages and disadvantages of these two philosophies (Table 4.1). In positivism, hypotheses are generated based on existing theory, and further tested and confirmed in whole or part, or refuted, leading to the further development of theory which may then be tested by further research. Thus, positivism possesses advantages such as economical collection of data, a clear theoretical focus, more opportunities to retain control of the research process, and easily comparable data, but it lacks rich information and flexibility. On the other hand, interpretivism is helpful in obtaining rich information about social processes, but is costly and difficult to analyse and compare.

Table 4.1 Key advantages and disadvantages of positivism and interpretivism

	Positivism	Interpretivism
Advantages	• Economical collection of large amount of data • Clear theoretical focus for the research at the outset • Greater opportunity for researcher to retain control of the research process • Easily comparable data	• Facilitates understanding of how and why • Enables researcher to be alive to changes that occur during the research process • Good at understanding social processes
Disadvantages	• Inflexible – direction often cannot be changed once data collection has started • Weak at understanding social processes • Often doesn't discover the meanings people attach to social phenomena	• Data collection can be time consuming • Data analysis is difficult • Researcher has to live with the uncertainty that clear patterns may not emerge • Generally perceived as less credible by "non-researchers"

The philosophical consideration of this study is positivism, as this research investigates Internet usage in the fresh produce supply chains in the UK and China by collecting large-scale data from the two countries.

4.1.2 Research approaches

A deductive approach involves developing a theory and hypotheses and designing a research strategy to test the hypotheses. An inductive approach consists of collecting data and developing theory as a result of data analysis (Saunders *et al.*, 2007). Major differences between the deductive and the inductive approach are

summarised in Table 4.2.

Table 4.2 Major differences between deductive and inductive approaches to research

Deduction emphasises	Induction emphasises
• Scientific principles • Moving from theory to data • The need to explain causal relationships between variables • The collection of quantitative data • The application of controls to ensure validity of data • The operationalisation of concepts to ensure clarity of definition • A highly structured approach • Researcher independence of what is being researched • The necessity to select samples of sufficient size in order to generalise conclusions	• Gaining an understanding of the meanings humans attach to events • A close understanding of the research context • The collection of qualitative data • A more flexible structure to permit changes of research emphasis as the research progresses • A realisation that the researcher is part of the research process • Less concern with the need to generalise

To relate this to research philosophies, deduction owes more to positivism and induction to interpretivism (Oates, 2006). A deductive approach is mainly used in this study, as the research will follow a positivist direction to collect data.

4.1.3 Research strategies

The selection of research strategies is largely concerned with the purpose of the research: exploratory, descriptive and explanatory (Robson, 2002). As mentioned in Chapter 1, the purpose of this research is: 1) investigating the current Internet usage by SMEs in China and the UK in their fresh produce supply chains, 2) evaluating factors affecting the post-adoption of Internet technologies by SMEs in their fresh produce supply chains, and 3) conducting a comparative study between the UK and China in order to reveal the gap between the two countries, aiming for successful knowledge transfer. It is mainly descriptive in nature and, therefore, a survey strategy is considered most appropriate.

Based on previous discussions, positivism and the deductive approach are considered for data collection. Those considerations determine the selection of the

research strategy, so a survey strategy is chosen from the research "onion". A survey strategy involves obtaining the same kinds of data from a large group of people (or events), in a standardised and systematic way (Oates, 2006). Although questionnaires are a common data collection technique for a survey strategy, other techniques like structured observation and structured interviews also belong to survey strategy (Saunders *et al.*, 2007). Following the research "onion", the next section will specify the methods that can be chosen for a survey strategy, and time horizons.

4.1.4 Research method choices and time horizons

The choice of research methods refers to the choice of quantitative methods or qualitative methods. Quantitative methods are used for any data collection technique (such as a questionnaire) or data analysis procedure (such as statistics) that generates or uses numerical data. Qualitative methods, on the other hand, are data collection techniques (such as an interview) or data analysis procedures (such as categorising data) that generate or use non-numerical data (Saunders *et al.*, 2007). Table 4.3 lists the fundamental differences between quantitative and qualitative research methods (Bryman, 2004).

Table 4.3 Fundamental differences between quantitative and qualitative research methods

	Quantitative	Qualitative
Principal orientation to the role of the theory in relation to research	Deductive; testing of theory	Inductive; generation of theory
Epistemological orientation	Natural science model, in particular positivism	Interpretivism

Based on these characteristics, this research mainly employs the quantitative approach to conduct investigation in the two countries. The qualitative approach was introduced at the first stage, questionnaire design, for three reasons. First, in

the fresh produce industry, the usage of Internet technology by SMEs is a relatively new topic in the academic information system and management information system literature, particularly for the Chinese fresh produce industry. The framework in Chapter 3 is proposed based on the previous research about other industries, in which the factors are introduced from either large companies' adoption of Internet technologies in their supply chains, or SMEs' adoption of Internet technologies in general. In this case, to use quantitative research methods prematurely may lead to inconclusive findings. A qualitative method was required to pilot-test the framework for the fresh produce industry in the two countries, in order to see whether the factors introduced are applicable to the fresh produce industry. The second reason for using a qualitative method was to examine whether the two countries are comparable under the same framework. The framework would be less meaningful if the results in the two countries are similar or there is an obvious gap between the two countries. The qualitative method would allow the researcher to gain "rich", "real", and "deep" information, which would ensure that the questionnaire is suitable to be used in the two countries. Third, the data collected from interviews can be used for triangulation after the survey, because the interviews could help explain and validate the quantitative results gained from the questionnaire survey. In summary, the complexity of the research requires a preliminary exploration in the two countries which is only possible through qualitative research prior to the large-scale data collection.

With respect to research time horizons, this research belongs to cross-sectional studies, because data collected from the UK and China will be analysed and compared. Bryman (2004) defines the concept of a cross-sectional research design,

which entails the collection of data on more than one case and at a single point in time in order to collect a body of quantitative or quantifiable data in connection with two or more variables, which are then examined to detect patterns of association. This concept indicates that the data collected in both countries should use the same questionnaire, from the same type of population, more or less simultaneously.

In summary, this section depicted the research paradigm related to this study, and clarified the research strategy, which is to use mainly the quantitative method, with the qualitative method employed in the exploratory stage. The next section describes the actual procedure of data collection in detail.

4.2 Data collection

As a cross-sectional research, the process of data collection involves the following stages in two countries: exploratory interview (4.2.1), questionnaire design and validation (4.2.2), and questionnaire delivery and collection (4.2.3). Due to cultural and environmental differences, different techniques of questionnaire delivery and collection are used in the two countries. A detailed diagram of data collection methods is depicted in Figure 4.2.

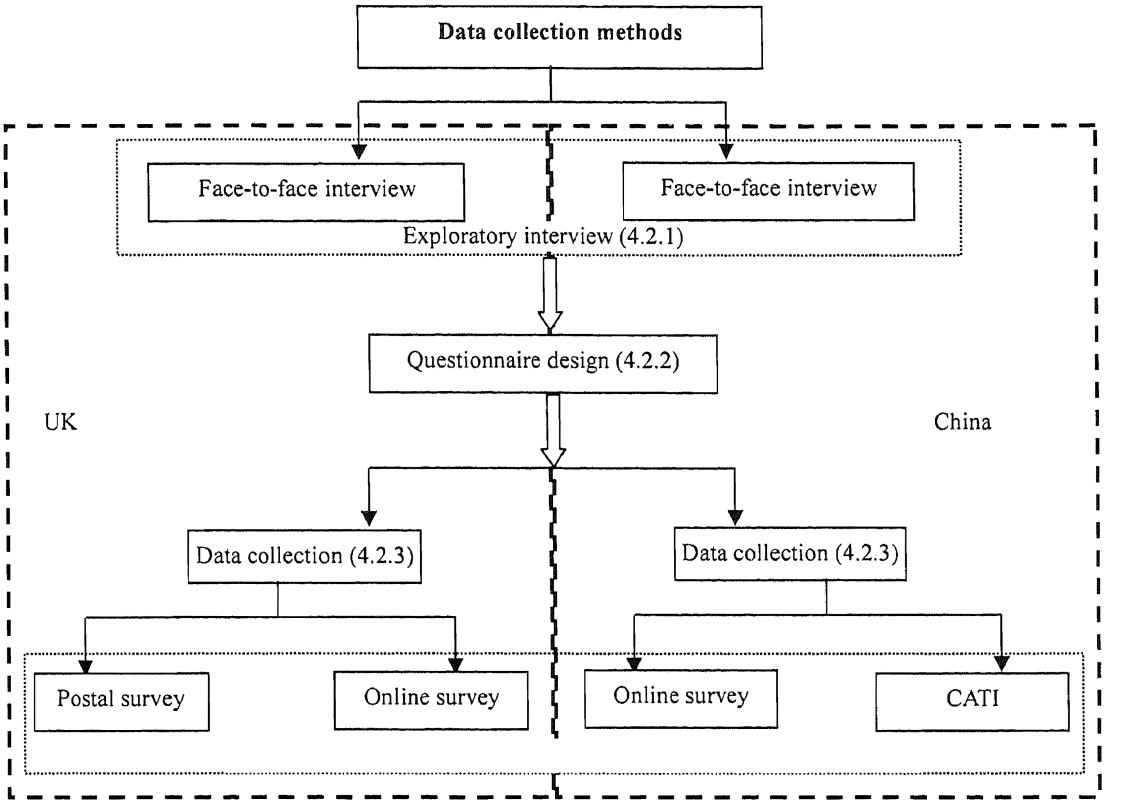

Figure 4.2 Data collection methods used in this research

4.2.1 Exploratory interviews

As explained in 4.1, the purpose of the exploratory interview is to identify important issues to be included in the questionnaire, such as the general situation of SMEs' supply chain management, motivations for and barriers to using the Internet in their supply chains, and benefits that the Internet brought to the whole supply chain. Moreover, this exploratory interview also aims to examine whether the two countries are comparable in the same industry. The comparative study would be meaningless if two countries are similar or if there is an obvious gap between the two countries. For these purposes, semi-structured interviews are conducted, and qualitative data are collected.

As a semi-structured interview, research questions comprised open questions, covering four areas, according to the research objectives: 1) What kinds of

Internet technologies are used? 2) What benefits are gained after using these technologies? 3) What are the enablers of using these technologies? and 4) What are the barriers to using these technologies? A detailed questionnaire is provided in Appendix 1a.

The interviews in the UK were conducted between August 2006 and November 2006 by randomly e-mailing 54 invitations to members of the Fresh Produce Consortium. Two companies (UK2 and UK3) expressed their interest in participating. Three further companies were invited by convenience sampling; these were available to the researcher by virtue of their accessibility (Saunders *et al.*, 2007). These companies play different roles in the fresh produce supply chain, from grower to retailer, and their usage of the Internet varies, which would be representative for the industry. However, for the development of the questionnaire design, UK4 and UK5, which were interviewed later, were also asked to validate the questionnaire.

The interviews in China followed the convenience sampling method, and were conducted in May 2006. Though fewer companies were interviewed in China, these companies are representative in terms of their role in supply chain and technology usage.

All the interviews were recorded and transcripts were taken after the interviews. However, when necessary, e-mail and telephone were used to supplement the information. To enhance the validity of the answers, summaries of the major findings of each interview were verified by the participants by e-mail. Interviews in China were conducted in Chinese, and the transcript was translated

accordingly.

The findings of exploratory studies are helpful in determining factors in each context. Appendix 1b lists a full description of these companies. The findings are presented in Chapter 5.

4.2.2 Questionnaire design

The questionnaire contains three sections:

1) Section one collects information about the company and respondent profile, including the role of the company in the fresh produce industry, company size, business scope, managers' understanding and skills.
2) Section two is about the technology issues of the company, such as the software used in the supply chain, Internet functions, and website functions. The development level of Internet-based supply chain is further defined, and the respondents are asked to carefully evaluate their companies. Respondents are asked to identify current development levels and to forecast the development levels in five years.
3) Section three covers other organisational and environmental factors that influenced the level of Internet usage and post-adoption.

To relate to variables in the framework, the dependent variables are in section two: the current development levels of Internet-based supply chain and its development in five years. They are measured by the five development levels explained in Chapter 3. Table 4.4 lists the independent variables together with similar variables identified by previous studies. The survey questions were primarily closed-ended

to elicit uniform, comparable and measurable responses. However, respondents were given the opportunity to add written comments where appropriate.

Table 4.4 The measurement of independent variables

	Independent Variables	Reference	No.
Technology	H1a: Number of Internet applications H1b: Number of website functions H1c: Number of software packages	(Zhu and Kraemer, 2005)	Q8, Q10, Q11
	H2a: Managers' IT skills H2b: Employees' IT skills	(Thong, 1999)	Q6 Q20
Organisation	H3: Company size	(Daniel and Wilson, 2002)	Q3
	H4: Financial resources	(Zhu and Kraemer, 2005)	Q4
	H5: Business geographic scope	(Gibbs and Kraemer, 2004)	Q5
	H6: Alignment of supply chain strategy with corporate strategies	(Pant *et al.*, 2003)	Q21
	H7: Business operational complexity	(Buonanno *et al.*, 2005)	Q22
	H8a: Managers' knowledge of supply chain management H8b: Employees' knowledge of supply chain management	(Ranganathan *et al.*, 2004) (Wong and Aspinwall, 2005)	Q7 Q19
Environment	H9: Mutual trust	(Soliman and Janz, 2004)	Q24
	H10a: Pressure from customers	(Soliman and Janz, 2004)	Q23a_3 Q23b_3 Q23c_3
	H10b: Pressure from suppliers	(Soliman and Janz, 2004)	Q23a_2 Q23b_2 Q23c_2
	H11a: Government incentives	(Xu *et al.*, 2004)	Q26_i
	H11b: Bank requirement of online transaction	From exploratory interviews	Q26_j

Prior to distribution, the questionnaire was reviewed by academic experts and knowledgeable industry representatives. The survey was also piloted by representatives with different roles in the fresh produce supply chain, to test the relevance of the questions and survey mechanics. The survey respondents were assured that individual responses would be non-attributable, and that all company-specific information provided would be kept confidential. The survey was mainly delivered by post, but an online version was also provided. The full questionnaire can be found in the Appendix 2a and at http://vegnet.beds.ac.uk/survey.

For the Chinese questionnaire, all questions were translated into Chinese and proofread by two Chinese native speakers, one of whom is an expert in linguistics. The full questionnaire can be found in Appendix 2b and at http://icb.cau.edu.cn/vegnet/survey.

4.2.3 Questionnaire delivery and collection

Questionnaire delivery and collection in the UK

The research focused on the fresh produce sector in the UK, including growers/farmers, food processors/manufacturers, wholesalers, importers/exporters, retailers and transporters. The target population is small and medium-sized companies. By adopting the SME definition provided by the UK Department for Business, Enterprise and Regulatory Reform (formerly DTI), an SME is defined as a company with a headcount of less than 250, but more than 9 employees, including temporary/casual/seasonal staff. The FAME database (Financial Analysis Made Easy) was used to select samples. Using the sample selection criteria, i.e. SMEs in the fresh produce industry, a total of 1,044 companies were generated from the FAME database.

Both postal questionnaires and online questionnaires were delivered. Postal questionnaires were addressed to Manager Directors, but if they believed that they were not the most knowledgeable person on the company's application of the Internet along the supply chain, they were asked to forward the questionnaire to an appropriate individual. The postal questionnaire also provided the Internet address for the online questionnaire, and indicated that the questionnaire could be completed and returned by either pre-paid envelope or online submission.

Every effort was made to reach a diverse but valid sample group from February until July 2007. For example, a free survey report was provided for every respondent. Industrial associations and trade magazines were contacted to promote the online questionnaire. For every SME with a website, approaches were made to company managers by e-mail. During this period, three rounds of postal surveys and two rounds of e-mail surveys were delivered. Finally, telephone contact was implemented to encourage companies' responses.

Of 1,044 companies, 16 questionnaires were undelivered due to the wrong address, while 26 companies did not reply because they did not currently do business in fresh produce. From the remaining companies, 130 replies were received; 35 companies were excluded because they did not conform to the definition of SMEs (14 companies had more than 250 employees and 21 companies less than 10), or were not sufficiently related to fresh produce. Four replies were invalid because they contained incomplete answers. There were 91 valid responses, which gives an overall response rate of 9%. However, every possible effort has been made to obtain as many respondents as possible. It would be fair to say that the survey results are representative, because they included the attitudes and approaches of various SMEs in the UK fresh produce supply chain.

Questionnaire delivery and collection in China

In China, the survey targeted a similar group as in the UK. However, due to the fact that the definition of SMEs in China was quite vague (Zhang, 2003), and difficult to follow, the UK definition of SMEs was applied, in order to obtain comparable data. As a result, the total population of Chinese fresh produce SMEs was not clear and

the postal addresses for them were not available.

The postal questionnaire was initially delivered by convenience sampling. The online questionnaire was promoted in association with the China Supply Chain Council (www.supplychain.cn). However, the results of the two methods were not satisfactory. Liang *et al.* (2007) indicate that collecting data for research purposes from Chinese companies is extremely difficult unless it is done through personal liaisons. To overcome potential problems arising from postal systems and the lack of reliable archival data, instead of using the "mail survey" approach, a number of researchers (e.g. Li and Atuahene-Gima, 2001; Zhang *et al.*, 2008; Zhu *et al.*, 2006a; Zhu *et al.*, 2006b) used data collection services provided by professional research companies. These data collection services use Computer Assisted Telephone Interviews (CATI) – a type of telephone interview in which an interviewer reads questions from a computer screen and enters the respondent's answers directly into the computer (Saunders *et al.*, 2007). Findings using the data collected by the service company have been published in top journals such as: MIS Quarterly, European Journal of Information Systems, Information Systems Journal and Academy of Management Journal (Li and Atuahene-Gima, 2001; Zhang *et al.*, 2008; Zhu *et al.*, 2006a; Zhu *et al.*, 2006b).

Enlightened by this approach, the researcher contacted IPSOS, a French-owned survey-based research company, to collect data in five representative cities in China, including Beijing, Shanghai, Guangzhou, Chengdu, and Wuhan. As a well-known market research company, IPSOS is very reliable, as they could guarantee the quality of data. From the data provided by IPSOS, 2,995 companies

in total were randomly contacted. The contacts were initially made with Managing Directors by phone. If they believed that they were not the most knowledgeable on the company's application of the Internet along the supply chain, they were asked to forward the request to an appropriate individual.

Every effort was made to reach a diverse but valid sample group. Out of 2,995 SMEs, 150 valid responses were obtained, which gave a 5% overall response rate. The original recordings were requested from the service, to examine the quality of the interview. For any interviews that were not satisfactory, the researcher asked IPSOS to re-collect data according to the sampling requirement. All the recordings are transcribed and translated by the researcher. The transcripts provide tremendous information about the reality and opinions of agribusiness managers in China. It would be fair to say that the survey results are representative, because they included the attitudes and approaches of various SMEs in the Chinese fresh produce supply chain.

However, there are limitations arising from different data collection methods used in the quantitative study. The data is collected mainly by postal questionnaires in the UK, whereas CATI is used in China. There are two shortcomings. On the one hand, as questions are read to respondents in CATI, some longer statements in the questionnaire may not be heard in full, such as the questions describing the development levels of Internet-based supply chains. On the other hand, it is very easy for respondents to provide missing values for the postal questionnaire, but not for CATI. These two shortcomings may influence the results of some questions. High percentages of missing values are found in the questions

regarding the development levels of Internet-based supply chains.

4.3 Data analysis

As the research begins with the qualitative method, followed by the quantitative method, the analysis of data would require both qualitative and quantitative data analysis.

4.3.1 Qualitative data analysis

This research would apply the content analysis method to analyse the semi-structured interviews and the comments provided during the questionnaire survey. Content analysis represents a formal approach to summarise any form of content by counting different aspects of the content (Hussey and Hussey, 1997). Silverman (1993) suggests drawing up simplified key parts of the text based on analysis and theoretical understanding of the substance of the text. There are two parts of qualitative data in this research: from exploratory interviews, and from the comments and open questions during the questionnaire survey. They would be used again to explain and validate the quantitative results (Bryman, 2004).

4.3.2 Quantitative data analysis

Many statistics tests are based on the assumption of parametric data, which is a normal distributed population (Hair *et al.*, 1998). It is important to test whether the data are parametric before conducting any statistics. Following Field's (2000) examination of parametric data, tests of normality for both dependent variables and independent variables are conducted using SPSS. Table 4.5 demonstrates the results of the normality test by Kolmogorov-Smirnov (a) (K-S) and the Shapiro-Wilk (S-W) test.

Table 4.5 Test of normality for dependent variables and independent variables

Dependent variable	Country	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Current development level	UK	.276	86	.000	.742	86	.000
	China	.389	138	.000	.667	138	.000
Development level in five years	UK	.222	66	.000	.893	66	.000
	China	.173	126	.000	.899	126	.000
Independent variable	country	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
H1a: Number of Internet applications	UK	.175	93	.000	.930	93	.000
	China	.150	151	.000	.929	151	.000
H1b: Number of website functions	UK	.257	93	.000	.866	93	.000
	China	.256	151	.000	.849	151	.000
H1c: Number of software packages	UK	.195	93	.000	.914	93	.000
	China	.215	151	.000	.804	151	.000
H2a: Managers' IT skills	UK	.294	93	.000	.845	93	.000
	China	.301	151	.000	.833	151	.000
H2b: Employees' IT skills	UK	.210	88	.000	.861	88	.000
	China	.164	144	.000	.890	144	.000
H3: Company size	UK	.269	93	.000	.780	93	.000
	China	.373	151	.000	.694	151	.000
H4: Financial resources	UK	.246	86	.000	.732	86	.000
	China	.184	150	.000	.510	150	.000
H5: Business geographic scope	UK	.199	93	.000	.849	93	.000
	China	.232	151	.000	.853	151	.000
H6: Alignment of supply chain strategy with corporate strategies	UK	.176	93	.000	.935	93	.000
	China	.164	148	.000	.921	148	.000
H7: Business operational complexity	UK	.164	93	.000	.934	93	.000
	China	.100	150	.001	.963	150	.000
H8a: Managers' knowledge of supply chain management	UK	.292	93	.000	.860	93	.000
	China	.181	150	.000	.910	150	.000
H8b: Employees' knowledge of supply chain management	UK	.187	88	.000	.898	88	.000
	China	.180	146	.000	.887	146	.000
H9: Mutual trust	UK	.251	90	.000	.816	90	.000
	China	.242	148	.000	.826	148	.000
H10a: Pressure from customers	UK	.198	93	.000	.821	93	.000
	China	.224	151	.000	.833	151	.000
H10b: Pressure from suppliers	UK	.469	93	.000	.511	93	.000
	China	.446	151	.000	.569	151	.000
H11a: Government provided incentives	UK	.253	87	.000	.847	87	.000
	China	.151	151	.000	.908	151	.000
H11b: Bank requirement for online transactions	UK	.167	88	.000	.914	88	.000
	China	.148	151	.000	.917	151	.000

a Lilliefors Significance Correction

From the results in Table 4.7, all results demonstrate significance ($p<.000$), which indicates a deviation from normality (Field, 2000). Both the K-S and S-W tests are

highly significant, indicating that both distributions are not normal, so parametric tests are not applicable in this research. Consequently, statistics methods need to choose from non-parametric statistics.

Non-parametric tests are known as assumption-free tests because they make no assumptions about the type of data on which they can be used (Field, 2000). Based on the nature of data, Spearman's Rank Order Correlation (rho) is applied for correlation analysis, and the Mann-Whitney test is applied to comparative study.

Spearman's Rank Order Correlation (rho) is an alternative non-parametric method in examining correlations between variables. Spearman's test works by first ranking the data, and then applying Pearson's equation to those ranks (Field, 2000). It applies to analysing the association between ordinal variables (Conover, 1980). Several researchers have applied this method in researching correlations, such as between the perception of suppliers' and manufacturers' strategies (Svensson, 2003), between supply chain relationships and the stages of the procurement process (Graham and Hardaker, 1998), and between the supply chain stage and quality perception (Korneliussen and Gronhaug, 2003). In this research, the dependent variables are mostly based on five development levels, and the independent variables are based on five Likert scales in the questionnaire.

The Mann-Whitney test is used for testing difference between means when there are two conditions and different subjects have been used in each condition. This test is the non-parametric alternative to the t-test of independent samples. Instead of comparing means of the two groups, as in the case of the t-test, the Mann-Whitney U Test actually compares medians. It converts the scores on the continuous variable

to ranks, across the two groups. It then evaluates whether the ranks for the two groups differ significantly (Pallant, 2005). This method has been used in marketing research (Hui, 2006; Ngai *et al.*, 2007). In this research, the Mann-Whitney U test is used for the comparison between the survey results in the UK and China.

4.3.3 Triangulation

Triangulation refers to the use of more than one approach to the investigation of a research question in order to enhance confidence in the ensuing findings (Bryman, 2004). Ramsey *et al.* (2003) employed both the inductive and deductive approach to investigate e-business awareness, attitudes and activities among the SMEs in the Irish service sector. Jaw and Chen (2006) undertake the same triangulation approach in their studies about SMEs' usage of the Internet. Therefore, by adopting both the inductive and deductive approach, the results of the research would be more reliable and convincing, and could provide deeper insights into SMEs' post-adoption of Internet-based supply chains in the UK and China.

Triangulation of the results, using a literature review, qualitative data from interviews and CATI explanations, and questionnaire surveys, is used for the discussion in Chapter 5 and 6 and for drawing conclusions in Chapter 7. For example, to better understand and explain the survey findings, qualitative data collected from case study interviews and the explanations provided by CATI were particularly helpful in understanding the results in China, where fewer empirical studies have been conducted in this research context.

4.4 Chapter summary

This chapter discusses the research design and methodology of the research. It

follows Saunders (2007)'s research onion to identify appropriate research methods and data collection methods. After exploratory interviews, a questionnaire survey was adopted by this research. The data collection methods are described, and statistics methods are chosen according to the nature of data.

Chapter 5 Results and Data Analysis

In this chapter, the results of the data analysis will be discussed. An interpretation of the findings will be derived from a synthesis of previous research with the quantitative and qualitative data that obtained from this study. The results and data analysis are presented in three parts: 5.1 The results of exploratory interviews, 5.2 The survey results in the UK and 5.3 The survey results in China. Each part will start with a respondent profile, followed by descriptive data analysis and hypothesis tests. Summaries for each country will be provided at the end of each part.

5.1 The results of exploratory interviews

Following the factors identified from the literature review, the purpose of the exploratory interview is to identify important issues to be included in the questionnaire, such as the general situation of SMEs' supply chain management, motivations and barriers of using the Internet in their supply chains, and benefits that the Internet brought to the whole supply chain. Five SMEs in the UK and three SMEs in China were contacted for the exploratory interview.

5.1.1 Respondent profile

Table 5.1 and 5.2 summarise the characteristics of the interview companies in the UK and China, respectively.

Table 5.1 Description of the companies during exploratory interviews in the UK

Company	UK1	UK2	UK3	UK4	UK5
Role in Supply Chain	Wholesaler	Food Processor	Food Processor/Retailer	Wholesaler	Grower/ food Processor
Interviewee's Position	Marketing Director	Managing Director	IT Director	Managing Director	Logistics/supply chain director
Customers	Major UK retailers	Schools, NHS	Local customers	Major UK discounters	Major UK retailers
Internet Used	Website, Intranet, Extranet	Website, Intranet	Website, Intranet,	Intranet	Website, Intranet, Extranet
Software Used	Barcode, EDI	Barcode	EDI, ERP, Barcode	ERP	ERP, EDI, CRM

The UK respondents played different roles in the fresh produce supply chain, including grower, wholesaler, food processor and retailer. Managing directors were invited for the interviews. For some companies, Marketing/IT/Logistics Directors were referred for the researcher to gain better insights from the companies. Those companies also owned various Internet technologies, such as Intranet and Extranet, EDI, ERP and CRM, which would be representative for the industry.

Table 5.2 Description of the companies during exploratory interviews in China

Company	CN1	CN2	CN3
Role in Supply Chain	Wholesaler and Retailer retailer		Grower, manufacture, and wholesaler
Interviewee's Position	Managing Director	Store Manager	Sale Manager
Customers	Major local retailers, local customers	Local customers	International wholesalers, local retailers
Internet Used	Website	EDI, Barcode	Website, Intranet, online communication tool, e-marketplace

In China, companies play the roles of grower, manufacture, wholesaler, and retailer in the supply chain. For company (CN1 and CN3), they play multi-roles in the supply chains. Companies' chief managers such as Store Manager, Managing

Director and Sale Manger were invited for the interview. Though not many technologies were used in the supply chain, managers demonstrated reasonable understandings about Internet technologies, especially web technologies.

5.1.2 Results of the exploratory interviews

The results are categorised in to three contexts, the technological, organisational, and environmental contexts. Summary of the findings are highlighted in Table 5.3.

Table 5.3 Summary of exploratory stage results

	Technological context	**Organisational context**	**Environmental context**
UK1	Perceived benefits × Employees' IT skill ✓ Number of software ✓	Operational complexity ✓ Business scope ✓	Pressure from customer ✓ Government influence ✓ Mutual trust ✓
UK2	Employees' IT skill ✓ Managers' IT skill ✓ Perceived benefits ✓	Operational complexity ✓ Knowledge about SCM ✓ Cost ✓	Bank requirement ✓ Pressure from customer ✓ Mutual trust ✓
UK3	Perceived benefits × Employees' IT skill ✓ Managers' IT skill ✓	Operational complexity ✓ Company size ✓ Knowledge about SCM ✓	Pressure from customer × Bank requirement ✓ Government influence ×
UK4	Employees' IT skill ✓ Perceived benefits ×	Business scope ✓ Strategy alignment ✓	Pressure from customer ✓ Government influence ×
UK5	Perceived benefits × Employees' IT skill ✓ Managers' IT skill ✓	Operational complexity✓ Knowledge about SCM ✓ Cost ×	Pressure from customer ✓ Bank requirement ✓ Mutual trust ✓
	Technological context	**Organisational context**	**Environmental context**
CN1	Employees' IT skill ✓ Perceived benefits ×	Cost × Company size ✓ Operational complexity ✓	Government influence ✓ Bank requirement ✓
CN2	Employees' IT skill ✓ Number of software packages ✓	Strategy alignment ✓ Operational complexity ✓ Knowledge about SCM ✓	Government influence ×
CN3	Perceived benefits × Managers' IT skill ✓	Cost × Knowledge about SCM ✓	Mutual trust ✓

In the technological context, most companies from the UK and China reflect that perceived benefits are not important when they using the Internet in supply chain. Only UK2 feels very excited about perceived benefits, because they are in the

process of launching new supply chain systems. Though not many technologies have been applied by Chinese managers, they reflect less interest in perceived benefits of Internet technologies. IT skills are confirmed by most of the case companies. This evidence supports the view in the literature that organisations that have high levels of information technology are more likely to adopt the Internet (Thong, 1999). Managers and employees are all confident with their IT skills and supply chain knowledge. This evidence is also identified by other literature that suggests that an adopting organisation will have skilled managers and staff (Gibbs and Kraemer, 2004, Buonanno *et al.*, 2005).

In the organisational context, all SMEs reflect that operational complexity is the cause which leads them to start to use and continuously use the Internet in their supply chains. Knowledge about supply chains is also confirmed by both SMEs in the UK and China. Strategies alignment is identified in one Chinese SME and one British SME. Unlike the British SME, one of the Chinese SME show lack of strategy alignment with overall company strategy, so they finally abandoned further usage of the Internet. Surprisingly, only one pilot company claims that cost is critical. However, since that company (UK2) is under planning of launching new system, and has not really utilised any system yet.

In the environmental context, the companies provided strong evidence about the impact of environmental factors. All companies confirm that they have suffered the pressure from partners regarding Internet usage, where the pressure from customers is much higher than that from suppliers. Companies trust their key partners, and this trust also enables them to confidently use the Internet with their key partners

(Dholakia and Kshetri, 2004, Russell and Hoag, 2004). All Chinese companies feel that government have strong influence in Internet usage. In addition, three UK companies and one Chinese company indicate that pressure from and services provided by the bank is a significant positive factor affecting their levels of the Internet usage. This factor is not well recognised by the literature. Hence, this factor is considered for hypothesis testing, that:

H11b: Companies with a higher level of bank requirement for online transaction are positively associated with the development level of Internet-based supply chain.

5.1.3 The revised framework

As exploratory interviews reveal the importance to bank requirement of online transaction, H11b were added into the environmental context. The revised framework is presented in Figure 5.1.

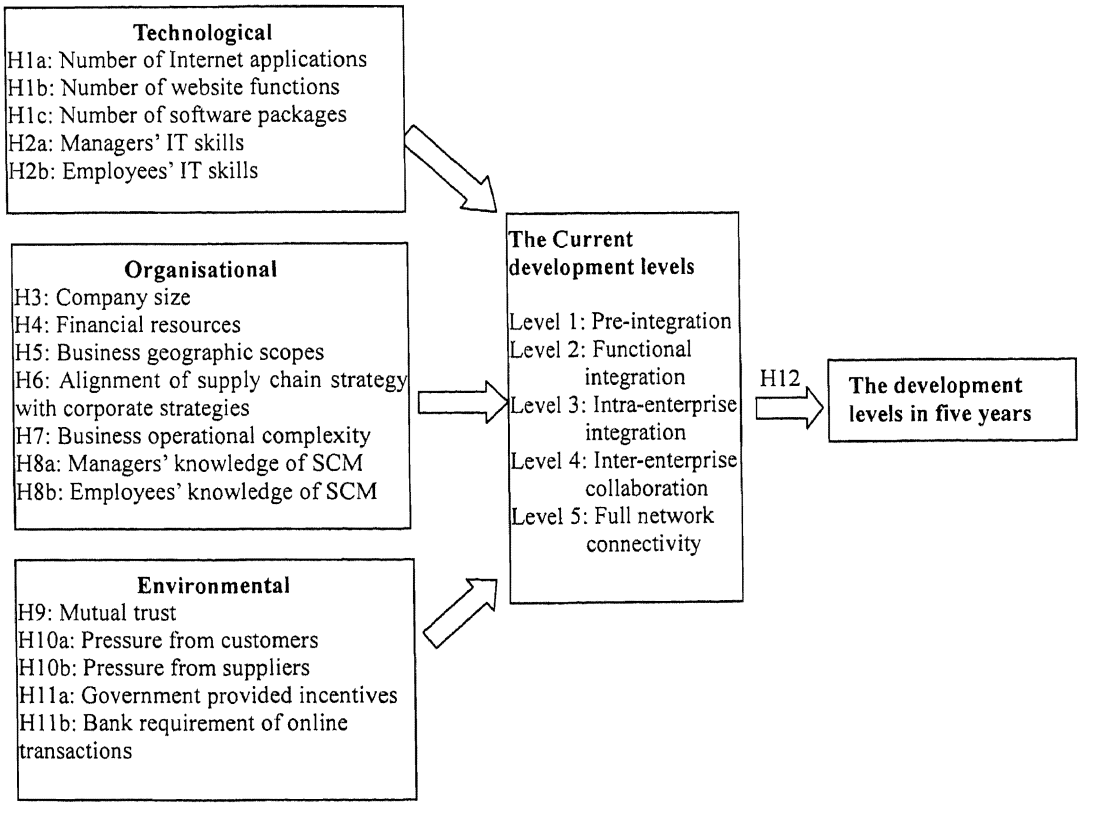

Figure 5.1 The revised framework

5.2 The survey results in the UK

Of 1044 companies, 91 valid responses were obtained, and the overall response rate was 9%. The data were entered to SPSS, and analysed by using Spearman's rho. The survey results in the UK are presented in three sections: 5.2.1 Respondent profile, 5.2.2 Situation of Internet usage in the fresh produce supply chain, and 5.2.3 Hypotheses tests.

5.2.1 Respondent profile

The responses covered almost all players in the UK fresh produce industry. Table 5.4 shows that there were more replies from growers/farmers and wholesalers, and less replies from retailers and transporters.

Table 5.4 Role of respondents in the supply chain

Role in supply chain	Frequency	Percentage	Role in supply chain	Frequency	Percentage
Grower/farmer	39	42%	Importer/exporter	27	29%
Wholesaler	37	40%	Retailer	11	12%
Food processor/manufacturer	36	39%	Transporter	10	11%

65% of the respondents are from company owners, CEOs, or managing directors, whereas 29% are completed by logistics/supply chain/operation directors, IT managers or others. In terms of company size, 42% of the respondents work for small companies (10-49 employees), the rest (58%) come from medium size companies (50-250 employees). The geographic business scope of respondents reflects a distributed coverage of the responses. 32% of the SMEs operate local and regional business, 29% operate their business nationwide, and the rest of them manage international business, with 22% of them in EU and 17% around the world.

5.2.2 Situation of Internet usage in the UK fresh produce supply chain

The situation of Internet usage in the UK fresh produce supply chain is investigated in three aspects: the use of the Internet and websites, the use of related software, and the development levels of Internet-based supply chain.

Use of the Internet

The use of the Internet and websites are shown in the Table 5.5. The survey results show that most of the SMEs have access to the Internet, and e-mail is the most widely accepted technology for SMEs (99% in use). 80% of surveyed companies own a company website, and 46% of them use Intranet. 43% of surveyed companies use online communication tools. Only 4 companies (4%) have no Internet access. Extranet is used less frequently, by only 18% of the SMEs.

Table 5.5 Use of the Internet

Internet Applications			Website functions		
N=90	Frequency	Percentage	N=73	Frequency	Percentage
E-mail system	89	99%	Company information	70	96%
Company website	73	80%	Products information	58	79%
Intranet	41	46%	Online ordering	13	18%
Online tools	39	43%	Online payment	6	8%
Extranet	16	18%	Customer account management	3	4%
No Internet	4	4%	Supplier account management	2	3%

As indicated in Table 5.5, 80% of the companies own a company website. A further enquiry about the website functions reveals that most of the websites are static, i.e. 96% provides company information and 79% provides product information. Only 13 companies (18%) enable online ordering, and 6 companies (8%) operate online payment. Customer account management and supplier account management are less frequently used.

Use of software

Table 5.6 shows the use of supply chain software packages in the UK fresh produce industry. Of the software packages currently used, barcode systems (59%) and electronic data interchange (EDI) (55%) are the most popular, whereas transportation management system (TMS) (10%) and geo-code track system (GTS) (8%) are less favoured by fresh produce companies.

Table 5.6 Use of software

	Barcode systems	EDI	ERP	RFID	AQC	WMS	CRM	TMS	GTS
NO. of respondents	87	89	87	82	86	85	85	83	83
Currently using	59%	55%	37%	20%	17%	18%	15%	10%	8%
Plan to use in 2 years	6%	11%	10%	12%	11%	11%	12%	6%	7%
Plan to use over 2 years	5%	3%	7%	6%	9%	6%	9%	2%	10%
No plan to use	9%	12%	23%	32%	42%	41%	44%	48%	45%
No need to use	21%	15%	17%	26%	14%	19%	15%	28%	28%
Do not know	1%	3%	6%	4%	7%	6%	5%	6%	2%

Looking into the future, apart from EDI, barcode system and enterprise resource planning system (ERP), the rest of the supply chain software packages seem to be less frequently used by SMEs, as more than half of the SMEs indicated "no need" or "no plan" to use them in the future. Particularly, companies have little intention to use TMS, as 48% of them have "no plan" to use the system, 28% of them feel "no need" to use it. A plausible reason might be that SMEs outsource transportation services to a third party, as only 10 companies (11%) of those surveyed have a transportation role in the supply chain.

The development level of Internet-based supply chains

According to the definition in Chapter 3, the development level of Internet-based supply chain can be categorised into five levels. The results show in Table 5.7 that

of 84 respondents, almost half of SMEs surveyed, are positioned in Level 1, pre-integration, to operate the supply chain manually. The outcome means that most companies used the basic functions of the Internet with limited integration. The results also indicate that about half of the SMEs manually operated their supply chain without the assistance of software packages for individual supply chain functions.

Table 5.7 The development levels of Internet-based supply chain

	Current (n=86)		In five years (n=66)	
	Frequency	Percent	Frequency	Percent
Level 1: Pre-integration	41	48%	7	11%
Level 2: Functional integration	36	42%	22	33%
Level 3: Intra-enterprise integration	6	7%	11	17%
Level 4: Inter-enterprise collaboration	2	2%	20	30%
Level 5 Full network connectivity	1	1%	6	9%
Total	86	100%	66	100%

Another 43% of the SMEs are in Level 2, to use software packages to assist in the operation. Only a few SMEs are positioned in Level 3 and Level 4, and only one company is in Level 5 (full network connectivity). This situation may be caused by limited Intranet and Extranet adoption by SMEs and limited online functions of the company website (as seen in Table 5.5). Some companies indicated that although they had Intranet, they hadn't used it to manage the supply chain. For example, the Intranet was used for providing internal information by the human resource department (from UK 2).

Nevertheless, the results suggest that SMEs have high expectations of their supply chain development in five years. Over half of the responding companies believed that they will use the Internet for internal and external integration, moving to Level 3 or above; despite some companies predicting that they would remain at

their current levels. The response rate to this question is relatively low. Only around two thirds of the respondents provide answer, which may suggest that some SMEs are not sure about their future Internet development directions.

5.2.3 Hypothesis tests

The purpose of hypothesis tests are to identify if the factors in the three contexts are correlated with the development levels of Internet-based supply chains. All the hypotheses are tested by using Spearman's rho, a nonparametric correlation method (Pallant, 2005). The results are presented in two parts, in terms of dependent variables, factors influencing the current development levels, and factors influencing the expected development levels in five years. The results of hypothesis tests regarding the factors influencing the current development levels are presented in Table 5.8.

Table 5.8 Results of factors influencing the current development levels in the UK

	Spearman's rho (n=86)	Current level
Factors in the technological context	H1a: Number of Internet applications	.223(*)
	H1b: Number of website functions	.168
	H1c: Number of software packages	.568(**)
	H2a: Managers' IT skills	.324(**)
	H2b: Employees' IT skills	.345(**)
Factors in the organisational context	H3: Company size	.436(**)
	H4: Financial resources	.131
	H5: Business geographic scope	.276(*)
	H6: Alignment of supply chain strategy with corporate strategies	.364(**)
	H7: Business operational complexity	.395(**)
	H8a: Managers' knowledge of supply chain management	.380(**)
	H8b: Employees' knowledge of supply chain management	.314(**)
Factors in the environmental context	H9: Mutual trust	-.033
	H10a: Pressure from customers	.289(**)
	H10b: Pressure from suppliers	-.010
	H11a: Government incentives	-.143
	H11b: Bank requirement of online transactions	.148
H12 Current levels' influence on the levels in five years		.581(**)

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Factors in the technological context

As shown in Table 5.8, four out of the five tested hypotheses in the technological context show significance at the current development levels. The Number of Internet functions (H1a), Number of software (H1c), Managers' IT skills (H2a), and Employees' IT skills (H2b) are found to be significant factors influencing the current development levels. However, the Number of website functions (H1b) is not a significant factor leading UK SMEs to engage in a high development level of Internet-based supply chain at present. Descriptive data show that 80% of surveyed SMEs in the UK have already equipped with websites. The functions are mainly related to marketing functions such as company information (96%) and products information (79%), but less related to supply chain functions, such as online ordering (18%), online payment (8%), customer account management (4%), supplier account management (3%). One possible reason could be that companies may not integrate the website with the back-office systems supporting supply chain functions. For example, UK1 and UK4 from exploratory interview addressed that they did have Extranet or Intranet to align well with their clients, but they only have very simple website for marketing. They explained the reason that their customers are large retailers or discounters, who are very well equipped with supply chain systems. As small suppliers, they can login to their clients' systems to manage their stock level, or they can also link their database with clients' to update the stock level.

Factors in the organisational context

The results in Table 5.8 show that most factors in the organisational context are

significant at the current development levels. Number of employees (H3), Business geographic scope (H5), Supply chain strategy alignment (H6), Operational complexity (H7), Managers' knowledge (H8a) and Employees' knowledge (H8b) are significant factors affecting the current development of Internet-based supply chain. However, Financial resources (H4) is not significant. This result may be contradict with many studies about SMEs, which believe that SMEs are limited in financial resource during Internet technology adoption and diffusion (Stockdale and Standing, 2006, Archer *et al.*, 2008), Probably the decreasing cost of hardware and software has reduced the impact of this variable, as the Internet has been used prevalently by the UK SMEs (99% of surveyed SMEs managers owns email). Furthermore, hosted service provider is also accessible for SMEs in the reasonable price (Lockett *et al.*, 2006). However, it should be noted that SMEs still face many hidden costs, such as the cost for continuous training, as well as the cost for the diffusion and integration of other supply chain systems.

Factors in the environmental context

Of the five factors in the environmental context, only Power of customers (H10a) is the significant factor influencing the current development levels, and Mutual trust (H9), Pressure of suppliers (H10b), Government incentives (H11a) and Bank requirement of online transactions (H11b) are not significant factors.

Mutual trust does not show a significant correlation with the current development levels. The trust in the fresh produce industry is very high (mean=3.97, 1=extremely weak, and 5=extremely strong). Several companies in the

exploratory interview addressed that in the fresh produce supply chain mutual trust is the foundation of doing business. Manager from UK 4 summarised three characteristics of fresh produce: perishable, in declining value, and not homogeneous product, which require quick response in the supply chains, but with no return of the product. As the result, they tend to trade more with friends, or people they knew. However, mutual trust becomes very weak when facing sensitive information such as price and stock volume. For example, though doing business with his friends, manager from UK 4 expressed his concern of revealing sensitive information such as the inventory level. "*I will not allow my customers to know how much inventory I have. Remember, my customers are my enemy! If they know I am having 100 boxes of apples, they would not buy from me. Because they know, the price would go down eventually. What they want is the low price. If I say 'I only have 1 or 2 boxes, if you don't buy them, they are gone', then they will probably buy from me, and will not bargain too much on the price.*" Similarly, for UK2, who has joint NHS e-purchasing programme, the manager expressed his concern about how his customers would use the sensitive information like prices in the database, which would have potential harm to his business. Consequently, information can not be effectively transferred through Internet technologies, so the usage of the Internet is limited to simple applications, such as emails, between trade partners.

Pressure of supplier is not supported by hypothesis test. For example, some surveyed company comments: *"Our suppliers are farmers and while we have data gathering system, some of them barely use Focuses!"* It seems that suppliers in fresh produce industries are probably a laggard force for the Internet usage and

integration in supply chain.

Government incentives are not a significant factor of the development levels. This result confirms previous research (Xu *et al.*, 2004, Zhu and Kraemer, 2005, Hsu *et al.*, 2006) that, in developed countries, government does not have a strong impact on business when implementing Internet technologies. Bank requirement for transactions shows no significant correlation at the current development levels, though several companies during the exploratory interviews indicated the main reason they used Internet technologies is due to bank requirement.

SMEs intention of the development levels in five years

SMEs' current development levels of Internet-based supply chain are positively related to their expected development levels in five years. These results demonstrate that based on the current development levels of Internet-based supply chain, Chinese SMEs are more likely to progress to higher development levels of Internet-based supply chain.

5.2.4 Summary of the results in the UK

The UK results demonstrate a prevalent usage of the Internet and websites. SMEs are mostly positioned in the first and second development levels of Internet-based supply chains. Several factors influence a company's current development levels of Internet-based supply chains in terms of the technological, organisational, and environmental contexts (see Table 5.9).

In the technological context, the number of Internet functions, the number of software package, and managers and employees' IT skills have a significant

impact on the current development levels. In the organisational context, company size, business geographic scope, supply chain strategy, operational complexity, and managers and employees' knowledge are significant factors influencing the current development levels. In the environmental context, only the power of customers demonstrates a significant impact about the current development level of Internet-based supply chain.

Table 5.9 Summary of the UK results

Hypotheses of the development levels of Internet-based supply chain		Results
Factors in the technological context	H1a: Number of Internet applications	√
	H1b: Number of website functions	×
	H1c: Number of software packages	√
	H2a: Managers' IT skills	√
	H2b: Employees' IT skills	√
Factors in the organisational context	H3: Company size	√
	H4: Financial resources	×
	H5: Business geographic scopes	√
	H6: Alignment of supply chain strategy with corporate strategies	√
	H7: Business operational complexity	√
	H8a: Managers' knowledge of supply chain management	√
	H8b: Employees' knowledge of supply chain management	√
Factors in the environmental context	H9: Mutual trust	×
	H10a: Pressure from customers	√
	H10b: Pressure from suppliers	×
	H11a: Government incentives	×
	H11b: Bank requirement of online transactions	×
H12 Current levels' influence on the levels in five years		√

The results indicate that most factors from the technological and organisational contexts have a significant correlation with the current development levels of the Internet-based supply chain. However, most factors in the environmental context show no significant correlation. Contrary to the hypotheses, no support is found for financial resource, trust between trade partners, pressure from suppliers, and government provided incentives with the current development levels of

Internet-based supply chain. Trust between trade partners is not related to the extent of Internet usage in supply chain. However, given the fact that the trust among fresh produce industry is suggested to be high (mean=3.97, 1=extremely weak, and 5=extremely strong), the results may suggest that SMEs in this sector tend to trust each other during business transactions, but this trust has no relation to the development levels of the Internet usage. Pressure from suppliers is also not related to the Internet usage in supply chain. In contrast, suppliers are sometimes blamed to be a laggard force in using the Internet. Finally, government incentive is believed to be low (mean=1.72, 1=not a motivator, and 5=a significant motivator), and have no impact at all.

Finally, the current development levels of Internet-based supply chain shows positive relationships with the expected development levels in five years.

5.3 The survey results in China

Of 2995 companies, 151 valid responses were obtained, and the overall response rate was 5%. The data were entered to SPSS and analysed by using Spearman's rho. The survey results in China are presented in three sections: 5.3.1 Respondent profile, 5.3.2 Situation of Internet usage in the fresh produce supply chain, and 5.3.3 Hypothesis tests.

5.3.1 Respondent profile

Table 5.10 shows that there are more replies from growers/farmers, wholesalers and retailers, and less replies from importers/exporters and transporters.

Table 5.10 Role of respondents in the supply chain

Role in Supply Chain	Frequency	Percentage	Role in Supply Chain	Frequency	Percentage
Grower/farmer	83	55%	Importer/exporter	35	23%
Wholesaler	103	68%	Retailer	78	52%
Food processor/manufacturer	41	27%	Transporter	35	23%

The questionnaires were sent to the company owners and managing directors. Nearly two thirds of the respondents are company owners, CEOs, or managing directors, whereas 16% are completed by logistics/supply chain/operation directors and 18% were answered by IT managers or others, etc. From all the surveyed companies, only 15% of them have an international business, most of them mainly trade within China.

5.3.2 Situation of Internet usage in Chinese fresh produce supply chains

Similar to the counterparts in the UK analysis, this section presents the use of the Internet and website, the use of related software, and the development levels of Internet-based supply chain.

Use of the Internet

As shown in Table 5.11, only 7% of the companies have no Internet applications, whereas e-mail systems and online communication tools are very common among the surveyed SMEs. The usage of Intranet and Extranet is limited compared with other usages.

More than half of the companies have company websites, and most of the websites contain company information and product information. Over half of the respondents' companies provide online ordering functions. Some of them also

Table 5.11 Use of the Internet

Internet Applications			Website functions		
N=151	Frequency	Percentage	N=89	Frequency	Percentage
E-mail system	126	83%	Company information	86	97%
Company website	117	77%	Products information	85	96%
Intranet	89	59%	Online ordering	47	53%
Online tools	54	36%	Online payment	29	33%
Extranet	45	30%	Customer account management	27	30%
No Internet	11	7%	Supplier account management	25	28%

-manage their online payment and customer and supplier accounts on the Internet. From their own explanations, they usually have an account in the online marketplace such as Alibaba.com, which hosts a homepage for their company. Orders are redirected from their website to the online marketplace to be processed. However, most deals are made after face-to-face meetings or phone calls. They express concerns over the authenticity of online information.

Use of software

Regarding the use of the supply chain management software in Table 5.12, results show that the technologies are becoming accepted by a limited group of SMEs. Of the software packages currently used, Barcode systems (31%) and WMS (warehouse management system) (30%) are the most popular, whereas GTS (geo-code track system) (11%) and RFID (radio frequency identification) (9%) are least popular by fresh produce companies.

Results also show that Chinese agribusiness managers have a limited knowledge of supply chain software packages, for example they argue that *"We are just growing/selling vegetable/ fruits, and those high technologies are not possible to use."* They haven't realised the possible impact that those emerging technologies

could bring, and still believe that agribusiness does not need to be technology driven. For many of them, it was their first time to hear those software names or explanations.

Table 5.12 Use of software

	Barcode systems	EDI	ERP	RFID	AQC	WMS	CRM	TMS	GTS
NO. of respondents	151	151	150	151	150	151	150	149	147
Currently using	30%	29%	25%	20%	18%	12%	11%	9%	7%
Plan to use in 2 years	14%	20%	22%	19%	19%	17%	17%	11%	8%
Plan to use over 2 years	13%	9%	8%	9%	9%	10%	17%	11%	11%
No plan to use	16%	21%	21%	21%	23%	22%	26%	20%	35%
No need to use	23%	16%	17%	19%	19%	35%	17%	40%	22%
Do not know	5%	5%	7%	13%	11%	3%	12%	8%	17%

Looking to the future, companies have little intention to use Radio Frequency IDentification (RFID), as 35% of them have no plan to use the system, 22% of them feel no need to use it. Customer Relationship Management (CRM) is more likely to be used in two years (22%). In the longer term, Enterprise Resource Planning system (ERP) is more likely to be used (17%). It is also quite common to know that many of the respondents felt hard to state their future plan, though they are company managers of SMEs.

The development level of Internet-based supply chains

The results in Table 5.13 clearly show that almost two thirds of SMEs surveyed are positioned in Level 1, pre-integration, to operate the supply chain manually. One fifth of the SMEs are in Level 2, to use software packages to assist the operation. None of them believe that they are in the final stage, full network connectivity. There are 7% of them not providing answers (n=144), and within valid respondents,

4% of them provide "do not know" to this question.

Table 5.13 The development level of Internet-based supply chain

	Current (n=144)		In five years (n=146)	
	Frequency	Valid Percent	Frequency	Valid Percent
Level 1: pre-integration	90	63%	14	10%
Level 2: Functional integration	30	21%	26	18%
Level 3: Intra-enterprise integration	13	9%	38	26%
Level 4: Inter-enterprise collaboration	5	4%	20	14%
Level 5 Full network connectivity	0	0%	28	19%
Do not know	6	4%	20	14%
Total	144	100.0	146	100.0

Regarding the future plan of usage, as illustrated in Table 5.13, 10% of the companies believe they would remain at Level 1, to manually operate the supply chain. Internet technologies are merely used for communication and obtaining information. They have never supposed that they would use any systems or so-called "high-technology" in this traditional industry.

Almost one fifth of them believe that they would reach the fifth level for full network connectivity. However, 14% of the companies do not provide any answers. According to the transcript, most of respondents initially did not know about their expected development levels in five years, so they cannot provide the forecast.

5.3.3 Hypothesis tests

Similar as the hypothesis tests in the UK, nonparametric correlation tests are used to evaluate factors in the technological, organisational, and environmental contexts. Table 5.14 contains Spearman's rho test results in the factors influencing the current development levels in China.

Table 5.14 Results of factors influencing the current development levels in China

	Spearman's rho (n=138)	Current level
Factors in the technological context	H1a: Number of Internet applications	.322(**)
	H1b: Number of website functions	.323(**)
	H1c: Number of software packages	.432(**)
	H2a: Managers' IT skills	.104
	H2b: Employees' IT skills	.316(**)
Factors in the organisational context	H3: Company size	.228(**)
	H4: Financial resources	.142
	H5: Business geographic scope	.004
	H6: Alignment of supply chain strategy with corporate strategies	.294(**)
	H7: Business operational complexity	.440(**)
	H8a: Managers' knowledge of supply chain management	.119
	H8b: Employees' knowledge of supply chain management	.236(**)
Factors in the environmental context	H9: Mutual trust	.170(*)
	H10a: Pressure from customers	-.015
	H10b: Pressure from suppliers	-.029
	H11a: Government incentives	.082
	H11b: Bank requirement of online transactions	.105
H12 Current levels' influence on the levels in five years		.338(**).

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Factors in the technological context

Of the five factors in the technological context, Number of Internet functions (H1a), Number of website functions (H1b), Number of software (H1c) and Employees' IT skills (H2b) are found to be significant factors influencing the current development levels of Internet-based supply chain. Managers' IT skills (H2a) is not a significant factor of the current development levels.

Many literatures have identified the importance of managers' IT skills within SMEs during the adoption and diffusion process (Thong, 1999, Ranganathan *et al.*, 2004). However, the result in China reveals that managers' IT skills are not significant in terms of the diffusion of Internet technologies over the fresh produce supply chain. It can be explained by the very low development levels of

Chinese SMEs' Internet-based supply chain, as two thirds of surveyed SMEs in China are in Level 1, pre-integration level. Chinese SMEs still view the Internet as a tool to search market information and to advertise their products, but not usually considered its complex applications among supply chain functions. In this case, they judge the necessary IT skill as to search and past information, as well as to send email or to use the online communication tools. Some managers address that *"I am highly skilled in using the Internet and computer, because I designed and promoted our company website, and our website received very high volume of visit. For example, we have several Chinese Internet domain name. If you put 'Chinese fruit', 'Golden pear' or 'Fruit young plant', you could easily reach our website directly. Therefore, I know a lot about Internet technologies." (Chengdu 1882).*

Factors in the organisational context

The organisational context contains several factors like company size, financial resource, business geographic scope, supply chain strategy alignment, operational complexity, and company's knowledge about supply chain management. Table 5.16 lists the results of factors in the organisational context. Four of seven factors in the organisational context are supported. Number of employees (H3), Alignment of supply chain strategy with corporate strategies (H6), Business operational complexity (H7), and Employees' knowledge about supply chain management (H8b) are significant factors of the current development levels in China.

Surprisingly, Financial resources (H4) is not a significant factor of the current

development levels, though many studies pointed out that cost would be a significant barriers for SMEs to adopt Internet technologies, and would inhabit their further diffusion (Soliman and Janz, 2004, Archer *et al.*, 2008), as SMEs may not have sufficient financial resource to support the cost like infrastructure, training, and implementation, which is particularly true for developing countries (Zhu and Kraemer, 2005). However, recorded comments collected along with the survey in China revealed two possible reasons which could explain this contradiction. On one hand, positioned in the pre-integration level by a majority of Chinese SMEs, companies do not consider Internet technologies cost very much. The IT spending as percentage of total revenue in 2006 is quite low (mean=1.28, S.D=0.84, whereas 1: 0%-5%, 2: 6%-15%, 3: 16%-25%, 4: 26%-49%, and 5: more than 50%). Some managers comment that *"We did not spend much on Internet technologies, because it is a very cheap advertisement, and could be effective. The costs are only computer, printer for receipts and spreadsheet, which is mainly for communication. (Beijing 18).* On the other hand, the close relationship within the Chinese fresh produce industry may limit the application of Internet technologies, and further deter further investment on Internet technologies. For example, manager from Chengdu 1350 indicated that *"We only have a website, and we did not invest much on the (online) advertisement. We have operated the business for many years, and have very mature relationship with customers. Our major businesses are conducted with the previous customers. Maoyitong (the online communication tool) is only used with the contact with new customers."*

Business geographic scope (H5) is not a significant factor of the current

development levels. In China, online communication tools are very popular (77% in use in Table 5.13). These tools are extensively used during companies' communication with customers, no matter if they are from abroad or local customers. The e-marketplace also shaped the way of international business communication, as it is fairly easy to contact with customers regardless of their locations. However, due to the perishable nature of fresh produce, Chinese managers do not believe that the Internet could free them from site visit for each transaction. *"We do use Maoyitong to communicate with the clients, and send pictures to them. However, when they decide to buy the products, they will send people to visit us and check the products. The fresh produce industry is very special, because fresh produce are not like other products, which are homogenous. Pictures sent through the Internet cannot prove anything. They will definitely need to physically go to the field to check the quality, sometimes even check them from the trees." (CD 1354)* Therefore, larger business scope only enable the fresh produce managers use the Internet for search and basic communication with their clients, but does not significantly encourage them to use more complex Internet technologies.

Contrary to the UK results, Managers' knowledge about supply chain management (H8a) is not a significant factor in China. Managers provided a fairly high score for their knowledge about supply chain management (mean=2.99, S.D=1.07, 1= Not at all, 5=Very knowledgeable, the data has been transformed inversely). However, as a majority of surveyed SMEs in China are still in the pre-integration level, managers may have certain limitation in understanding the concept of supply chain management. For example, *"By using the Internet to*

communicate with our customers, I can easily obtain more market information, like the trade of fruits with foreign countries, as well as the trading characteristics of fruits in different provinces. I would learn from their way of doing export." (Chengdu1350) "My understanding to supply chain management is to know how to sell the products and how to receive the money." (Beijing 18). These comments show that Chinese SMEs focus more about the outbound logistics, but not a holistic view of supply chain. This understanding may somehow restrict managers' view about supply chain development, and would harm the development of Internet-based supply chain in China.

Factors in the environmental context

Three aspects are discussed within the environmental context, including Mutual trust (H9), Pressure from customers (H10a) and suppliers (H10b), and regulatory environment, which consists of Government incentives (H11a) and Bank requirement for online transactions (H11b). The results are provided in Table 5.16, and only Mutual trust (H9) demonstrates a weak significance with the current development levels.

Pressure of customers and suppliers are not significant for Chinese SMEs with the current development levels of Internet-based supply chain. In China, advanced applications of Internet technologies in supply chain management are still limited even among large retailers (Wang and Gu, 2005), so SMEs feel very little pressure of Internet technology adoption from their customers and suppliers. Manager from Beijing 14 indicated that *"what my customers want is the fresh produce that we sell, but not Internet technologies that we use. For example, we are used to*

sending fax with customers. We would feel awkward if they request us to use email. However, we could try our best to meet the requirement of our customers".

Contrary to the literature (Xu *et al.*, 2004, Zhu and Kraemer, 2005), as a developing country, government incentives provided by the Chinese government does not show significance for SMEs' development levels of Internet-based supply chain. The Chinese government does issues several policies to encourage the technologies usage in agriculture (Han, 2006), like supporting the construction of agricultural websites. However, companies frequently cite significant obstacles of using Internet technologies, including inadequate legal protection for online business activities, unclear business laws, and security concerns. The Internet is not perceived as a trustworthy business platform, which is particularly important at the early stages of Internet-based supply chain development in an economy (Zhu and Kraemer, 2005).

Similarly, bank requirements for online transactions are found no significant relationship with the current development levels, as SMEs expressed their concern of the security issues of online transaction. Additionally, SMEs complained the charge incurred during the online transaction, both of which inhabit SMEs' usage of Internet technologies in the supply chain.

SMEs intention of the expected development levels in five years

SMEs' current development levels of Internet-based supply chain are positively related to their expected development levels in five years. These results demonstrate that based on the current development levels of Internet-based supply chain, Chinese SMEs are more likely to progress to higher development levels of

Internet-based supply chain.

5.3.4 Summary of the results in China

The results for China reflect a complex but colourful picture with several dimensions. Although less advanced than the results for the UK, Chinese results demonstrate a fairly high percentage of Internet and websites usage. About a third of SMEs used different software packages, and they expressed a growing trend in short term. One unique feature of Chinese SMEs was the popular usage of online communication tools, which are supported by e-marketplace.

Several factors influence the companies' current development levels of Internet-based supply chain in terms of the technological, organisational, and environmental contexts – this is shown in Table 5.15.

Table 5.15 Summary of China results

Hypotheses of the development levels of Internet-based supply chain		Results
Factors in the technological context	H1a: Number of Internet applications	√
	H1b: Number of website functions	√
	H1c: Number of software packages	√
	H2a: Managers' IT skills	×
	H2b: Employees' IT skills	√
Factors in the organisational context	H3: Company size	√
	H4: Financial resources	×
	H5: Business geographic scopes	×
	H6: Alignment of supply chain strategy with corporate strategies	√
	H7: Business operational complexity	√
	H8a: Managers' knowledge of supply chain management	×
	H8b: Employees' knowledge of supply chain management	√
Factors in the environmental context	H9: Mutual trust	√
	H10a: Pressure from customers	×
	H10b: Pressure from suppliers	×
	H11a: Government incentives	×
	H11b: Bank requirement of online transactions	×
H12 Current levels' influence on the levels in five years		√

In the technological context, IT infrastructure and employees' IT skills have a significant impact on the current development levels. In the organisational context, company size, supply chain strategy, operational complexity, and employees' knowledge are significant factors influencing the current development levels. In the environmental context, only mutual trust demonstrates a significant impact on the current development levels of Internet-based supply chain.

The results indicate that most factors from the technological and organisational contexts have more significant effects than those from the environmental context with respect to the current development levels of the Internet-based supply chain. No support is found for managers' IT skills and knowledge of supply chain management, business geographic scopes, pressures from customers and suppliers, government incentives and bank requirement of online transaction with the current development levels. As around two thirds of Chinese SMEs used simple Internet technologies, with limited integration with supply chain software, managers' IT skills and knowledge are restricted in a very basic level. As frequently cited by many SMEs, Internet technologies are only considered for searching market information and advertising. With less valid information online, business communications are therefore mainly conducted by site visit, face-to-face communication, telephone and fax. The management of supply chain via the Internet and software packages is relatively a new concept for them. Consequently, their business geographic scope can not significantly influence SMEs to move the management of their supply chain online. In the meantime, they have not suffered pressures from customers and suppliers in terms of the usage of Internet technologies. Similarly, government incentives and bank

requirement of online transaction are not significant enough to influence SMEs to progress to a more advanced level of Internet-based supply chain. However, though the current development levels of Internet-based supply chain are still low, they are believed to have positive relationships with the expected development levels in five years.

5.4 Chapter summary

This chapter presents the data analysis in the UK and China. First, the results from exploratory interview were presented, and the research framework was revised based on the exploratory interview results. Second, descriptive data was presented for each country, hypotheses tests were then conducted, and finally summaries were provided. The results for the two countries demonstrate different pictures about the development in Internet-based supply chains. A further comparative study and discussion are presented in the next chapter.

Chapter 6 Discussion of the results

In this chapter, the results from both the UK and China will be discussed and compared. An interpretation of the findings will be derived from a synthesis of previous research with the quantitative and qualitative data obtained in this study.

There are ninety-one responses from the UK and one hundred and fifty-one responses from China. Though the total number of responses from the UK is smaller than those of China, it is hoped that some useful insights can be obtained from the study. The respondents' profile is summarised and depictured in the following section, followed by a comparison and discussion of descriptive data and the hypothesis tests. The Mann-Whitney U test, a nonparametric alternative method to the t-test, is used to test the differences between the two countries.

6.1 Respondents' profile

The questionnaires were delivered to SMEs in the UK and China under the same criteria. Some differences exist between the populations that were sampled. In the UK, the questionnaires were sent to all the SMEs within the fresh produce industry in the FAME database. However, in China, the SMEs were sampled from five representative cities in China: Beijing, Shanghai, Wuhan, Chengdu and Guangzhou.

Table 6.1 provides a comparison of the respondents from the UK and China. There are many more wholesalers and retailers in China than in the UK. Moreover, providing multiple choices, agribusiness managers claim that they simultaneously

operate both wholesale and retail businesses. With many SMEs selling at the end of supply chains, as retailers, the Chinese fresh produce market appears to be more fragmented than the fresh produce market in the UK (Asia Access Limited, 2004).

Table 6.1 Role of respondents in the fresh produce supply chain

Role in Supply Chain	Percentage		Role in Supply Chain	Percentage	
	UK	China		UK	China
Grower/farmer	52%	55%	Importer/exporter	37%	23%
Wholesaler	46%	68%	Retailer	13%	52%
Food processor/manufacturer	40%	27%	Transporter	13%	23%

Most SMEs are located in traditional markets, which continue to be a presence throughout China, although many of the street markets in big cities are being closed or consolidated. With the development of supermarket chains in China, the selling of fresh produce in supermarket chains is becoming accepted by residents. However, street vendors selling fresh vegetables outside of supermarkets are in fact a common sight, and even appear to be encouraged by the supermarkets as a way of generating foot traffic (Bean, 2005).

6.2 Discussion of the development levels of Internet-based supply chains

The differences in the current development levels of Internet-based supply chains are presented in Figure 6.1. As previously mentioned, around half of SMEs from both the UK and China are at Level 1, pre-integration, whereas a higher proportion of SMEs in China belong to Level 1 compared to those in the UK. A higher percentage of SMEs in the UK belong to Level 2, functional integration, compared with SMEs surveyed in China. However, in terms of higher development levels, SMEs from the two countries do not show major differences.

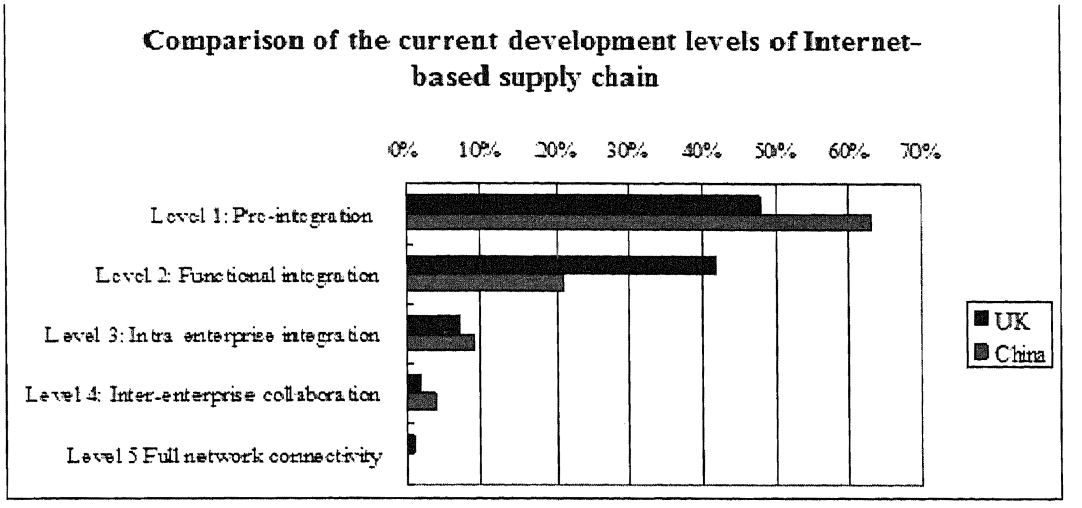

Figure 6.1 Differences in the current development levels of Internet-based supply chains

Figure 6.2 shows the comparison of the expected development levels of Internet-based supply chains in five years. Looking into the future, SMEs in both countries express a strong willingness to move forward. Only one tenth of SMEs indicate that they will remain at Level 1. A majority of them predict that they will reach Level 2 or above. There are more British SMEs to reach Level 2 or 4 than Chinese SMEs. However, nearly 20% of Chinese SMEs aim for Level 5, whereas only half of British SMEs are aiming for Level 5.

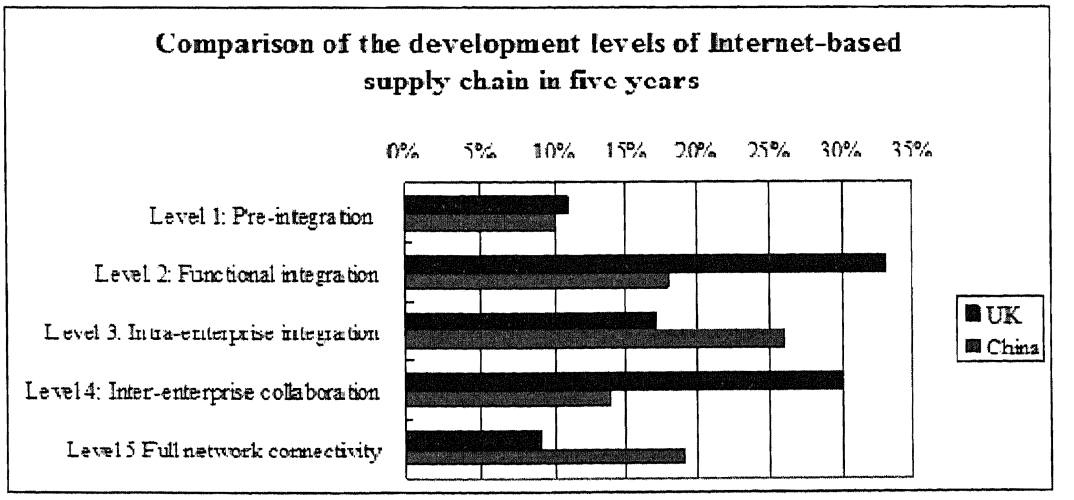

Figure 6.2 Differences in the development levels of Internet-based supply chains in five years

In line with the results mentioned above, the Mann-Whitney U test (Table 6.2) reveals a significant difference between the UK and China in terms of the current development levels (U=5075, z=-2.070, p=.038, r=-.14), but no significant differences between the two countries in terms of the development in five years. It means that although currently SMEs in the two countries are at different development levels of Internet-based supply chains, in five years, there will not be a significant difference between the two countries.

Table 6.2 Differences in the current development levels and in five years

	Country	N	% of missing values	Mean	M-W U	Z	Asymp. Sig.	r
Current	UK	86	7.5%	1.674	5075	-2.070	0.038	-0.14
	China	138	8.6%	1.514				
In five years	UK	66	29%	2.939	3724	-1.216	0.224	-0.09
	China	126	16.5%	3.175				

Compared with the SMEs in the UK, Chinese SMEs seem to be very ambitious. However, conclusions cannot be drawn from this result as more careful investigation is needed. On the one hand, the missing values are noticeable in these questions. In answering questions regarding the current development levels, the percentages of missing values for the UK and China are not that different. However, in terms of the development levels in five years, the percentage of missing values in the UK is almost two times that in China. SMEs may experience difficulties in predicting their development in the future, regardless of whether they are in the UK or China.

The difference within missing values might be caused by the different data collection methods used in the two countries. In the UK, a postal survey was conducted, with self-completion questions. The researcher was not able to make

this question compulsory to answer. In China, however, computer-assisted telephone interviews (CATI) were used. Previous research (Lepkowski *et al.*, 1995) concludes that CATI leads to less missing data because it prevents routing errors. Data collection companies tried everything they could to obtain an answer through conversation. For example, some comments from Chinese respondents, taken from the transcripts, reflect their viewpoints:

- *"It would be too difficult to predict our company's development level in five years. I don't know the trend of technologies and also feel difficult to tell the trend of our industry."(Wuhan 659)*
- *"According to the market development, it is really hard to say. Our company may not exit in five years. The price of fresh produce has fallen almost 20% compared with the price last year. If this situation continues, we will be driven out of the market." (Chengdu 1882)*

6.3 Discussion of independent variables

6.3.1 Factors in the technological context

This section discusses and compares the UK and Chinese SMEs' responses in the technological context, such as usage of the Internet, websites and software packages, as well as managers' and employees' IT skills.

Use of the Internet

Use of Internet applications in China and the UK varies. Figure 6.3 demonstrates the differences in the use of Internet applications. Generally speaking, simple applications, such as e-mail, are predominantly used by SMEs in both countries, but complex applications, such as intranet and extranet, are less used by SMEs in

the two countries. The two countries vary significantly in the usage of online communication tools. Online communication tools seem to be more common in China than in the UK. Online communication tools, like Zhifubao by Taobao.com and Maoyitong by Alibaba.com, are value-added services that online marketplaces provide to customers in China. However, this type of communication tool is not available in UK online trading communities (Griffiths, 2007).

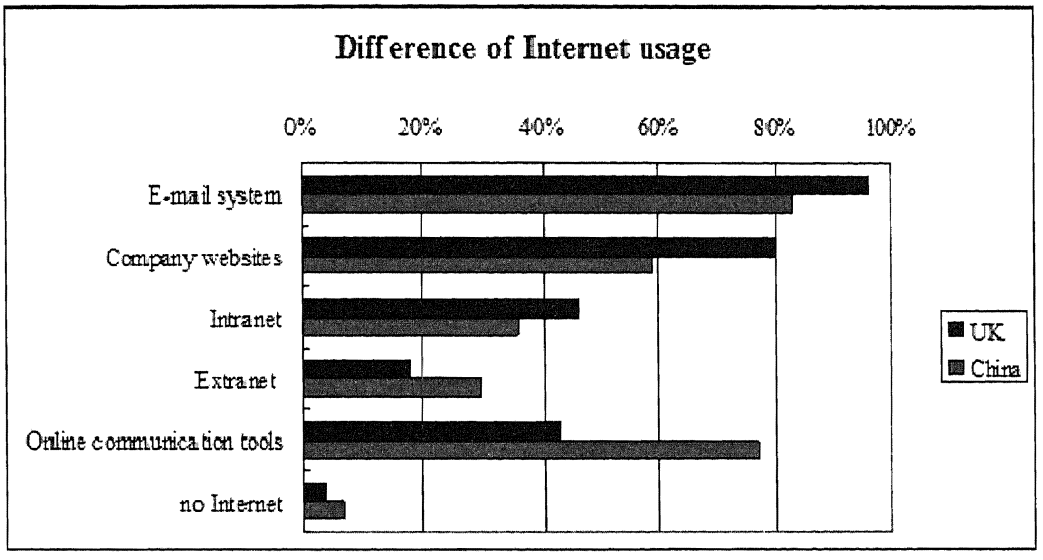

Figure 6.3 Differences in Internet usage

Table 6.3 shows the results of the Mann-Whitney U test of the use of Internet applications. Different pictures show the use of Internet applications in the UK and China. The countries are significantly different in the use of e-mail, company websites, extranet, and online communication tools, and are not significantly different in the use of intranet. The UK companies have higher percentages of using e-mail systems and company websites, but lag behind Chinese companies in terms of using extranet and online communication tools.

Table 6.3 Differences in the use of Internet applications

	Country	%	M-W U	Z	Asymp. Sig.	r
E-mail system	UK	96%	5746	-3.731	0.000	-0.24
	China	83%				
Company websites	UK	80%	5409	-3.402	0.001	-0.22
	China	59%				
Intranet	UK	46%	6130	-1.502	0.133	-0.10
	China	36%				
Extranet	UK	18%	5978	-2.072	0.038	-0.13
	China	30%				
Online communication tools	UK	43%	4475	-5.356	0.000	-0.35
	China	77%				

As mentioned previously, a lower percentage of SMEs in China own company websites, compared with SMEs in the UK. However, if the usage of website functions by those owning a company website is considered, Figure 6.4 shows that a higher percentage of website functions are implemented by Chinese SMEs compared with the percentage of website functions launched by British SMEs.

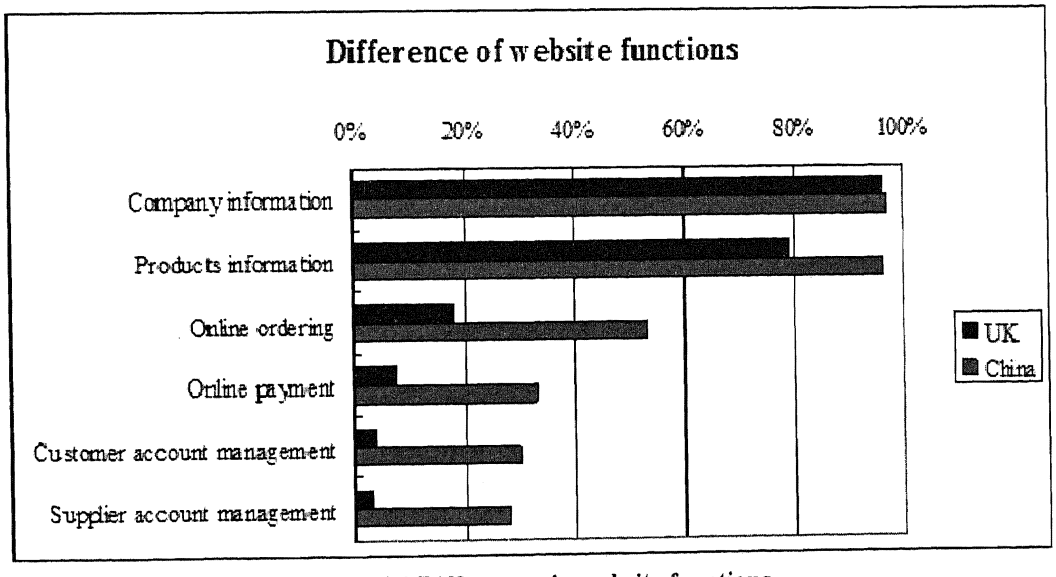

Figure 6.4 Differences in website functions

In particular, Chinese SMEs use more functions of online ordering, online payment and account management. Chinese SME managers explained how they

incorporate their company websites into electronic marketplaces. Many of the company websites are even hosted by online marketplaces, which integrate the functions of online ordering, online payment, and account management.

- *"We use Zhifubao to process online ordering and payment, and all information about us is presented in Alibaba.com."(Shanghai 507)*
- *"All these functions are located in our homepage in Alibaba.com, which hosts our website." (Wuhan 1920)*

Interestingly, the results depict different Internet usage by SMEs in the UK and China. In the UK, the use of the Internet is widespread in SMEs, and popular applications are e-mail systems and websites. However, more complex functions, such as online ordering and online transactions, are fairly limited. On the other hand, despite the less widespread usage of Internet technologies in China, Chinese SMEs actively participate in online marketplaces, and manage online ordering and online transactions assisted by value-added services of online marketplaces.

The gap in the usage of the Internet and website functions may be caused by the different business structures of the fresh produce supply chains in the two countries. As mentioned in Chapter 2, the UK fresh produce supply chain is in a high degree of vertical integration, influenced by major supermarket chains, while the Chinese fresh produce supply chains are known for their fragmented structures. Mainly working in the upstream of major supermarket chains, SMEs in the UK are encouraged by major retailers to implement similar technologies for sharing

information (Jones and Clarke, 2002). For example, Tesco[1] and Sainsbury's[2] provide SMEs with online access to manage their supply information, instead of SMEs spending a large amount of money to implement advanced applications on their own websites. However, most Chinese SMEs do not have this type of ready-access from large retailers. Mainly as retailers, Chinese SMEs face individual customers in the marketplace. Internet technologies are used to gain market information and to choose a better supplier. As a result, online marketplaces, such as Taobao.com and Alibaba.com, serve as a platform for information exchange, and attract a large number of SMEs in the market.

Use of software packages

The differences in the usage of software packages are listed in Table 6.4. There is an apparent difference between SMEs in the UK and China in the current usage of the following nine software packages. More SMEs in the UK implement barcode systems, EDI, ERP and RFID than users in China, whereas WMS and CRM are more popular for SMEs in China. In terms of plans for the near future, Chinese SMEs express much stronger willingness to use than British SMEs. However, there are larger proportions of Chinese SMEs indicating that they have no idea about the software packages mentioned. From the feedback of Chinese SMEs, many respondents indicate that it is their first time hearing about these packages. Many of them also indicate that their companies are still very small, and that these software packages are not appropriate to use in their business.

[1] http://www.tesco.com/regionalsourcing/
[2] http://www.sainsburys.co.uk/sid/

Table 6.4 Differences in the use of software packages

Item / value	Country	Barcode systems	EDI	ERP	RFID	AQC	WMS	CRM	TMS	GTS
No. of replies	UK	87	89	87	82	86	85	85	83	83
	China	151	151	150	147	150	151	150	151	149
Currently using=1	UK	59%	55%	37%	20%	17%	18%	15%	10%	8%
	China	29%	20%	11%	7%	18%	30%	25%	12%	9%
Plan to use in 2 years=2	UK	6%	11%	10%	12%	11%	11%	12%	6%	7%
	China	20%	19%	17%	8%	19%	14%	22%	17%	11%
Plan to use after 2 years=3	UK	5%	3%	7%	6%	9%	6%	9%	2%	10%
	China	9%	9%	17%	11%	9%	13%	8%	10%	11%
No plan to use=4	UK	9%	12%	23%	32%	42%	41%	44%	48%	45%
	China	21%	21%	26%	35%	23%	16%	21%	22%	20%
Item / value	**Country**	**Barcode systems**	**EDI**	**ERP**	**RFID**	**AQC**	**WMS**	**CRM**	**TMS**	**GTS**
No need to use=5	UK	21%	15%	17%	26%	14%	19%	15%	28%	28%
	China	16%	19%	17%	22%	19%	23%	17%	35%	40%
Do not know	UK	1%	3%	6%	4%	7%	6%	5%	6%	2%
	China	5%	13%	12%	17%	11%	5%	7%	3%	8%
Mean	UK	2.24	2.10	2.56	3.18	3.04	3.15	3.18	3.60	3.69
	China	2.91	3.38	3.59	4.08	3.39	3.03	3.03	3.66	3.93

Mann-Whitney U Test

	Country	Barcode systems	EDI	ERP	RFID	AQC	WMS	CRM	TMS	GTS
Median	UK	1	1	2	4	4	4	4	4	4
	China	3	4	4	4	4	3	3	4	4
M-W U		4921	3872	4352	4285	5658	6210	6047	6008	5304
Z		-3.353	-5.627	-4.348	-3.731	-1.604	-.423	-.672	-.541	-1.864
Asymp. Sig.		.001	.000	.000	.000	.109	.673	.502	.589	.062
r		-.216	-.363	-.281	-.241	-.104	-.027	-.043	-.035	-.120

Mann-Whitney U tests in software usage reveal a significant difference between Chinese and British SMEs in barcode systems (U=4921, z=-3.35, p=.001, r=-.216), EDI (U=3872, z=-5.627, p<.000, r=-.363), ERP (U=4352, z=-4.348, p<.000, r=-.281) and RFID (U=4285, z=-3.731, p<.000, r=-.241), but the two countries demonstrate no significant differences for AQC, WMS, CRM, TMS and GTS.

The difference can be interpreted by comparing mediums (1=currently using, 5=no need to use, from Table 6.4). The UK results indicate that more companies are currently using the barcode system and EDI, and that ERP is likely to be used in

two years. On the contrary, Chinese SMEs are planning to use the barcode system after two years, and show no plans to use EDI and ERP.

The results demonstrate that SMEs in both countries are not at an advanced level of using software packages in their fresh produce supply chains, though SMEs in the UK indicate a relatively higher level of usage. For both countries, RFID, AQC, TMS, and GTS are less likely to be used by SMEs in the fresh produce supply chain. Compared with UK SMEs' willingness to use the barcode system, EDI and ERP, Chinese SMEs are still less motivated to use software packages, and lack knowledge about how software packages are to be used in the supply chain. For a better understanding of Chinese SMEs' use of supply chain software packages, comments from the transcript are provided here:

- *"Whether to use any software could not be decided by me. I have to see the trend of the industry." (Chengdu 206)*
- *"It is my first time to hear those strange words. I have to decide whether to use them according to the development of my company as well. Our company is still small, not like the big companies." (Beijing 16)*
- *"I usually contact our trade partners by telephone, and seldom use the Internet. I don't trust anything online." (Shanghai 947)*
- *"Fresh produce business is quite different from others. You have to see the real products. Every orange is different, even though they grow on the same plant. You have to see them by yourself. It is impossible to have online transaction for this type of business. The Internet just worked as a (information) dissemination tool." (Wuhan 421)*

Companies' IT skills

The differences between the two countries in terms of companies' IT skills are significant (Table 6.5). Managers in British SMEs possess better IT skills than those in Chinese SMEs, but employees in Chinese SMEs demonstrate better IT skills than those in British SMEs. Such differences may reflect a different

management style, recalling that Chinese managers depend on their employees in using technologies, because they believe that they might be too old to learn.

Table 6.5 Differences in IT skills

	UK		China		M-W U	Z	Asymp. Sig.
	Mean	S. D	Mean	S. D			
H2a: Managers' IT skills	3.49	0.95	3.01	0.73	4562	-4.95	0.000
H2b: Employees' IT skills	2.25	1.17	2.72	1.34	5101.5	-2.56	0.010

6.3.2 Factors in the organisational context

Table 6.6 shows the differences between UK and Chinese SMEs in terms of factors in the organisational context, by using the Mann-Whitney U test. Apart from business geographic scopes, all factors show significant differences between the two countries. Compared to managers in British SMEs, the managers in the Chinese SMEs have less knowledge about supply chain management. However, they claim a better alignment of supply chain strategy with corporate strategies, and a higher level of complexity in business management, and their employees are better at understanding supply chain management.

Table 6.6 Differences in factors in the organisational context

	UK		China		M-W U	Z	Asymp. Sig.
	Mean	S. D	Mean	S. D			
H3: Company size	2.85	0.82	1.58	0.79	2122	-9.59	0.000
H4: Cost of implementation	3.27	1.40	2.30	1.28	4032	-5.051	0.000
H5: Business geographic scopes	2.24	1.09	2.36	1.05	6547	-0.92	0.357
H6: Alignment of supply chain strategy with corporate strategies	2.43	1.38	2.95	1.42	5514	-2.66	0.008
H7: Business operational complexity	2.02	1.13	2.57	1.09	4898	-3.95	0.000
H8a: Managers' knowledge of supply chain management	3.73	0.92	2.99	1.07	4268	-5.29	0.000
H8b: Employees' knowledge of supply chain management	2.51	1.05	2.96	1.35	5192	-2.54	0.011

Although China joined the World Trade Organization (WTO) less than a decade ago (World Trade Organization, 2001), it is not surprising that Chinese SMEs are as global as the British SMEs in the fresh produce industry. China is the main

country that exports fresh produce to many Asian countries, and is ranked as the first country in terms of exporting prepared vegetables and fruits by value (Kasnakoglu, 2005). However, recall that SMEs surveyed in China are located in five major cities: it is therefore important to be cautious when attempting to generalise this result.

With respect to other differences between the two countries, it is surprising to find that Chinese SMEs have a better alignment of supply chain strategy with corporate strategies compared to British SMEs. This may result from Chinese managers' insufficient understanding of supply chain management, as the results in the Mann-Whitney U test showed that Chinese managers have a lower level of knowledge of supply chain management. Chinese SMEs claim a higher operational complexity than British SMEs. This result is in line with the fact that more Chinese SMEs are positioned at Level 1, a pre-integration level with many manual operations, whereas more British SMEs move to Level 2, functional integration.

6.3.3 Factors in the environmental context

In terms of the environmental context, the differences between the SMEs of the two countries are shown in Table 6.7. There is no significant difference between SMEs from the two countries with respect to factors of mutual trust, pressure from suppliers, and bank requirement of online transactions, but they are significantly different in terms of pressure from customers and government-provided incentives.

Table 6.7 Differences in factors in the environmental context

	UK		China		M-W U	Z	Asymp. Sig.
	Mean	S. D	Mean	S. D			
H9: Mutual trust	4.06	1.04	4.01	1.04	6458.5	-0.41	0.679
H10a: Power of customers	0.51	0.41	0.38	0.36	5799.5	-2.37	0.018
H10b: Power of suppliers	0.11	0.25	0.11	0.21	6779	-0.61	0.540
H11a: Government incentives	1.72	1.22	3.04	1.49	3284	-6.56	0.000
H11a: Bank requirement of online transaction	2.44	1.47	2.77	1.53	5789.5	-1.69	0.091

The significant differences between the two countries in terms of these factors reflect the different characteristics of the environmental contexts in the UK and China. Compared to Chinese SMEs, British SMEs perceive a greater pressure from their customers, and fewer incentives from the government. As mentioned in Chapter 2, multiple retailers in the UK are a major force driving the vertical integration of the fresh produce supply chain. Influenced by them, SMEs perceive significant pressures from the customers' side. With respect to the influence from the regulator environment, Chinese SMEs recognise a far more significant influence, as predicted earlier. China is undergoing a transformation from a planned economy to a market-oriented economy (Xu *et al.*, 2004), so greater incentives provided by the government seem to reflect more government interventions in China.

6.4 Discussion of hypothesis tests

The results of hypothesis tests are briefly summarised and compared in this section. Table 6.8 lists all the results of hypothesis tests for the two countries. The discussion consists of two parts: similarities between China and the UK, and differences between the two countries.

Table 6.8 Summary of hypotheses tests

		Hypotheses	
		UK	China
Factors in the technological context	H1a: Number of Internet applications	√	√
	H1b: Number of website functions	×	√
	H1c: Number of software packages	√	√
	H2a: Managers' IT skills	√	×
	H2b: Employees' IT skills	√	√
Factors in the organisational context	H3: Company size	√	√
	H4 Financial resources	×	×
	H5: Business geographic scopes	√	×
	H6: Alignment of supply chain strategy with corporate strategies	√	√
	H7: Business operational complexity	√	√
	H8a: Managers' knowledge of supply chain management	√	×
	H8b: Employees' knowledge of supply chain management	√	√
Factors in the environmental context	H9: Mutual trust	×	√
	H10a: Pressure from customers	√	×
	H10b: Pressure from suppliers	×	×
	H11a: Government incentives	×	×
	H11b: Bank requirement of online transaction	×	×
	H12 Current levels→ The levels in five years	√	√

6.4.1 Factors in the technological context

In the technological context, Number of Internet applications (H1a), Number of software packages (H1c), and Employees' IT skills (H2b) are significant factors in both countries.

Number of Internet applications and software packages used by companies can be considered as the technological conditions under which Internet-based supply chains are possibly implemented. In China, a developing country, SMEs are equipped with fewer Internet applications and less supply chain software, so the usage of Internet technologies by the supply chains is limited in marketing or sourcing functions, like online searching products and advertising. However, in the UK, a developed country, with a better technological infrastructure, the use of the Internet is gradually switched to the support of supply chain operations.

Therefore, though SMEs may not possess the same sophisticated supply chain technologies as large companies with better technological conditions, it is easier for SMEs to connect their business operations with the supply chains of large companies. Premkumar (2003) pointed out that some small firms are adopting Internet technologies because they have become a strategic necessity for surviving in the business. Though SMEs may not have the power to influence large companies in using higher development levels of Internet-based supply chain, they can prepare themselves with necessary Internet technologies as potential competitive advantages in the future.

The number of website functions is not a significant factor in the UK, but it is a significant factor in China. Compared to Chinese SMEs, a higher percentage of British SMEs own company websites and launch products and company information online. However, British SMEs are very cautious about online transactions and payment, as they have a low percentage of hosting online transactions and payment on their websites. One plausible explanation is that, driven by multiple retailers who are equipped with advanced technologies in supply chain integration, British SMEs offer functions such as online transactions and payment via larger customers' sites or extranet. As a result, SMEs in the UK may not need to invest in improving the online transaction functions on their own company websites.

Regarding IT skills, managers' IT skills are unrelated to the current development levels of Chinese SMEs, whereas employees' IT skills are significant. The UK SMEs show that both managers' and employees' IT skills are critical in terms of

the development levels of Internet-based supply chains. These results address the importance of employees' IT skills when companies intend to move to high development levels of Internet-based supply chain. Though managers' IT skills are important during this process, managers need to rely on their employees, who are the real users of Internet technologies. Managers' IT skills did not show a significant correlation with the development levels in China. Comments from Chinese recording transcripts indicate that the use of Internet technologies is only one of the methods of communication for most SMEs. As their use of Internet technologies is mainly for online searching, and online advertising, Chinese managers prefer more direct communication methods with their clients, which are more traditional and more accepted by their clients. Therefore, employees' IT skills play a more important role than managers' IT skills in China.

6.4.2 Factors in the organisational context

In the organisational context, Company size (H3), Alignment of supply chain strategy with company strategies (H6), Business operational complexity (H7) and Employees' knowledge of supply chain management (H8b) are all significant factors in both countries, but Financial resources (H4) shows no significance for the two countries.

Company size still plays an important role and larger firms in the small business category in both countries have a greater propensity to use Internet technologies in the supply chain.

Alignment of supply chain strategy with company strategies is critical for SMEs in terms of adopting and diffusing Internet technologies. The implementation of

an Internet-based supply chain needs active participation from operations, logistics, warehouse, and other functional managers, as well as IT managers. Therefore, only alignment of supply chain strategy with a company's overall strategies would bring a collective effort among various functional departments, which would enhance the implementation of an Internet-based supply chain.

Business operational complexity is also a significant factor. Fresh produce is not a homogenous product, and needs to be assessed in terms of colour, size, taste, nutrition, etc. Moreover, multiple retailers have different requirements regarding the packages. Internet technologies can streamline the flow of information and ensure the fresh produce move quickly and accurately in this industry, which is difficult to achieve by manual operations.

The result shows that employees' knowledge of the supply chain is significant in terms of the development levels of Internet-based supply chains in both countries. Previous research identified the importance of management's knowledge during technology adoption (Premkumar, 2003; Ranganathan *et al.*, 2004). This study argues that, as the end users of Internet-based supply chains, employees with a better understanding of supply chain management may realise more benefits of Internet technologies, and would be more innovative in using them, so as to enable SMEs' move to higher development levels of Internet-based supply chain.

Surprisingly, this study found that financial resources are not significant in terms of the development levels of Internet-based supply chains in both countries. Internet technologies are considered to be cost-saving tools by SMEs. As the cost of hardware and software has reduced, and more low-cost or even free services

and applications are available online, SMEs do not suffer heavily by their financial resources when considering using Internet technologies.

The results in the UK and China were different in two factors – business geographic scope and managers' understanding of supply chain management – both of which are significant in the UK but have less of an effect in China.

Business geographic scope is a significant factor in the UK, but not in China. In the UK, as the fresh produce is largely imported from many countries around the world, the purchasing activity of the UK SMEs follows the different seasons of the target locations. *"All year round, we have to move all over the world"* (cited by UK5). To manage a large amount of suppliers, Internet technologies are frequently used by the UK SMEs in the supply chain. However, in China, the fresh produce does not rely on imports, but is produced domestically. The suppliers to SMEs are local farmers, and their customers are from various countries, most of which are Asian countries. Chinese SMEs are not facing frequent seasonal change of suppliers and customers, so the use of Internet technologies can be maintained at a basic level, which is to search information and to send emails to their clients.

In terms of managers' knowledge of supply chain management, Chinese managers' knowledge has no effect on the current development levels, whereas UK managers' knowledge of the supply chain is significantly related to the development levels of Internet-based supply chains. Literatures have indicated that, in SMEs, the primary decision maker is the owner of the business, and his or her vision of the use of these technologies can determine the level of support for

adoption and diffusion of the innovation (Thong, 1999; Premkumar, 2003). From descriptive data, Chinese managers demonstrate a moderate level of understanding of supply chain management (mean=2.99, S.D=1.07, 1=poor, 5=very knowledgeable), but some of them are very limited in providing a holistic view of supply chain management (as cited in Chapter 5). As most Chinese SMEs are positioned at relatively low development levels of Internet-based supply chain, it is plausible that Chinese managers are not very aware of the modern concept of supply chain management. However, additional research needs to be conducted before more concrete conclusions can be drawn.

6.4.3 Factors in the environmental context

In the environmental context, Pressure from suppliers (H10b), Government incentives (H11a), and Bank requirement of online transaction (H11b) are not significant for either country.

Pressure from suppliers is not significant for either country. Ranganathan (2004) suggests that Internet technologies can lower the switching costs of B2B relationships with suppliers. However, as frequently commented by both countries, the fresh produce suppliers are farmers, who are lagging behind in terms of their use of Internet technologies. SMEs do not suffer much pressure from their suppliers, and sometimes they have to be flexible to accommodate the communication methods that their suppliers are used to.

Previous research has shown that government incentives are not significant in developed countries, but are significant in developing countries in terms of the use of Internet technologies (Gibbs and Kraemer, 2004). However, this study shows

that government incentives are not a stimulator for SMEs in the two countries in terms of improving their development levels of Internet-based supply chain. It is noticeable that Chinese SMEs do reflect better government incentives than British SMEs. A plausible explanation could be that invalid online information may discourage Chinese SMEs from further use of Internet technologies.

Though indicated to be a motivator by several SMEs during the exploratory interviews, bank requirement of online transaction is not confirmed to be significant for the development levels of Internet-based supply chains in either country.

Regarding factors in the environmental context, only one factor in each country has a significant impact. Power of customers significantly influences the development levels in the UK, whereas mutual trust is a significant factor influencing the development levels in China.

In the UK, the power of customers is driven by large multiple retailers, but in China, due to fragmentation of the fresh produce industry, there are fewer powerful multi-retailers selling the fresh produce. In this case, SMEs are facing retailers of a similar size as them, or individual buyers. The power of these customers is not as significant as large supermarkets in the UK. Therefore, Chinese SMEs lack the push from their customers in terms of the use of Internet technologies.

The result also shows that mutual trust is a significant factor for Chinese SMEs, but not for the British SMEs. It is not clear why mutual trust is significant in

China but not in the UK, where the development level of Internet-based supply chains is higher. One possible explanation could be that strong pressure from customers can override this effect in the UK. The primary reason why SMEs use an Internet-based supply chain is because of the push from their customers. However, Chinese SMEs are facing fewer pressures from their customers, as there are fewer multiple retailers selling the fresh produce. Mutual trust has the effect of alleviating the concerns that firms may have on the potential loss and misuse of proprietary information that may be flowing through the systems (Grover and Saeed, 2007).

6.4.4 SMEs' intentions for the development levels in five years

It is important to consider the positive relationship between the current development levels of Internet-based supply chains and the development levels in five years in both countries. The result complements Ranganathan *et al.*'s study (2004) that suggests companies with e-enabled internal supply-chain operations, such as manufacturing logistics, inventory planning, and warehouse management, are more likely to succeed in diffusing these technologies into the inter-organisational supply chain. Moreover, this result extends Ranganathan *et al.*'s finding to the development levels before internal integration. The trend of development of Internet-based supply chains is confirmed, from pre-integration to various integrations, and finally achieving full network connectivity. As most fresh produce SMEs in China and the UK are at pre-integration and functional integration levels, this empirical finding lends support to the idea that, before moving forward on ambitious plans for intra-enterprise integration and inter-enterprise integration, SMEs should first ensure that their supply chain

software packages are adequately connected by Internet technologies.

6.5 Chapter summary

This chapter discusses research findings in the UK and China and compares the similarities and differences between the two countries in terms of Internet usage in the fresh produce supply chain. The comparison results reveal a number of key differences with respect to the development levels of Internet-based supply chains. Generally speaking, the UK SMEs are currently positioned in slightly advanced development levels of Internet-based supply chains. Chinese SMEs lag behind in using software packages in the fresh produce supply chain, but are advanced in website functions. However, in terms of the development in five years, the British and Chinese SMEs predict that they will progress to similar development levels.

The two countries show differences in many factors in the organisational context, whereas factors in the environmental context are not too different, apart from government incentives. Finally, hypotheses tests were compared and discussed with the back-up of qualitative data.

Chapter 7 Conclusion

This final chapter starts with a summary of the research undertaken, including the justifications for and objectives of the research, followed by a section on the key findings related to the objectives. It then provides discussion of the managerial implications and main contributions of the study. Finally, the limitations of the research and suggestions for future research are presented.

7.1 Important literature

Fresh produce is perishable, seasonal and fragile. These specific characteristics pose significant challenges in fresh produce supply chain management, which requires a quick response to market conditions, to ensure that the right products are supplied with the right quality and in the right quantity in the right marketplace. It is argued that effective implementation of Information and Communication Technologies has great potential in terms of improving efficiency and reducing wastage within the fresh produce supply chain. While the Internet is used by many small and medium-sized enterprises (SMEs) in the fresh produce industry, the extent to which it is applied and further developed after the initial adoption varies widely. Much research has been carried out to investigate Internet adoption and usage, but very limited effort had been focused on the identification of the current level of technology integration and development and the factors affecting the level of the development after the adoption, especially in the context of SMEs in the fresh produce supply chain.

The literature review indicates that research in the post-adoption development of

Internet technologies appears to have been neglected compared to studies on their initial adoption (Premkumar, 2003; Grover and Saeed, 2007), so the focus in terms of studying SMEs' usage of Internet technologies needs to be switched from initial adoption to post-adoption development. Moreover, the research on SMEs in supply chains has not received sufficient attention, which is not in line with the importance of SMEs in the economy, particularly in the fresh produce industry. It is apparent that post-adoption development of Internet technologies by SMEs in supply chain management is currently an under-researched area.

The process of post-adoption development of Internet technologies along the supply chain has been defined in five levels, pre-integration, functional integration, intra-enterprise integration, inter-enterprise integration, and full network connectivity, according to theories of supply chain development framework (Poirier and Bauer, 2000, Muzumdar and Balachandran, 2001) and the evolution of e-business (Rao *et al.*, 2003, Mendo and Fitzgerald, 2005). Enlightened by innovation diffusion theory, the study follows Tornatzky and Klein (1990)'s (TOE) framework to identify factors influencing SMEs post-adoption behaviour of Internet technologies in their supply chain management. TOE framework is chosen because it is appropriate in studying adoption and diffusion behaviours at organisational and inter-organisational levels, but TAMs and Roger's innovation diffusion is suitable for individual level of adoption. Factors are sourced from literature summarised in Table 3.5. As discussed in Chapter 5 and 6, most factors from the technological and organisational contexts are confirmed during hypotheses tests, whereas fewer factors from the environmental context are confirmed.

7.2 Research objectives

To make a contribution to the current understanding and knowledge of SMEs' Internet usage and post-adoption development in fresh produce supply chain management, this research sought to:

- Research relevant studies in Internet-based supply chain operations and management, the characteristics of the fresh produce supply chain, and the technology adoption theories and models.
- Develop a theoretical framework for analysing the development levels of post-adoption of Internet technologies in supply chains and the key influential factors.
- Investigate the current Internet usage by SMEs in China and the UK in their fresh produce supply chains, with a view to understand the differences between the two countries.
- Evaluate factors affecting the post-adoption of Internet technologies by SMEs in the fresh produce supply chains in the UK and China.

7.3 Key findings

To achieve the research objectives, first, five development levels of post-adoption of Internet technologies in the supply chain were defined, and factors from the technological, organisational and environmental contexts were identified according to the literature review and exploratory interviews with both UK and Chinese fresh produce SMEs. Five UK and three Chinese SMEs were visited and interviewed for the exploratory studies. Second, questionnaire surveys were conducted in the UK and China to investigate the current situation of Internet

technologies used by SMEs in the fresh produce supply chains in the two countries. About 1,000 UK fresh produce supply chain SMEs were targeted for the questionnaire survey, and 91 valid responses were received, which represented a 9% response rate. Using Computer Assisted Telephone Interviews by an international data collection service company, 150 valid responses were collected in China. Finally, a number of research hypotheses were statistically tested and significant factors in the proposed framework were identified and discussed.

Research outcomes and key findings in relation to the research objectives are highlighted in the following sections.

> *Objective 1: Research relevant studies in Internet-based supply chain operations and management, the characteristics of the fresh produce supply chain, and the technology adoption theories and models.*

The literature review of this study has covered a number of main areas, such as fresh produce supply chain management, use of the Internet in SCM, and adoption and diffusion theories and their applications in the adoption of ICTs. Though the study is about the fresh produce industries in the UK and China, the literature review was not limited to these two countries, because the studies regarding the adoption and diffusion of Internet technologies in the fresh produce supply chain are very rare. Despite the extensive literature search, only a few relevant articles can be found on the study of managing food or agriculture products. Some of them are related to general supply chain management and they are quite outdated. In particular, when reviewing the fresh produce supply chain in the UK, the limited numbers of studies on the fresh produce supply chain are focused on large retailers. It is argued that the UK fresh produce supply chain is highly

sophisticated in the retailing of fresh produce (Wilson, 1996), due to the strong buying power of multiple retailers.

Despite the limited literature in the same area as this study, previous research is also limited in studying Internet usage in the industry. Therefore, relevant studies have to be sourced from similar studies in other countries, such as studies about information systems used by American farmers (Salin, 1998), e-commerce in the Greek food industry (Papathanassiou *et al.*, 2003; Manthou *et al.*, 2004), and a survey about Internet usage in the American food industry (Dresner *et al.*, 2001). In investigating the Chinese literatures, the researcher found that previous research was mostly based on anecdotal evidence when analysing the role of the Internet in agriculture (Wang and Liu, 2005), the benefits that the Internet can bring to farmers (Wan, 2007), the difficulties of farmers to accept it, and suggestions to promote Internet usage by farmers (Tian and Chen, 2006). The situation of Internet technology usage by fresh produce SMEs is still unclear, and factors discussed by anecdotal articles need empirical evidence to support them.

The critical literature review reveals that the use of Internet technologies by SMEs in the fresh produce supply chain is largely ignored by empirical studies in both the UK and China. It is evident that the findings of this study can fill this gap.

From a theoretical perspective, the literature review reveals the tendency that research about the usage of Internet technologies in supply chains has turned the focus from the initial adoption to the post-adoption and diffusion process, in terms of the popular usage of the Internet by many companies. Moreover, the study

identifies the appropriateness of using the TOE model in studying innovation adoption and diffusion in the setting of supply chain management. Unlike innovation adoption and diffusion at the individual level, TOE is better suited for the studies of the organisational and inter-organisational levels, where SMEs in the supply chain can be fitted in. As post-adoption is far more complicated and involves several stages, the research adapted theories of supply chain development frameworks (Poirier and Bauer, 2000; Muzumdar and Balachandran, 2001) and the evolution of e-business (Rao *et al.*, 2003; Mendo and Fitzgerald, 2005) to develop the five development levels of Internet-based supply chains.

Objective 2: Develop a theoretical framework for analysing the development levels of post-adoption of Internet technologies in supply chains and the key influential factors.

Based on the literature review, the process of post-adoption development of Internet technologies along the supply chain has been defined as having five levels: pre-integration, functional integration, intra-enterprise integration, inter-enterprise integration, and full network connectivity. This five-level framework is in particular underpinned by theories of supply chain development frameworks (Poirier and Bauer, 2000; Muzumdar and Balachandran, 2001) and the evolution of e-business (Rao *et al.*, 2003; Mendo and Fitzgerald, 2005). Enlightened by innovation diffusion theory, the study follows Tornatzky and Klein (1990)'s (TOE) framework to identify factors influencing SMEs' post-adoption behaviour of Internet technologies in their supply chain management. The TOE framework is chosen because it is appropriate in studying adoption and diffusion behaviours at organisational and inter-organisational levels,

but TAMs and Roger's innovation diffusion is suitable for an individual level of adoption. As discussed in Chapters 5 and 6, most factors from the technological and organisational contexts are confirmed during hypotheses tests, whereas fewer factors from the environmental context are confirmed. The final theoretical framework has been tested in this study, and several influential factors are identified (see Figure 7.1).

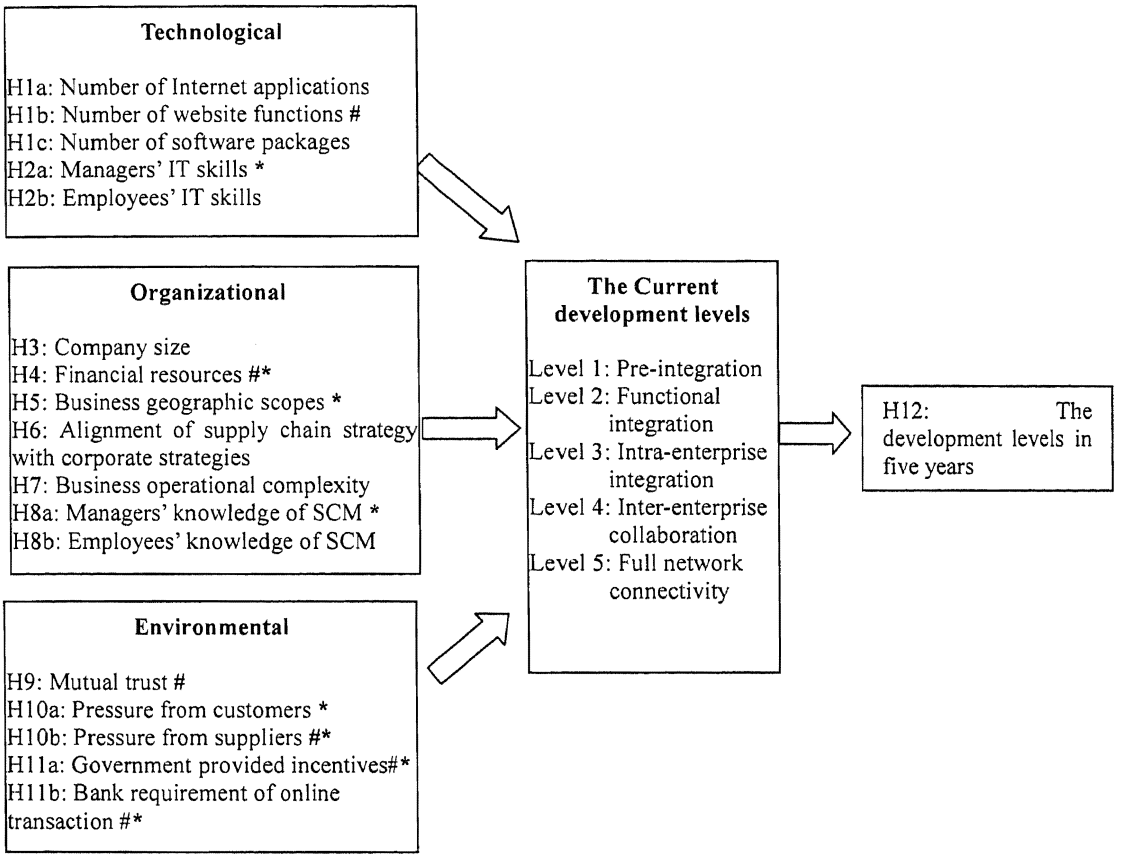

Figure 7.1 Theoretical framework for SMEs' development levels in the fresh produce supply chain

refers to the rejected hypotheses in the UK,
* refers to the rejected hypotheses in China

Detailed discussion regarding factors is presented in the following section. The framework also shows the positive impact of the current development levels of Internet-based supply chain on its development in five years.

Objective 3: Investigate the current Internet usage by SMEs in China and the UK in their fresh produce supply chains, with a view to understanding the differences between the two countries.

The results of the empirical investigations have revealed that simple functions of Internet technologies have been implemented in the supply chain management by SMEs in both the UK and China. The application of more complex functions, such as Intranet, extranet, online ordering, online transacting, and supply chain software packages, are limited. SMEs in the UK are currently positioned in marginally more advanced development levels of Internet-based supply chains. However, in terms of the development in five years, the British and Chinese SMEs predict that they will progress to similar levels.

In their usage of Internet technologies, the UK and Chinese SMEs show different strengths in implementing simple applications, but demonstrate no significant differences in using complex applications. For example, in the UK, SMEs apply more Internet applications like e-mail and websites, whereas Chinese SMEs are advanced in using online communication tools. There is no significant difference between the UK and China in more complex applications, such as Intranet and extranet. In terms of website functions, although fewer Chinese SMEs own company websites, the percentage of providing information about the company and products is similar for the UK and Chinese SMEs. However, Chinese SMEs demonstrate a much more advanced application compared to the SMEs in the UK, given the fact that a higher percentage of Chinese SMEs implements online ordering and payment.

With respect to supply chain software packages, SMEs in the UK show a

considerably higher usage of popular software packages such as barcode systems, EDI, ERP, and RFID. On the other hand, there is no difference between the two countries in terms of the applications of AQC, WMS, CRM, TMS, and GTS. From the exploratory interviews with SMEs, some of them indicate that they either do not have a large enough volume of business to operate these functions by software, or they outsource those transportation functions to specialties, such as warehouse management systems (WMS), transportation management systems (TMS), and geo-track systems (GTS). It might indicate that for these specialised applications, further investigations, restricted to specialised players, might need to be conducted to investigate the usage of those software packages.

Objective 4: Evaluate factors affecting the post-adoption of Internet technologies by SMEs in the fresh produce supply chains in the UK and China.

In the technological context, the number of Internet functions, the number of software packages and employees' IT skills are significant factors affecting the current development levels in both countries. However, the number of website functions does not show significance in the UK, whereas managers' IT skills do not demonstrate a significant impact on development levels in China.

In the organisational context, company size, supply chain strategy alignment with the overall strategies, operational complexity, and employees' knowledge about supply chain are significant factors influencing the current development levels in both countries, but financial resources are not significant with respect to the current development levels in the two countries. However, business geographic scope and managers' knowledge of the supply chain are significant in the UK, but

are not confirmed in China.

In the environmental context, there are inconsistent findings about the influential factors in the two countries. In the UK, pressure of customers demonstrates a significant impact, whereas mutual trust is confirmed in China. However, three factors are proved to be non-significant: pressure of suppliers, government incentives, and bank requirement of online transaction.

7.4 Main contributions

This research has made a number of important contributions from both theoretical and practical perspectives.

First, it fills the gap in the current studies on Internet adoption and diffusion, and calls for more understanding of the post-adoption process of the Internet from an integrative perspective in the context of supply chain operations and management. Unlike adoption, post-adoption development is far more complicated and involves several stages. To better understand and benchmark post-adoption development, the research defines five development levels of Internet-based supply chains from the technology integration perspective. This five-level model of development is not only useful in benchmarking the post-adoption development in the fresh produce supply chain, but is also applicable to any other types of supply chains.

Second, the research studies an under-researched sector, namely SMEs in the fresh produce industry. Thus, the empirical data collected has added value to and sheds lights on the understanding of the current applications of the Internet in the supply chain in general, and in fresh produce SMEs in particular. The empirical findings

show that the Internet is no longer a new technology for most SMEs in the UK and China. However, a large proportion of SMEs surveyed are still using basic functions of the Internet, and the UK and Chinese SMEs do not show much difference when comparing the use of complex applications in the supply chains. The results show that Internet technologies are still in their infancy and that the potential for further implementation within companies and between partners is considerable.

Third, the research attempts to identify and validate the factors in the technological, organisational, and environmental context that affect the development levels of Internet-based supply chains. The results indicate that technological and organisational factors have significant effects on the current development level of the Internet-based supply chain, and some of the technological factors will lose their influence on further Internet implementation. In the technological context, IT infrastructure is critical for SMEs both for their current development level and for future trends. A company's IT skills are important for the current development level but will become less important in terms of further development. In the organisational context, most factors are significant for both countries at the current development level, such as company size, alignment of supply chain strategy with corporate strategies, business operational complexity, and employees' knowledge of supply chain management. Only a few factors show a significant impact in the environmental context. In the UK, pressure from customers is a powerful influence on SMEs in terms of implementing Internet technologies, while mutual trust is a major driver in China.

Finally, the findings from the two-country study reveal the differences in Internet usage in the fresh produce supply chain by British and Chinese SMEs, thus providing a platform for knowledge-sharing and transfer. It is found that British SMEs are more influenced by the higher level of vertical integration of the fresh produce supply chain in the UK, which is mainly driven by major multi-retailers. Due to multi-retailers' extranet access to supply chain systems, SMEs in the UK may not need to spend any effort on constructing a sophisticated website. However, they do apply various software packages to optimise internal operations. For Chinese SMEs, due to the fragmented nature of the fresh produce market, e-marketplaces play a key role in helping SMEs to promote their products online. With the value-added service provided by e-marketplaces, SMEs are able to manage online transactions, but they use very limited software packages in their supply chain. Therefore, manual operation is still a major method in supply chain management in the fresh produce industry.

7.5 Managerial implications

The outcome of this study has several practical implications for managers in SMEs when implementing Internet technologies in supply chain management during post-adoption.

First, the study provides a general guide to post-adoption development for SMEs' managers when they consider investing in new technologies. The five development levels of Internet technologies' post-adoption depict the development process for SMEs to consider. Though most SMEs are currently benchmarked at level 1 and 2, they expressed a strong willingness to grow within

five years, and envisaged their firms moving to a higher development level. Moreover, their current development levels demonstrate a positive impact on the development levels in five years. This implies that with current usage of Internet technologies, SMEs are more likely to improve the integration by using Internet applications to connect individual back-office software packages, to achieve better integration both within functions and organisations and between organisations.

Second, within the TOE framework, most factors in the technological and organisational context and some factors from the environmental context can drive SMEs to advanced development levels of Internet-based supply chains. As shown by the empirical results in Figure 7.1, all factors in the technological context and six out of seven factors in the organisational context are significant facilitators of SMEs' development levels of Internet-based supply chains. This suggests that fresh produce SMEs with stronger technological capabilities and better organisational readiness are more likely to progress to higher development levels of Internet-based supply chains. Moreover, given a favourable environmental context, such as greater pressure from customers or better mutual trust between trading partners, SMEs are able to achieve better levels of post-adoption development. With regards to specific factors, some of them need to be highlighted.

- The number of Internet applications and software packages are significant factors for both countries. Gibbs and Kraemer (2004) have indicated from their study that technology resources are important in determining the scope of e-commerce. The result of this study confirms this result, and implies that

SMEs with more technology resources would have greater potential to diffuse those technologies into their supply chain management, and to enable the Internet-based supply chain.

- Employees' IT skills and knowledge of supply chain management are proven to be significant in terms of the development levels of Internet-based supply chains. Previous studies have focused more on managers' IT skills and knowledge when studying SMEs' IT adoption and diffusion behaviours (Levy and Powell, 2003; Archer *et al.*, 2008). However, this study argues that employees' IT skills and knowledge of supply chains are also important for both Chinese and UK SMEs. In SMEs, employees are actually the real users and key operators of Internet-based supply chains. To reduce manual operations, and achieve a higher development level of Internet-based supply chain, it is necessary for employees to understand the concept of supply chain management and to be proficient in the technologies.

- Financial resources often restrict SMEs' adoption of Internet technologies, but during post-adoption, they do not appear to be an obstacle for SMEs in terms of moving to a better development level of Internet-based supply chain. Previous literature has shown that financial resources are an important factor inhibiting SMEs' adoption of Internet technologies, because SMEs are limited in terms of their financial resources (Levy and Powell, 2003; Premkumar, 2003; Ngai *et al.*, 2004; Archer *et al.*, 2008). Despite Internet technologies being a relatively large drain on financial resources for SMEs, they are considered as cost-saving tools by SMEs. Moreover, the cost of

hardware and software has reduced dramatically, and more low-cost or even free services and applications are available online. Hence, for SMEs in both China and UK, they do not suffer heavily by their financial resources when considering using Internet technologies.

- Located in different environments, the fresh produce SMEs are influenced by different factors. Pressure from customers is more significant for the UK SMEs, whereas mutual trust is more significant for the Chinese SMEs. SMEs in the UK have to respond to large supermarkets' implementation of Internet technologies by launching relevant technologies, because they are more dependent on large supermarkets. However, in China, due to market fragmentation, SMEs do not suffer much from the vertical integration brought by customers, so pressure from customers is not significant. Instead, mutual trust plays an important role in China, as in China relationships are very important in business.

Third, this study points out potential opportunities, in terms of the e-marketplace and Internet service providers, for SMEs in China. Grover and Saeed (2007) suggest that companies tend to have low inter-organisation systems integration when the market is fragmented. In the Chinese fresh produce market, a large number of SMEs fiercely compete for business, so companies want to explore the Internet to get better market information and do comparison shopping. The e-marketplace is the right place for SMEs to expand the search space and survey the market more thoroughly. In this case, fancy supply chain software may not always be the best approach for Chinese SMEs to pursue. In this fragmented

market, the e-marketplace may be appropriate for Chinese SMEs by offering more options and information. With currently prevalent usage of the Internet and popular acceptance of services provided by the e-marketplace, Chinese SMEs are potential users of online hosted application services. Major e-marketplaces in China are valuable "trusted third parties" for SMEs, as they have hosted their website and online transaction services for many years and provided simple online communication tools. However, one note of caution is the fact that there is less-trustworthy online information in China. Managers voice their serious concern over online information. It may be a challenge for the Chinese e-marketplace and the development of online hosted application services in the future.

Finally, the study discusses and compares the similarities and differences between the two countries, which could be valuable for researchers, policy-makers and practitioners in both countries. As mentioned by Wilson (1996), in 1980, 90 per cent of fresh produce was sold through traditional greengrocers in the UK, whereas in 1996 the UK multiple retailers commanded around 70 per cent, and more recently this number has gone up to 83 per cent (Gower, 2007). Dramatic changes can be seen in the UK fresh produce industry. As the Chinese government attempts to change the selling of fresh produce and move it from street markets to supermarkets, the researcher foresees that similar changes might happen to the Chinese fresh produce industry.

The comparison discussion might be useful for Chinese researchers, policy-makers and practitioners in terms of providing a clearer picture of how to

facilitate the usage of Internet technologies in the fresh produce supply chain. For example, pressure from customers is a significant factor for the UK SMEs, who are positioned at higher development levels of Internet-based supply chains than those in China. It can be foreseen that Chinese SMEs may be motivated to further use Internet technologies in their fresh produce supply chains when they feel greater pressure, which may come from Chinese supermarkets, which have stronger power over the selling of fresh produce and Internet technologies that are more integrated with their SME suppliers. In this case, to achieve an advanced development level, more vertical integration and a more competitive market environment would be needed. As large supermarkets in China begin to sell increasing amounts of fresh produce, they could come to be one of the impulses that drive SMEs to integrate Internet technologies along their supply chain. Similarly, some other factors, which are significant in the UK but not in China, can be considered as motivators, such as managers' IT skills and knowledge of supply chain management. It can imply that managers' who have better IT skills and knowledge of supply chain management could help Chinese SMEs use Internet technologies in the fresh produce supply chain.

On the other hand, the Chinese results can also be beneficial to UK practitioners. For example, selling fresh produce through the e-marketplace (B2B) might be a good example for the UK SMEs. In the UK, local farmers and local greengrocers are facing tremendous pressure under a highly vertical integrated supply chain. The e-marketplace might be a good choice for them in terms of promoting local fresh produce, as it provides them with a wider market. In China, a large

e-marketplace (alibaba.com) could help SMEs to set up a company webpage, and also provide online communication tools for SMEs to communicate with the suppliers and customers, who searched and found the companies on the e-marketplace. This type of business is not only for B2C, but also for B2B transactions. In this way, local fresh produce SMEs could be better known by potential clients, thus enhancing their business opportunities.

7.6 Research limitations

There are several limitations of the research in this study.

First, the current study adopted a cross-country design, which was conducted using the same questions to ensure that the results are comparable. However, the shortcoming of this cross-country design is that different characteristics of the fresh produce industries in the UK and China may not be fully revealed. Some country-specific questions and areas should be explored in future research, such as cultural differences, market structure, political systems, and company dependency.

Second, limitations can be found from different sampling methods in the two countries. In the UK, the FAME database was used, and the questionnaires were sent to all the fresh produce companies. However, the samples in China were restricted to the survey company's database of five major cities. The Chinese results cannot reflect a complete picture of the usage of Internet technologies, as the situation of remote rural areas could be much less advantageous. Therefore, it is suggested that there should be caution when generalising the findings. For

example, the overall level of Internet usage in the fresh produce supply chain in China could be lower than the data obtained in this study indicates.

Third, another limitation is related to the use of a single respondent from each target company, without cross-validating responses from other informants in the same company. Although the use of a single respondent is common in the related research, the information collected was based on one informant's judgments about a company's technological, organisational and environmental characteristics. However, the survey was targeted to company managers, IT managers, and supply chain managers in SMEs, who are believed to be the people who are most knowledgeable about the operation of the Internet-based supply chain. Future research can mitigate this problem by collecting data from more than one respondent from the same firm.

Fourth, this research investigated the general usage of supply chain software in the fresh produce industries. Due to their different roles in the supply chain, SMEs may have different software packages. For example, TMS is suitable for transporters, but not for growers. In future research, it would be helpful to investigate the usage of one particular supply chain software package, in order to obtain a more in-depth insight into the utilisation of a particular technology.

However, the acknowledged limitations of this study have led to suggestions for future research.

7.7 Future research

Although this study makes contributions to the understanding of post-adoption

development in SMEs and helps to clarify the relationship between the post-adoption of Internet technologies and key factors from the technological, organisational and environmental contexts, a number of unanswered questions, relating to the use of Internet technologies in supply chain management, still remain. This section suggests related areas of research, where additional investigations can make further contributions.

One direction for future research would be to expand the model to include other variables. The variables included in this research model were those found in the literature and those that resulted from the exploratory interviews. Nevertheless, this research could be followed by future research that includes industrial characteristics, like market fragmentation and market volatility, and product characteristics, such as demand uncertainty and product complexity, as mentioned in Grover and Saeed's study (2007).

Another direction of study is to develop the constructs of each variable. Due to the non-parametric nature of the data, this research used simple correlations to identify the relationships between independent variables and dependent variables. There are an increasing number of researchers using PLS (partial least square) or SEM (structural equation modelling) to test the proposed framework in IS field studies (Chin, 1995), such as Pramatari and Theotokis' research about the acceptance model of RFID (2009), Grover and Saeed's study about inter-organisational information systems (2007), and Zhu and Kraemer's study about e-business (2005), among others. SEM and PLS provide researchers with the flexibility to model relationships among multiple predictor and criterion

variables and construct unobservable latent variables. More insight into the relationship would be obtained if SEM or PLS is used adequately. However, these two methods have very strict requirements in terms of the data collection (Chin, 1995). Further research would need to pay extra attention to the research design, to meet the requirement of data if SEM or PLS is employed.

Longitudinal study could also benefit this research in understanding the development levels of Internet-based supply chains over time. For example, Molla (2006) conducted a longitudinal study about a small business in Spain, which ultimately failed in e-commerce adoption, and explained the adoption factors from contextual, organisational, managerial and e-commerce-specific categories. Similar to this study, some comments from Chinese agribusiness managers in this research also revealed the discontinuity of Internet technology diffusion during the development of Internet-based supply chains. By using a longitudinal study, selected companies can be closely examined and followed over a period of time, so reasons for the success or failure could be identified, and this result might be more valuable for diffusion studies.

Finally, future research might take the approach of an in-depth case study to obtain more information for this study. Fresh produce SMEs from the two countries are rooted in two distinct market environments. Although one of the purposes of this study was to investigate the current Internet usage by SMEs in China and the UK in their fresh produce supply chains, and a large-scale questionnaire survey is appropriate in reflecting a relatively complete picture of the two countries, some special characteristics in the environmental context were

not included in the framework. For instance, the UK fresh produce industry was highly vertically integrated by large multiple retailers, whereas the Chinese fresh produce industry was fragmented and smaller-sized companies dominated the market. To further explore the factors from the environmental context, in-depth case studies would be helpful. For example, Gengatharen and Standing (2005) used case studies to verify the framework that can examine the factors affecting the success or failure of e-marketplaces. Apart from the quantitative approach, qualitative approaches like case studies and interviews are also popular in studying the development levels of Internet-based supply chains. Molla *et al.* (2006) take a chronological approach to study a small wine company, and develop a conceptual model on factors affecting different phases of the e-commerce adoption process. Therefore, a qualitative approach in future research may be able to provide more in-depth insights into the post-adoption development levels of Internet-based supply chains.

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Appendix:

Appendix 1a Questions in exploratory interviews

The Internet usage

1. Could you please specify what kind of the technology is currently used on your supply chain management? Do you use the following technology?

   The Internet, Email, supply chain Software, Eg:

1	Bar Coding Technology	8	Transportation Management Systems (TMS)
2	Radio Frequency (RF) systems (or RFID)	9	Computer Aided Design (CAD) systems
3	Electronic Data Interchange (EDI)	10	Manufacturing Execution Systems (MES)
4	Enterprise Resource Planning (ERP) system	11	Automated Quality Control (AQC) system
5	Customer Relationship Management (CRM)	12	Product Data Management (PDM)
6	Supply Chain Event Management	13	Demand Forecasting Management
7	Warehouse Management Systems (WMS)	14	Geo-coded Tracking Systems

2. Please could you specify any software for Inventory management, production scheduling (forecasting), order processing (purchasing), relationship management (customers/ suppliers), and how do you use it?

Benefits

3. What kind of benefit do the Internet and related software packages bring for your company supply chain?
   Eg:
   Reduced cost
   Improved operation efficiency
   Reduced inventory levels
   Improved order accuracy
   Saved processing time
   Faster market reaction speed
   Improved coordination of logistics activities with partners
   Increased customer satisfaction
   Improved forecast accuracy
   Improved relationship with trading partners
   Improved internal communication
   Improved external communication
   Dynamic global sourcing

4. Are there any particular benefits for fresh produce? (For example, Reduce the perishability rate of the fresh produce)

Enablers

5. Would you like to specify the enablers of your company adopt the Internet on SCM?

Technology

Perceived benefits of IT implementation

Organisation

Part of Business strategy/

part of enterprise integration process

Top management support

The scope of our business

Environment

Pressure from customers

Pressure from suppliers

Pressure from the market competition

The nature of fresh produce industry

Government regulation (E-government requirement)

Government requirement for export process

Barriers

6. Would you like to specify the barriers of your company during the process of Internet adoption?
7. Would you like to specify the reason why your company fail to adopt the Internet?

Technology

Poor IT infrastructure

Lack of IT know-how

Lack of awareness on supply chain operation and management

Fear of Internet security

Organisation

Lack of SCM strategy

Lack of fund on IT skill and SCM training

Cost of IT implementation

Low priority by the management

Resistance to change on adopting the Internet on SCM

Environment

Lack of trust in trading partners

Lack of corresponding partners

Lack of legal protection for online trade

Appendix 1b Description of interview companies

UK1

UK1 is one of the UK's largest independent produce companies. Originally an exotics company, the company today has a wide product range. The Group now includes companies in Holland, Spain and Germany. Founded in 1964, UK1 today has sales of £45.8million with combined group sales of £90million.

UK1 has high capacity on ripening of fruits, non-destructive testing of ripening and automated packing and labelling. UK1 is a company with variety of international trade. They have business on 31 fruits and 40 vegetables with the trade partners from Asia, Europe, America, Australia and Africa. Case UK1 has very strong logistics capability. They own a one-stop transport, warehousing and logistics company. Fresh produce is delivered daily to UK and Europe, with latest refrigeration and temperature recording vehicles. Approximately 150,000 packages were delivered to customers every week (from the company website).

On the Internet usage, UK1 owns the company website, with the company information and product information. Customers could check the product catalogues with pictures, availability, the origin of the product, and preparation guidance of the product with tips and comments. They used Intranet to communicate with different companies within the group, and to reinforce the standard between different departments. Extranet is used to contact with suppliers and customers, who will check the price, quantity, quality of the produce. One technician and the Commercial Director accepted my interview.

UK2

UK2 is one of the leading independent sandwich manufacturers in the UK. It was established in 1988. Through investment in their staff, the company has evolved into a viable, creative, and responsive management team which includes family and non-family members. In 2005, UK 3 was accredited by STS on behalf of the NHS and the British Sandwich Association (BSA), and joint the NHS e-procurement programme.

At the time of interview, UK 2 was on the process of launching the new labelling system. The manager explained the coming system and his perceived outcome of the new system. The interview was taken with company director and IT director.

UK 3

Established by the B family in Islington in 1989, UK 3 is the UK's best-value retail sandwich chain. In August 2000, UK3 has cleaned up the company, improved quality standards and re-engineered the brand, transforming UK3 into a leading sandwich chain, providing outrageous value across a constantly evolving product range. UK3 currently has 60 stores in London and the South East employing over 650 people. The company had undergone a £4 million nation-wide expansion plan, rolling out the network of franchised shops and

bringing the great value to most UK cities. As both a manufacture and high street retailer, UK 3 managed its retail stores by using barcode system, and operate the factor by ERP system. There is a growing desire for UK3 to manage a leaner supply chain. The interview was taken with IT director.

UK 4

UK 4 is a small company, originally being part of UK1. Different from UK1, UK4 targets at UK discounters, like Lidl, and other cheaper wholesalers and processors. With different customer base, UK4 does not operating packing business. They are have independent system from UK1, but will need IT support from the UK1 technical team. Intranet and e-mail are the basic tools for these two companies to share information. The interview was taken with company director.

UK5

Founded in 1987, UK 5 was a diversification enterprise to a family farm business specialising in the growing and pre-packing of onions and shallots. The business quickly expanded and now produces a wide range of vegetables some of which are still grown on the farm. UK5 operate from a 52,000ft purpose built factory in Bedfordshire, providing a wide range of freshly processed-to-order vegetables, with many grown on the 700 acres of vegetable farmland surrounding the factory. They have received various accreditation's including EFSIS, Soil Association and Investors in People.

As the key supplier of Mark&Spencer, UK5 has been driven to utilise various information systems to meet customer's requirement. The Interview was taken with company's operation manager.

CN1

CN1 is a research and wholesale company in northeast China. It owns less than 100 employees, and its business covers the central and south area of the Province. The use of the Internet is purely for marketing. A larger market is gained, after the establishment of their company website and pasting the company information on other commercial websites. Some customers from the South China approach them by email or telephone number obtained from the Internet. Due to the different climate between the North and South China, some southern customers would like to grow the vegetables in Northern area in the summer, when Southern area is too hot to grow a plant. The Internet provides the Vegetable Research Institute a perfect chance to grow and study different vegetable seeds in different seasons. This interview is with the manager of the Research Institute.

CN2

CN2 is a local supermarket in a small city of northeast China. Though it is small, the products range from food to daily commodity. For a small city, this supermarket is sufficient to meet the daily consumption for the local residents. The fresh produce is a main section in CN2, and they take daily supply practice to

guarantee the freshness of their products. Its suppliers are mostly local fresh producer, and sometime they would procure from local wholesale market. With local fresh producer, it usually sources the primary products from the producer, and conducts packing in itself. There was a try of using the Internet in its supply chain management with the platform from Beijing, but it is finally abandoned due to different reasons. This interview is carried out with the store manager, who has worked for CN2 since its establishment in 2000.

CN3

With 10 years history, CN3 has grown up to the largest broccoli planting and exporting company in China. CN3 is part of the cooperation, which is composed with Vegetable Company, Livestock Company, Grain and Oil Company, and Landscape Company, and several functional department such as R&D, quality assurance and logistics department. There are more than 1,000 employees in vegetable company, managing and exporting around 20,000 Ares broccoli. The products completely export to East Asia area, such as Hong Kong, Japan, Korea, Malaysia, and Singapore. As a strong company, CN3 has utilised the Internet since they have the International business. This interview is carried out with the manager of Vegetable export department.

Appendix 2a English Questionnaire

Section A Respondent Profile

1. **What is the role of your organisation in the fresh produce supply chain? (Please tick all that apply).**

- ☒ Grower / Farmer
- ☐ Importer/ Exporter
- ☐ Food processor/ Manufacturer
- ☐ No relation to fresh produce
- ☐ Wholesaler
- ☐ Retailer
- ☐ Transporter
- ☐ Others please specify: _____

2. **Which of the following positions best describes your job?**

- ☐ Owner/ CEO/ Managing Director
- ☐ Logistics/ Supply Chain/ Operation Director
- ☐ IT manager (related to supply chain management)
- ☐ Others, please specify: _____

3. **What is the total number of employees in your company?**

- ☐ Up to 9
- ☐ 10-49
- ☐ 50-99
- ☐ 100- 249
- ☐ More than 250

4. **What is the IT spending as percentage of total revenue in 2006?**

- ☐ 0% - 5%
- ☐ 6% -15%
- ☐ 16% - 25%
- ☐ 26% - 49%
- ☐ More than 50%

5. **What is the business scope of your company?**

- ☐ Local and regional
- ☐ Domestic
- ☐ Within EU
- ☐ Global

6. **What is the best way to describe your present IT skills?**

- ☐ An expert
- ☐ Proficient
- ☐ Skilled
- ☐ A novice
- ☐ A non-user

7. **Please rate your understanding of supply chain management.**

- ☐ Very knowledgeable
- ☐ Knowledgeable
- ☐ Familiar
- ☐ Somewhat familiar
- ☐ Not at all

Section B The Internet and Supply Chain Operations

8. Please indicate the situation of software packages used by your company.

Type of software packages	Explanations	Examples	Currently using	Plan to use in 2 years	Plan to use over 2 years	No plan to use	No need to use	Don't know
Barcode systems	Systems or products that are used in conjunction with any of the above systems to produce bar codes for any purpose.	KTEC group, PRISYM	☐	☐	☐	☐	☐	☐
Radio Frequency Identification (RFID)	Technology or tools that support wireless communication to read and transmit data from data points such as bar codes.	PRISYM NORAND, Intermec, Symbol	☐	☐	☐	☐	☐	☐
Electronic Data Interchange (EDI)	The computer-to-computer exchange of business information using a standardised data format. Standardised EDI messages are based on common business documents such as purchase orders, invoices and bills of lading and are sent from one computer application to another over telecommunications links without human intervention or interpretation.	Freeway, Transalis	☐	☐	☐	☐	☐	☐
Enterprise Resource Planning system (ERP)	ERP offers a centralised system to control information flow through a manufacturing environment. ERP covers functions such as capacity planning, cost and accounting, order entry, production management, inventory, and finance. Examples: SAP, Oracle, JD Edwards, PeopleSoft.	COMiT, De Facto, Fresh Dynamic, Freshware, Linkfresh, Prophet, Protrak, Rubicon, Tectura, WIZDOM	☐	☐	☐	☐	☐	☐
Customer Relationship Management (CRM)	CRM is an intelligent relationship management tool that can offer Web-based analytic and operation systems to unify all inbound and outbound sales, service, and marketing customer interactions with a single enterprise- wide view of each customer, CRM solutions analytically help a company better understand and proactively serve customers in real time.	Siebel, Tectura, Vantive.	☐	☐	☐	☐	☐	☐
Automated Quality Control Systems (AQC)	AQC systems help monitor quality assurance process, inspection procedures, specifications, and gauge calibration statistics.	Q-SYS, QMS, Power Way, Pilgrim Software	☐	☐	☐	☐	☐	☐
Warehouse Management Systems (WMS)	WMS track and control the movement of inventory through the warehouse, from receiving to shipping. WMS manages utilization of resources such as space and personnel. It also offers systematic management of material handling to optimise and shorten fulfilment cycle time reducing cost.	Catalyst, EXE, Manhattan, Optum.	☐	☐	☐	☐	☐	☐
Transportation Management Systems (TMS)	TMS are intended to achieve enterprise-wide load control centres by allowing companies to address the complex requirements of transportation between channel partners. TMS solutions can offer sophisticated planning algorithms to optimise different shipping scenarios.	i2, Manugistics, Descartes, nPassage, Capstan.	☐	☐	☐	☐	☐	☐
Geo-coded Tracking Systems	Geo-coded Tracking systems: Satellite or cellular tracking devices most commonly used in trucks or trailers to identify position and feed the information to ancillary systems such as TMS, Routing or WMS.	Qwset	☐	☐	☐	☐	☐	☐

Other software packages, please specify:	☐	☐	☐	☐	☐	☐

9. **Please indicate the number of employees working as IT specialists in your company**

☐ 0 ☐ 1-5
☐ 6-10 ☐ 11-20
☐ More than 20

10. **Please tick all that apply to the Internet applications that your company currently have**

☐ Email system ☐ Company website
☐ Intranet3 ☐ Extranet4
☐ Online communication tools, Eg: skype, msn, etc. ☐ Do not have any Internet applications

11. **If your company currently have a website, which of the following functions does it support? Please tick all that apply.**

☐ Company information ☐ Products information
☐ Online ordering ☐ Online payment
☐ Supplier account management ☐ Customer account management
☐ Other services, E.g. customer claims ☐ No website

12. **To what extent are your web applications electronically integrated with back-office systems?**

☐1 ☐2 ☐3 ☐4 ☐5 ☐0
No integration — Integrated extensively — Do not know

13. **To what extent are your company's databases electronically integrated with those of your suppliers?**

☐1 ☐2 ☐3 ☐4 ☐5 ☐0
No integration — Integrated extensively — Do not know

14. **To what extent are your company's databases electronically integrated with those of your customers?**

☐1 ☐2 ☐3 ☐4 ☐5 ☐0
No integration — Integrated extensively — Do not know

[3] An **intranet** is a private computer network to securely share part of an organisation's information or operations with its employees. Sometimes the term refers only to the most visible service, the internal website.

4 An **extranet** is a private network to securely share part of an organisation's information or operations with suppliers, vendors, partners, customers or other businesses. An extranet can be viewed as part of a company's Intranet that is extended to users outside the company (eg: normally over the Internet).

15. This question will help you assess your company's current stage of using Information Technologies to support the supply chain operations.

Please read the definitions first and identify your company's current position accordingly.

☐ **Level 1: pre-integration**
The supply chain activities are mainly operated manually, with phone, fax, personal contacts, and emails. Additionally, online searching has been used for searching market information.

☐ **Level 2: Functional integration**
Software packages are used to assist the management of individual functions, such as barcode systems, RFID, EDI, ERP, CRM, AQC, WMS, TMS, and geo-coded tracking systems.

☐ **Level 3: Intra-enterprise integration**
Companies do not only use software packages, but also set up the Intranet as the internal interface of the software packages to share the timely information between departments.

☐ **Level 4: Inter-enterprise collaboration**
Extranet is extensively used between the company and important partners to share the information and to facilitate transactions.

☐ **Level 5: Full network connectivity**
This is the world of full network collaboration and the use of technology to gain positions of market dominance. The information is shared electronically between network members, with the application of e-commerce, e-business and cyber-communication techniques to enable end-to-end visibility across the value chain network.

15.a How do you predict your company's level in 5 years? Level _____.

16. Where do you believe your company is with respect to Internet adoption on supply chain when compared with other fresh produce companies?

☐ A non-adopter ☐ A slow adopter
☐ A quick adopter ☐ A leader
☐ Do not know

17. In the past year (2006), what was the overall impact of the Internet on the cost of your supply chain?

☐1 ☐2 ☐3 ☐4 ☐5 ☐0

No Change — Reduced significantly — Do not know

18. In the past year (2006), what was the overall impact of the Internet on the company revenue?

☐1 ☐2 ☐3 ☐4 ☐5 ☐0

No Change — Reduced significantly — Do not know

Section C Factors Affecting Internet Adoption

19. **How would you rate your employees' understanding of supply chain strategies?**

☐1 ☐2 ☐3 ☐4 ☐5 ☐0

Poor Excellent Do not know

20. **How would you rate your employees' skills of using supply chain software packages or web-enabled supply chain operation?**

☐1 ☐2 ☐3 ☐4 ☐5 ☐0

Poor Excellent Do not know

21. **How well is your supply chain strategy aligned with your overall corporate strategy?**

☐1 ☐2 ☐3 ☐4 ☐5 ☐0

Not at all Fully Aligned No supply chain strategy

22. **How do you judge the level of complexity of your supply chain operations?**

	Extremely simple				Extremely complex	Don't now
Internally	☐1	☐2	☐3	☐4	☐5	☐0
Externally	☐1	☐2	☐3	☐4	☐5	☐0

23. **Please identify which players mainly take the following action in your business transaction.**

	Your company	Your suppliers	Your customers	No activity	Do not know
Set the model of communication (e.g. fax, email, EDI, etc.)	☐	☐	☐	☐	☐
Decide on what information systems applications are to be used for exchanging information.	☐	☐	☐	☐	☐
Decide on the rules and regulations for using the Internet or related software packages in order processing	☐	☐	☐	☐	☐

24. **How would you characterise the degree of mutual trust between your company and your major trading partner?**

☐1 Extremely weak ☐2 ☐3 ☐4 ☐5 Extremely strong ☐0 Don't know

25. **In your opinion, what are the most significant benefits of using Internet technologies in the fresh produce supply chain?**

_____

_____

_____

_____

_____

_____

26. **To what extent, do you believe that the following factors act as motivators of the adoption of the Internet in your supply chain?**

Motivators	Not a motivator		A moderate motivator		A major motivator	Do not know
Perceived benefits of IT implementation	☐1	☐2	☐3	☐4	☐5	☐0
Pressure from top management	☐1	☐2	☐3	☐4	☐5	☐0
The geographic scope of your company	☐1	☐2	☐3	☐4	☐5	☐0
Pressure from customers for integration	☐1	☐2	☐3	☐4	☐5	☐0
Pressure from suppliers for integration	☐1	☐2	☐3	☐4	☐5	☐0
Pressure from market competition	☐1	☐2	☐3	☐4	☐5	☐0
The nature of fresh produce industry (e. g. uncertainty, perishable, etc)	☐1	☐2	☐3	☐4	☐5	☐0
High complexity of business operation	☐1	☐2	☐3	☐4	☐5	☐0
Government provided incentives	☐1	☐2	☐3	☐4	☐5	☐0
Bank requirements for transactions	☐1	☐2	☐3	☐4	☐5	☐0
Others, please specify: _____	☐1	☐2	☐3	☐4	☐5	☐0

27. **To what extent, do you believe that following factors act as the barriers of the adoption of the Internet in your supply chain?**

Barriers	Not a motivator		A moderate motivator		A major motivator	Do know
Cost of implementation	☐1	☐2	☐3	☐4	☐5	☐0
Poor IT infrastructure	☐1	☐2	☐3	☐4	☐5	☐0
Lack of know-how	☐1	☐2	☐3	☐4	☐5	☐0
Lack of training	☐1	☐2	☐3	☐4	☐5	☐0
Concern over Internet security	☐1	☐2	☐3	☐4	☐5	☐0
Reluctance of sharing information	☐1	☐2	☐3	☐4	☐5	☐0
Resistance to changes of adopting the Internet in supply chain	☐1	☐2	☐3	☐4	☐5	☐0
Lack of trust in trading partners	☐1	☐2	☐3	☐4	☐5	☐0
Lack of collaborative partners	☐1	☐2	☐3	☐4	☐5	☐0
Inadequate legal protection for online trade	☐1	☐2	☐3	☐4	☐5	☐0
Others, please specify: _____	☐1	☐2	☐3	☐4	☐5	☐0

Please leave your comments on any issues related to this survey below:

_____

_____

_____

_____

Thank you for Completing this survey

Please return this survey by email to:
Prof. Yanqing Duan
Director of RICTA, Centre for research in ICT business applications (RICTA)
The University of Bedfordshire Business School,
Luton LU1 3JU, UK
Email: yanqing.duan@beds.ac.uk , Tel: +44 (0)1582 743134

Would you like to receive a summary report of the survey findings?
☐No
☐Yes. Please leave your email _____

Appendix 2a Chinese Questionnaire

第一部分 答卷人及公司基本情况

1. 请选择您公司在蔬菜水果供应链中的角色（可多选）

☐ 种植商 / 农民 ☐ 批发商
☐ 进出口商 ☐ 零售商
☐ 食品加工商 ☐ 运输商
☐ 与新鲜蔬菜水果无关 ☐ 其他，请详细说明: _____

2. 您在公司的职位是

☐ 公司所有者 / 公司主要负责人 / 公司经理
☐ 物流经理 / 供应链经理 / 运营主管
☐ 公司 IT 主管 （与供应链相关）
☐ 其他，请详细说明： _____

3. 您公司的职工总数是

☐ 不多于 9 人 ☐ 10-49 人
☐ 50-99 人 ☐ 100- 249 人
☐ 多于 250 人

4. 2006 年，您公司在信息技术方面的花费（比如网络维护、网络使用、电脑硬件设备更新等等一些有代表性的消费支出）占总营业额的百分之几?

☐ 0% - 5% ☐ 6% -15%
☐ 16% - 25% ☐ 26% - 49%
☐ 多于 50%

5. 您公司主要经营区域为

☐ 本地范围 ☐ 本省（直辖市）范围
☐ 国内范围 ☐ 全球范围

6. 您目前的电脑使用水平为

☐ 专家水平 ☐ 比较精通
☐ 比较熟练 ☐ 初学者
☐ 不使用电脑

7. 您如何评价您对供应链管理知识的理解程度?

☐ 非常熟悉 ☐ 比较熟悉

☐ 了解　　☐ 有一些了解

☐ 完全不了解

第二部分　互联网与供应链管理

8. 请选择您公司的软件应用情况。

软件类型	解释以及例子	目前正在使用	计划在两年内使用	计划在两年后使用	没有使用计划	不需要使用	不知道
条码系统	条码系统是通过给产品添加条码标签来记录生产以及销售情况。	☐	☐	☐	☐	☐	☐
射频识别系统 (RFID)	射频识别即 RFID 技术，又称电子标签、无线射频识别，是一种通信技术，可通过无线电讯号识别特定目标并读写相关数据，而无需识别系统与特定目标之间建立机械或光学接触。	☐	☐	☐	☐	☐	☐
电子信息交换系统 (EDI)	电子数据交换是指按照协议，把具有一定结构特征的经济信息，通过电子数据通讯网络 ，在商业贸易伙伴的计算机系统之间进行自动交换和自动处理。	☐	☐	☐	☐	☐	☐
企业资源计划系统 (ERP)	企业资源计划系统是指建立在信息技术基础上,以系统化的管理思想,为企业决策层及员工提供决策运行手段的管理平台。ERP 不仅仅是一个软件,更重要的是一个管理思想,它实现了企业内部资源和企业相关的外部资源的整合。通过软件把企业的人、财、物、产、供、销及相应的物流、信息流、资金流、管理流、增值流等紧密地集成起来,实现资源优化和共享。例如: SAP, Oracle, JD Edwards, PeopleSoft.	☐	☐	☐	☐	☐	☐
客户关系管理系统 (CRM)	客户关系管理的内含是企业利用 IT 技术和互联网技术实现对客户的整合营销，是以客户为核心的企业营销的技术实现和管理实现。	☐	☐	☐	☐	☐	☐
自动质量控制系统 (AQC)	自动质量控制系统帮助企业监控产品质量，检测生产环节，规范以及统计产品规格等。	☐	☐	☐	☐	☐	☐
仓库管理系统 (WMS)	仓库管理系统通过仓库来追踪以及监控从接货到装货的库存流动情况。他提供系统化的物料管理来缩短运营时间，减少成本。	☐	☐	☐	☐	☐	☐
交通管理系统 (TMS)	交通管理系统目的在于通过贸易伙伴对公司提供不同的复杂运输要求来实现企业范围内的装货控制中心。	☐	☐	☐	☐	☐	☐
地理位置追踪系统	卫星定位跟踪器经常被用在运输车中定位，来提供追溯信息。	☐	☐	☐	☐	☐	☐
其它软件，请详细说明：_____		☐	☐	☐	☐	☐	☐

软件类型	解释以及例子	目前正在使用	计划在两年内使用	计划在两年后使用	没有使用计划	不需要使用	不知道

9. 请指出您公司中专职信息技术应用的员工人数

☐ 无　☐ 1-5 人
☐ 6-10 人　☐ 11-20 人
☐ 多于 20 人

10. 请选择您公司目前应用的互联网技术。

☐ 电子邮件系统　☐ 公司网站
☐ 公司内部网 （Intranet）
公司内部网是私人计算机网络，它应用互联网协议，网络连接以及公共电信系统来安全的在组织内部共享信息。有时候，公司内部网也用来指代企业雇员可以浏览的内部网站。
☐ 公司外部网 (Extranet)
公司外部网是私人计算机网络，它应用互联网协议，网络联机以尽可能的公共电信系统来安全的在组织与供应商，顾客，合作伙伴以及其他的商务伙伴之间共享信息。一个公司外部网也可以使公司内部网的一部分，但是可以在公司网络以外浏览。
☐ 在线沟通工具，例如：QQ, skype, msn 等.　☐ 没有任何的互联网应用

11. 如果您公司目前拥有公司网站，您的网站支持下列哪些功能？

☐ 公司信息　☐ 产品信息
☐ 在线订货　☐ 在线转账/在线交费付款
☐ 供货商账户管理　☐ 客户账户管理
☐ 其他在线服务　☐ 没有公司网站

12. 您的公司网站在何种程度上与公司后台系统电子化关联整合？

☐1 ☐2 ☐3 ☐4 ☐5 ☐0
无联系　很大程度上关联　不知道

13. 您公司的数据库在何种程度上和供货商的数据库电子化关联整合？

☐1 ☐2 ☐3 ☐4 ☐5 ☐0
无联系　大程度上关联　不知道

14. 您公司的数据库在何种程度上和客户的数据库电子化关联整合？

☐1 ☐2 ☐3 ☐4 ☐5 ☐0
无联系　大程度上关联　不知道

16. 本题将帮助您评估您公司目前供应链的信息技术应用阶段。

请仔细阅读关于每一个阶段的定义，然后根据您公司的目前情况选择。

☐ 阶段一：关联整合前期

供应链的主要功能由手动完成，例如电话，传真，私人沟通以及电子邮件沟通等，另外，公司也通过浏览器在线搜索市场信息。

☐ 阶段二：功能性整合

公司应用软件来帮助管理单独的供应链功能，例如条码系统，RFID，EDI，ERP，CRM，AQC，WMS，TMS 以及地理位置追踪系统。

☐ 阶段三：企业内部整合

公司不仅应用软件来帮助管理供应链，同时也建立 Intranet（公司内部网）来连接各个软件，以在公司内部的各个部门之间共享即时信息。.

☐ 阶段四：企业间协同合作

Extranet（公司外部网）被广泛的应用在公司和重要合作伙伴之间，用来共享信息和加快交易进度。

☐ 阶段五：全网络化关联整合

这个阶段里，公司将通过整个网络的连接和应用信息技术来达到信息共享并获取市场主导位置。电子化信息被广泛的共享与网络成员中，其中包括了电子商务，数字化沟通技术等来达到整个价值网络的连接。

15.a 在将来的五年，您认为您公司最有可能达到供应链的那个阶段？阶段_____。

16. 和其他新鲜蔬菜水果企业比较，您公司在供应链中采用互联网技术这个问题上属于下列哪一个角色？

☐ 未采用者　　☐ 缓慢采用者

☐ 快速采用者　　☐ 领先采用者

☐ 不知道

17. 在过去的一年里（2006），互联网对供应链成本有何影响？

☐1　☐2　☐3　☐4　☐5　☐0

无影响　　成本明显降低　不知道

18. 在过去的一年里（2006），互联网对公司收益有何影响？

☐1　☐2　☐3　☐4　☐5　☐0

无影响　　收益明显增加　不知道

第三部分 影响互联网技术应用的原因

您如何评价您的员工对企业供应链战略的理解程度？

19. ☐1 ☐2 ☐3 ☐4 ☐5 ☐0
很差 非常好 不知道

您如何评价您的员工应用供应链软件的技能水平或者应用电子化供应链的技能水平？

20. ☐1 ☐2 ☐3 ☐4 ☐5 ☐0
很差 非常好 不知道

您公司的供应链战略与公司总战略的一致程度如何？

21. ☐1 ☐2 ☐3 ☐4 ☐5 ☐0
根本不一致 完全一致 不知道

您如何判断您公司供应链运作的复杂程度？

22.

	极其简单				极其复杂	不知道
内部复杂程度	☐1	☐2	☐3	☐4	☐5	☐0
外部复杂程度	☐1	☐2	☐3	☐4	☐5	☐0

23. 请指出在下列商业活动中，哪位参与者起主要决定作用。

	您的公司	您的供应商	您的客户	无此活动	不知道
决定沟通交流方式，例如传真，电话，电子邮件，EDI 等	☐	☐	☐	☐	☐
决定采用哪个信息系统来交流信息	☐	☐	☐	☐	☐
决定在订货过程中采用互联网或相关软件交流的规则	☐	☐	☐	☐	☐

24. 您认为您的公司与合作伙伴间的相互信任程度如何？

☐1 ☐2 ☐3 ☐4 ☐5 ☐0

信任程度很低 信任程度很高 知道

25. 您认为在蔬菜水果供应链中采用互联网技术的好处有哪些？

26. 您认为下列因素在何种程度上对供应链中采用互联网技术起到促进作用？

促进因素	非促进因素				主要促进因素	不知道
采用 IT 技术的益处	☐1	☐2	☐3	☐4	☐5	☐0
来自管理层的压力	☐1	☐2	☐3	☐4	☐5	☐0
您公司的地理经营范围	☐1	☐2	☐3	☐4	☐5	☐0
来自客户要求整合的压力	☐1	☐2	☐3	☐4	☐5	☐0
来自供应商要求整合的压力	☐1	☐2	☐3	☐4	☐5	☐0
市场竞争的压力	☐1	☐2	☐3	☐4	☐5	☐0
蔬菜水果供应链的自身特点（例如，不确定性，易腐烂性等）	☐1	☐2	☐3	☐4	☐5	☐0
商务运作的高复杂性	☐1	☐2	☐3	☐4	☐5	☐0
政府鼓励使用互联网技术	☐1	☐2	☐3	☐4	☐5	☐0
银行要求电子化付款	☐1	☐2	☐3	☐4	☐5	☐0
其他因素，请详细说明: _____	☐1	☐2	☐3	☐4	☐5	☐0
促进因素	非促进因素				主要促进因素	不知道

27. 您认为下列因素在何种程度上对供应链中采用互联网技术起到障碍作用？

障碍因素	非障碍因素				主要障碍因素	不知道
互联网技术实施成本	□1	□2	□3	□4	□5	□0
IT 基本设施不完善	□1	□2	□3	□4	□5	□0
缺乏相关知识	□1	□2	□3	□4	□5	□0
缺乏培训	□1	□2	□3	□4	□5	□0
担心互联网交易的安全性	□1	□2	□3	□4	□5	□0
不愿意分享信息	□1	□2	□3	□4	□5	□0
企业不愿改变目前的供应链现状	□1	□2	□3	□4	□5	□0
与贸易伙伴间缺乏信任	□1	□2	□3	□4	□5	□0
缺少信息技术水平相当的合作伙伴	□1	□2	□3	□4	□5	□0
缺乏针对在线交易的法律保护	□1	□2	□3	□4	□5	□0
其他，请详细说明:_____	□1	□2	□3	□4	□5	□0
障碍因素	非障碍因素				主要障碍因素	不知道

请您留下对本次调研的任何意见或建议

感谢您完成问卷！

您是否希望收到本问卷的调查报告？

□否
□是，请留下电子邮件或名片