UNIVERSITY OF LIVERPOOL

AN EXAMINATION OF MULTI-TIER SUPPLY CHAIN STRATEGY ALIGNMENT IN THE FOOD INDUSTRY

Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor in Philosophy

By

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ABSTRACT

A deep understanding of Supply Chain Management (SCM) is key to a company's ability to achieve and maintain competitive advantage. In order to leverage the full potential for shaping competitive performance that is presented by contemporary supply chain configurations, the congruence between supply chain strategy, business strategy and market requirements has to be firmly established. This research presents the findings of a survey of 170 companies that was undertaken to examine the alignment of product and supply chain types of companies operating in food supply chains in the UK and Malaysia. The study provides both an empirical, comparative analysis of the two-dimensional (Fisher, 1997) product-supply chain array and the three-dimensional (Huang et al., 2002) product supply chain array within a single sector and the means to examine how competitive priorities match supply chain characteristics for different types of food products. Competence index is calculated to compare the performance of product-supply chain strategy combinations.

The results indicate that the association between product type and supply chain strategy is not significant. The results show that functional food products are generally supported by supply chains that possess lean characteristics uniformly across their tiers that they and place emphasis on price and quality. This conforms to Fisher's (1997) and Huang et al.'s (2002) theories. The alignment between product and supply chain strategy across supply chain tiers indicates good alignment for functional products in the food supply chains of both countries. However, innovative food products are not uniformly supported by agile supply chains. In general, innovative products were found to be supported by short, leagile supply chain where manufacturers have an efficient (analogous to functional) focus while downstream partners have an agile focus. The three-dimensional product-supply chain array indicates similar results to the two-dimensional array.

Delivery speed and delivery reliability were conspicuous competitive priorities for these products. In addition, the functional-lean relationship was commonly found in Malaysian supply chains with relatively few product-supply chain mismatches. Price and quality were strongly aligned across all tiers. A far greater proportion of product-supply chain mismatches were found in the UK. The results show the competence index does not show any significant performance between matched and mismatched product-supply chain strategy combinations.

Keywords: supply chain strategy; food industry; performance; product type; supply chain design

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Chapter 1 INTRODUCTION

1.1 Introduction

This chapter discusses the background to this research and explains the reasons for pursuing it. The chapter also demonstrates the importance of the research output for both industrial practitioners and academia. In order to set a clear direction for the research journey, research questions and hypotheses are developed, as shown below. The remainder of the chapter focuses on the research scope and sample, chapter summary and thesis overview.

1.2 Research Background and Motivation

The term 'supply chain management' (SCM), when first used in the early 1980s, referred to the management of materials across functional boundaries within organisations. However, the term was then broadened to include 'upstream' manufacturing chains and 'downstream' distribution channels (Lamming et al., 2000, Mentzer et al., 2001, Waddington et al., 2001,). SCM has been defined as '*....a set of approaches utilised to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations and at the right time, in order to minimise system-wide costs while satisfying service level requirements....*' (Simchi-Levi et al., 2007). Successful SCM requires a co-ordinated approach to customer satisfaction across the tiers of the chain. Customers make demands of these tiers in terms of, for example, fast delivery of products (Stewart, 1997, Christopher and Towill, 2002), speedy fulfilment of orders (Stewart, 1997, Childerhouse and Towill, 2000), provision of a wide variety of products (Childerhouse and Towill, 2000, Christopher et al., 2004, Kaipia and Holmstrom, 2007), meeting high demand for specific products (Christopher et al., 2004), and ensuring shorter life cycles for products (Childerhouse and Towill, 2000, Waller et al., 2000, Christopher et al., 2004).

Despite the obdurate issue of separate business unit ownership (Lambert et al., 1998, Lambert and Cooper, 2000, Christopher and Towill, 2002), supply chains are being looked upon as units of competition and their management is increasingly being undertaken from an holistic and integrated perspective (Fearne and Hughes, 1999). Such a vantage point makes the development of a supply chain strategy feasible and meaningful across a multi-business chain. The alignment of such a strategy with product characteristics has been said to enable businesses to unlock many benefits (Cousins, 2005), such as an improvement in supply chain competitiveness (Croom et al., 2000), the achievement of optimum supply chain performance (Lambert and Pohlen, 2001, Sun et al., 2009), the enhancement of delivery flexibility (Duclos et al., 2003) and the reduction of cost throughout the whole supply chain (Rahman, 2002). Due to diverse and varying customer requirements, it is not possible to provide a single supply chain strategy, as '*one size does not fit all*' (Shewchuck, 1998). The firm that shared strategic collaborations have much higher propensity to develop commitment, learning, shared vision and knowledge sharing (Calanto et al., 2002). Thus, it fully benefits to supply chains. Therefore, the examination of multi-tier supply chain strategy is important to improve competitive position and marketing position of the firm.

Fisher (1997) reported that a study of the US food industry showed that 30 billion dollars was wasted due to poor co-ordination among supply chain partners who failed to predict customer demand, resulting in a markdown of sales price in order to clear excess stocks, while the products that experienced high demand were out of stock. In addition, a study by Stanford University and Accenture of 100 manufacturers in the food and consumer products industries indicated that companies which were employed in joint replenishment and planning programmes with their trading partners obtained higher profits than companies which were not (Lee, 2002). It is evident that an appropriate supply chain strategy should strive to align business goals with customer needs and should be coordinated across supply chain tiers (Fisher, 1997, Cousin, 2005).

Fisher (1997) had proposed a two-dimensional matrix to align supply chain type with product type. Huang et al. (2002) extended Fisher's framework by incorporating hybrid and leagile supply chains to the two-dimensional matrix forming a three-dimensional matrix. The framework has become synonymous with supply chain strategy and is purported to improve supply chain performance. This research examines multi-tier supply chain strategy alignment through the identification and analysis of product characteristics and attributes, and their relationship to supply chain structure and behaviour. Fisher's (1997) and Huang et al. (2002) theories indicate that such an alignment should provide the mechanism for establishing linkage between supply chain strategy and customer satisfaction in the marketplace. The marketplaces in question are the UK and Malaysian food sectors, which are scrutinised with the use of a survey-based approach to empirical data collection.

In this study, the food industry was selected because it is the largest manufacturing sector, accounting for 15% of overall manufacturing industry with a total turnover of £70 billion annually in the UK (Boothby et al., 2007). The food industry in Malaysia contributes 10% of the overall manufacturing output and is dominated by small and medium-sized companies (Malaysian Industry Development Authority, 2008). Fisher (1997) and Lee (2002) devoted much attention to SC strategy development in the food industry. According to Fisher (1997), some products, such as ice cream, coffee and cookies, may be classified as either functional or innovative depending upon the characteristics of their demand patterns. Furthermore, the food sector is required to provide robust supply, distribution and sales channels and handle products with quite heterogeneous characteristics(Fisher, 1997, Ruteri and Xu, 2009). This sector, therefore, has clear potential for a rich mix of functional, innovative, lean and agile product and supply scenarios. The food sector is chosen due to its critical contributor to physical well-being and a major source of pleasure, worry and stress (Rozin, Fischler, Imada, Sarubin, & Wrzesniewski, 1999), crises like dioxin pollution, classical swine fever, and avian influenza that contributed to the customer's concerns about quality and safety of food production system (Wognum et al., 2011). Besides, consumers are faced with a wide range of competitively priced food products of consistently high quality. Food supply chain characteristic is different from other industries such as shelf life constraint (Vorst et al., 2005, Ruteri and Xu, 2009), perishability (Vlajic et al., 2008), requirements regarded product freshness and food safety (Francis, 1979), production seasonality (Fisher, 1997, Lee, 2002, Ruteri and Xu, 2009), unpredictable demand (Lee, 2002, and legislations (Vorst et al., 2005, Vlajic et al., 2008). Moreover, the empirical work in this area is still limited. These characteristics provide the justification for focusing on the food sector. Moreover, it was felt that there was a genuine business need to gain the full benefits of this research's findings of the examination of supply chain strategy alignment. The findings also contributes to the prove (or disprove) the previous conceptual work.

Further motivation was provided by a desire to draw a comparison between a developed (UK) and developing (Malaysia) economy that suitable for comparative study between Western and non-Western supply chain strategy activity. The empirical evidence that have been undertaken, have usually for single country such as Australia (Lo and Power, 2010), Taiwan (Sun et al., 2009) and Sweden (Selldin and Olhager, 2007). The empirical evidence of comparative studies between Western and non-Western country have received limited attention. The importance of the study also to examine supply chain behaviour in a sector where the demand pattern is often dependent on climate (MacDonald, 2000, Lee, 2002) and its implications for a country with four seasons (UK- winter, spring, summer and autumn) compared to one with only two (Malaysia – rain and summer).

1.3 Objectives of the Study

The objectives of this research are to examine the alignment of multi-tier supply chain strategies between product types and supply chain types for food supply chains in the UK and Malaysia. The investigations include:

a) A comparative analysis related to the product-supply chain arrays proposed by Fisher (1997) and Huang et al. (2002),

b) A comparative analysis related to the product-supply chain strategy alignment with competitive priorities as proposed by Mason-Jones et al. (2000(a)), (2000(b)) and Roh et al. (2008), and

c) Competence index performance of a supply chain when adopting specific competitive priorities adapted from Cleveland et al.'s (1989) approach.

Research questions formulated to meet the aims of the research are as follows:

a) Does Fisher's (1997) model represent the association between product nature and supply chain strategy appropriately?

b) Do product type have a significant influence on the adoption of supply chain in food industries?

c) Do product supply chain strategy combination have a significant influence on any specific competitive priorities across tiers?

d) Are companies with a good fit between products and supply chains strategy better performers than companies with mismatch companies?

In order to answer the research questions, the investigations are divided into two aspects:

a) Multi-tier supply chain analysis

b) Comparative analysis between the UK and Malaysia

1.4 Hypotheses

The hypotheses for this research were developed based on the previous theoretical frameworks of supply chain strategy proposed by Fisher (1997), Huang et al. (2002), Mason-Jones et al. (2000(a)), Mason-Jones et al. (2000(b)) and Roh et al. (2008). The hypotheses are as follows:

H_0: Product and supply chain type are directly related.

H_1: Food companies with a functional product adopt lean supply chain characteristics as opposed to agile supply chain characteristics.

H_2: Food companies with an innovative product adopt agile supply chain characteristics as opposed to lean supply chain characteristics.

H_3: Food companies with a hybrid products adopt leagile supply chain characteristics, where lean and agile in upstream and downstream supply chain respectively.

H_{1a}: Food companies with a functional-lean combination adopt a low selling price as a key competitive priority.

H_{1b}: Food companies with a functional-lean combination adopt quality as a key competitive priority.

H_{2a}: Food companies with an innovative-agile combination adopt high product variety as a key competitive priority.

H_{2b}: Food companies with an innovative-agile combination adopt large order size flexibility as a key competitive priority.

H_{2c}: Food companies with an innovative-agile combination adopt quality as a key competitive priority.

H_{2d}: Food companies with an innovative-agile combination adopt delivery speed as a key competitive priority.

H_{2e}: Food companies with an innovative-agile combination adopt delivery reliability as a key competitive priority.

H_{2f}: Food companies with an innovative-agile combination adopt product design as a key competitive priority.

H_{3a}: Food companies with a hybrid-lean combination adopt quality as a key competitive priority in upstream supply chains.

H_{3b}: Food companies with a hybrid-lean combination adopt a low selling price as a key competitive priority in upstream supply chains.

H_{3c}: Food companies with a hybrid-agile combination adopt quality as a key competitive priority in downstream supply chains.

H_{3d}: Food companies with a hybrid-agile combination adopt delivery speed as a key competitive priority in downstream supply chains.

H_{3e}: Food companies with a hybrid-agile combination adopt delivery reliability as a key competitive priority in downstream supply chains.

H_{3f}: Food companies with a hybrid-agile combination adopt flexibility as a key competitive priority in downstream supply chains.

H_{4a}: Food companies with a functional-lean product-supply chain strategy combination perform better in terms of cost and quality.

H_{4b}: Food companies with a functional-agile product-supply chain combination strategy perform better in terms of cost, flexibility and quality.

H_{4c}: Food companies with an innovative-lean product-supply chain strategy perform better in terms of speed of delivery and flexibility.

H_{4d}: Food companies with an innovative-agile product-supply chain strategy perform better in terms of speed of delivery, flexibility and innovation.

H_{5a}: Food supply chains for functional products adopt lean characteristics throughout the tiers of the chain.

H_{5b}: Food supply chains for innovative products adopt agile characteristics throughout the tiers of the chain.

H_{5c}: Food supply chains for hybrid products adopt leagile characteristics throughout the tiers of the chain.

1.5 Research scope and sample

This research examines mainly the alignment between product-supply chain strategies in multi-tier supply chains within food industries. This study concerns an empirical analysis of the manufacturers, distributors, wholesalers and retailers in the UK and Malaysia. The samples of respondents include all sizes of industries: small and medium enterprises (SMEs), which are the most common, and medium and large companies. The scope of the research does not include food industries that provide packing, labelling, catering, restaurants, or pet food companies.

1.6 Chapter Summary

This study is organised into eight chapters: introduction, a literature review, methodology, analyses in three different chapters and, finally, a discussion and conclusion, as shown in Figure 1.1 below.

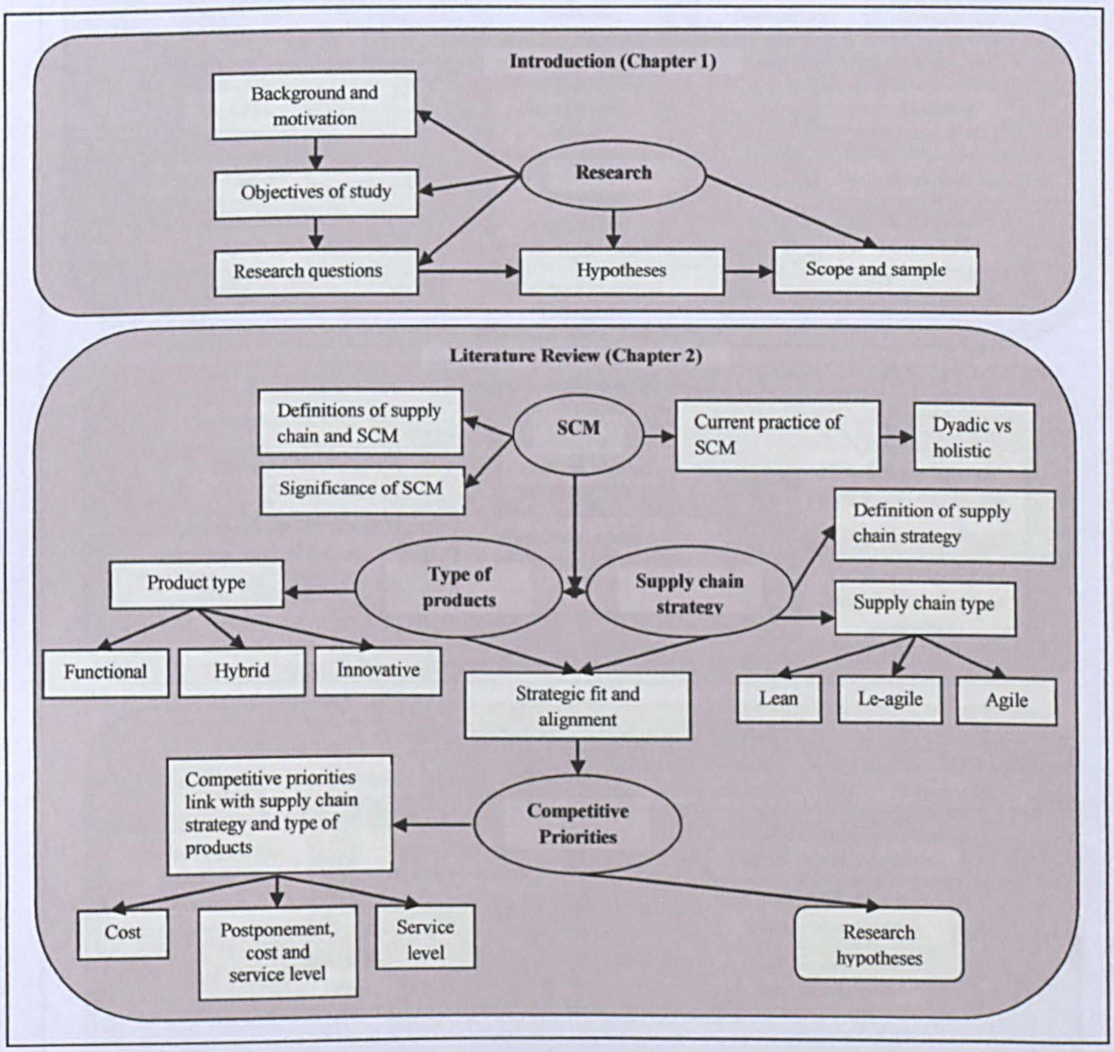


Figure 1.1(a): Thesis Overview

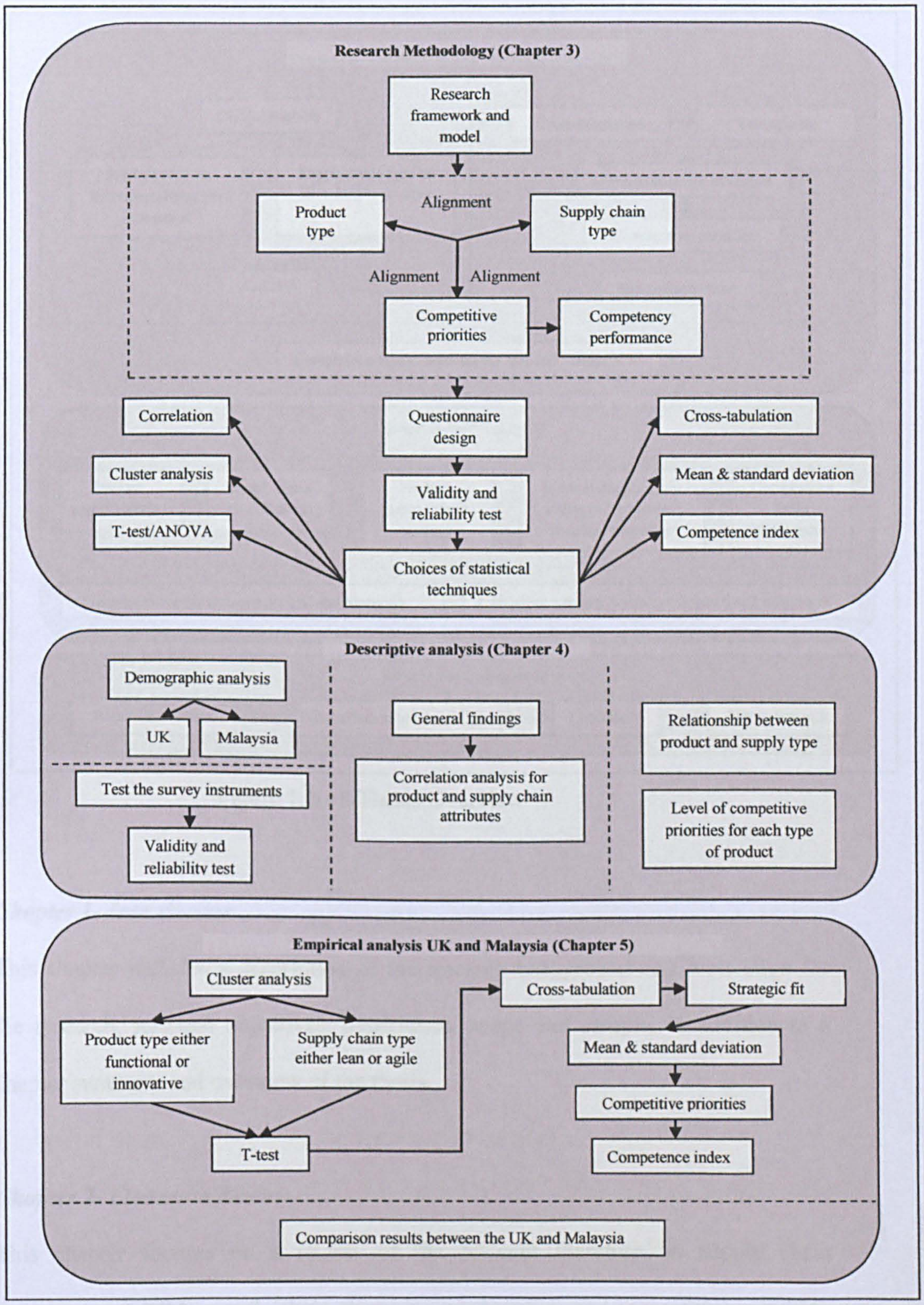


Figure 1.1(b): Thesis Overview

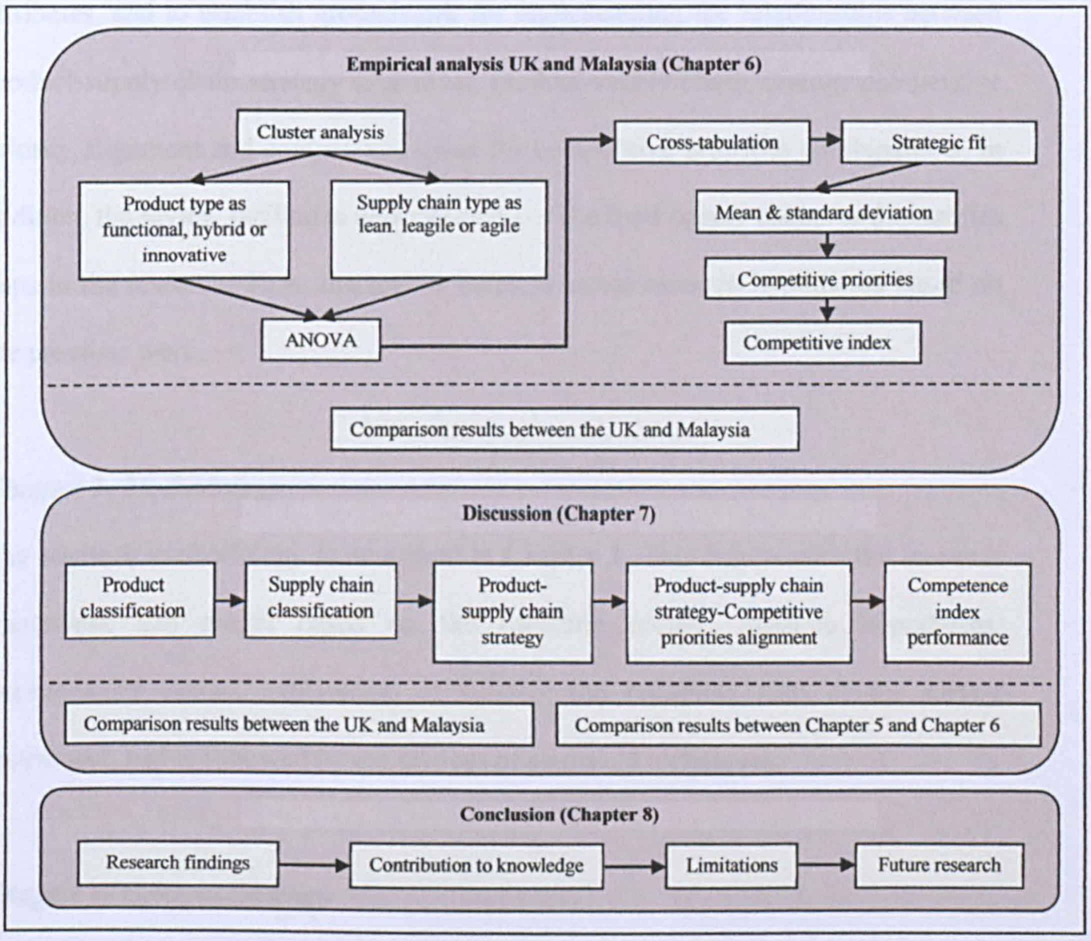


Figure 1.1(c): Thesis Overview

Chapter 1- Introduction

This chapter includes a description of the research background and motivation for the research, research objectives, hypotheses, scope and sample, in addition to a chapter summary and overview of the thesis.

Chapter 2- Literature Review

This chapter focuses on a review of the relevant literature on supply chain management (SCM), supply chain strategies, product type and competitive priorities. The main purpose of this chapter is to identify product attributes, supply chain attributes, and to establish groundwork for understanding the relationships between product-supply chain strategy alignment, product-supply chain strategy-competitive priority alignment and competence index for competitive priorities combinations. In addition, the review facilitates understanding of the food supply chains and identifies gaps in the research. Thus, the review helps to create research hypotheses based on the previous work.

Chapter 3- Methodology

The research methodology is described in Chapter 3. This begins with the research framework and model based on the literature review, research hypotheses, questionnaire design, explanation of validity and reliability tests of the survey instrument, and is followed by the choices of statistical techniques.

Chapter 4- General findings

The descriptive analysis discusses a demographic analysis comparing the UK and Malaysian food industries. General findings include validity and reliability test results of the survey instruments, correlation analysis for product attributes and supply chain design criteria, and the alignment between product types and competitive priorities in the UK and Malaysia.

Chapter 5- Analysis 2x2 matrix for the UK and Malaysia

Chapter 5 consists of the statistical analysis for examining the classification of product and supply chains, alignment between product-supply chain strategy and alignment between product-supply chain strategy-competitive priorities. Product classification concerns functional and innovative types, while supply chain types considered are lean and agile. All analyses are concerned with the UK and Malaysian food industries. The empirical results and analysis in this chapter are based on cluster analysis, t-test, cross-tabulation, mean (μ) and standard deviation (*SD*). The performance of product-supply chain strategy is then evaluated using the notion of a competence index. In the summary section, comparisons of results between the UK and Malaysia are displayed.

Chapter 6- Analysis 3x3 matrix for the UK and Malaysia

This chapter is presented in a similar format as Chapter 5, with the addition of hybrid and leagile supply chain strategies. Cluster analysis, multi-variate ANOVA, mean (μ), standard deviation *(SD)* and competitive index analyses were undertaken. Based on the literature review, for the food industries it is appropriate to add a hybrid product classification as food products include a mix of different attributes called 'intermediate' products. Moreover, the two product classifications in Chapter 5 are at extremes between two obvious differences without taking into consideration the intermediate type of product. The notion of the leagile supply chain is also included in this chapter to verify the application of postponement across supply chain tiers employed in the food industry. In the summary section, the differences in findings between the UK and Malaysia are presented.

Chapter 7- Discussion

This chapter contains discussions on five aspects, including product type, supply chain type, product-supply chain strategy alignment, product-supply chain strategy-competitive priorities alignment and competence index performance. All aspects of discussions compare results for the UK and Malaysia. The arguments relate the findings to the literature and supply chain knowledge before generalising it to relate to the area of study.

Chapter 8- Conclusion

Chapter 8 is the final chapter of this thesis. This chapter provides a summary of the research findings, contributions to knowledge, limitations of the study and recommendation for future work. The conclusion also answers the research hypotheses and questions.

Chapter 2 LITERATURE REVIEW

2.1 Introduction

This chapter is divided into three sections to provide the background theory covering each of the topics as the basis of this research. It also helps to clarify the chronology of the previous research, thus presenting the significance of this research.

The first section covers the concepts of supply chains and supply chain management (SCM). The introduction to supply chains is accompanied by a review of food supply chain research. A series of SCM issues and challenges is also scrutinised.

The second section discusses the development of supply chain strategies. The core of the literature review provides discussions on existing supply chain strategies in the food industry. These are based on different perspectives on supply chain strategies provided by previous researchers. A review of supply chain strategies follows, providing a suitable platform for their alignment.

Finally, the third section discusses competitive priorities and key performance indicators in order to support supply chain strategy alignment and help businesses achieve their full potential.

2.2 Supply Chain

A supply chain can be defined as:

Author(s)	Definition
Steven (1989)	A system whose constituent parts include materials suppliers, production facilities, distribution services and customers linked together via the feed forward flow of materials and the feedback flow of information.
Scott and Westbrook (1991)	The chain linking each element of the production and supply process, from raw materials through to the end customer. Typically such a chain will cross several organisational boundaries. It consists of flows of materials and products through various production and distribution processes in one direction, and flows of information to provide control mechanisms, mostly in the other direction.
La Londe and Masters (1994)	Firms that pass materials forward, which includes raw materials and component producers, product and assemblers, wholesalers, retailer merchants and transportation companies involved in manufacturing and placing products in the hands of the end user (customer).
Lummus and Alber (1997)	The network of entities through which material flows. Those entities may include suppliers, carriers, manufacturing sites, distribution centres, retailers and customers.
Lummus and Vokurka (1999)	All the activities involved in delivering a product from raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, delivery to the customer, and the information systems necessary to monitor all of these activities.
Ballou et al. (2000)	The supply chain refers to all those activities associated with the transformation and flow of goods and services, including their attendant information flows, from the sources of raw materials to end users.
Smith and Lockamy (2000)	Supply chain is a network of operating entities through which an organisation delivers products or services to a particular customer market (cf Poirier and Reiter, 1996). This network constitutes an indispensable portion of the business system that Porter (1995) later called value stream, and which cost management theorist and practitioners now refer to as either the extended enterprises (Ansari et al., 1997) or the value chain (Drury and McWatters, 1998; Shank and Govindarajan, 1993).
Mentzer et al. (2001)	As a set of three or more entities (organizations or individual) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer.
Rafele (2004)	Supply chain can be divided into two parts which are: intra-firm (internal to the firm) and inter-firm aspects (external, tie together supplier and buyer).
Harrison and Hoek (2008)	As a network of partners who collectively convert a basic commodity (upstream) into a finished product (downstream) that is valued by end customers, and who manage returns at each stage. Each partner of supply chain is responsible directly to a process that adds value to a product. A process means transforms input in the form of materials and information into outputs in the forms of good and services.

Table 2.1: Supply Chain Definitions

Based on the above definitions, it is clear that material flows and information systems that involve suppliers, carriers, distributors and retailers are important in delivering products to customers. Members of a supply chain involve suppliers, manufacturing plants, warehouses, customers and distributors (Duclos et al., 2003). In other words, a supply chain is the network of organisations that involve upstream and downstream associations delivering either products or services to the end user.

2.3 Supply Chain Management (SCM)

The term 'supply chain management' (Council of Supply Chain Management Professional, 1998), first used in the early 1980s, referred to the management of materials across functional boundaries within organisations, but was then widened beyond the traditional boundaries of organisations to incorporate 'upstream' manufacturing chains and 'downstream' distribution channels (Lamming et al, 2000; Mentzer et al, 2001). SCM has been defined as follows:

Authors	Definition
Houlihan (1988)	Differences between supply chain management and classical materials and manufacturing control: 1) The supply chain is viewed as a single process. Responsibility for the various segments in the chain is not fragmented and relegated to functional areas such as manufacturing, purchasing, distribution, and sales. 2) Supply chain management calls for, and in the end depends on, strategic decision making. 'Supply' is a shared objective of practically every function in the chain and is of particular strategic significance because of its impact on overall costs and market share. 3) Supply chain management calls for a different perspective on inventories which are used as a balancing mechanism of last, not first, resort. 4) A new approach to system is required - integration rather than interfacing'.
Stevens (1989)	'Supply chain is the connected series of activities which is concerned with planning, coordinating and controlling material, parts and finished goods from suppliers to the customer. It is concerned with two distinct flows through the organisation: material and information.'

	'The objective of managing the supply chain is to synchronise the requirements of the customer with the flow of materials from suppliers in order to effect a balance between what are often seen as conflicting goals of high customer service, low inventory management, and low unit cost.'
Council of Supply Chain Management Professional (1998)	'Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies.'
Harland (1996)	Managing business activities and relationships (1) internally within an organization, (2) with immediate suppliers, (3) with first and second-tier suppliers and customers along the supply chain, and (4) with the entire supply chain.
Beamon (1998)	An integrated process wherein a number of various business entities (i.e., suppliers, manufacturers, distributors, and retailers) work together in an effort to: (1) acquire raw materials, (2) convert these raw materials into specified final products, and (3) deliver these final products to retailers.
Lummus and Vokurka (1999)	SCM coordinates and integrates; all of activities involved in delivering a product from raw material through to the customer including sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, delivery to the customer into a seamless process.
Mentzer et al (2001)	'...the systemic; strategic coordination of the traditional business functions and the tactic across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long term performance of the individual companies and the supply chain as a whole'
Duclos et al. (2003)	'Supply chain management includes managing supply and demand, sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, and delivery to the customer.'
Simchi-Levi et al. (2007)	'....a set of approaches utilised to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations and at the right time, in order to minimise system-wide costs while satisfying service level requirements...'
Harrison and Hoek (2008)	Planning and controlling all of the business processes - from end customer to raw materials suppliers - that link partners in a supply chain in order to serve the needs of the end-customer.

Table 2.2: Supply Chain Management Definitions

However, confusion over the definition of supply chain management is one of the obstacles to good SCM practice (Lambert and Cooper, 2000, Lummus et al., 2001). According to Kemppainen and Vepsäläinen (2003), current supply chain practices differ from those of the early 1990s and also with those expected in the near future.

In 1986, the supply chain was viewed as the logistics beyond a firm's boundaries, including customers and suppliers (Lambert and Cooper, 2000). Then, in 1998, the concept of the supply chain was redefined by the Council of Supply Chain Management Professionals (CSCMP). According to Lummus et al. (2001), supply chain management includes information systems integration and the coordination of planning and control activities, which are not typically included in a logistics definition.

Supply chains are also known by various other terms, such as '*extended enterprises*' (Browne et al, 1995), '*value streams*' (Womack and Jones, 1996), '*value chains*' (Walters and Lancaster, 2000), and '*demand chains*' (Frohlich and Westbrook, 2002). The objectives of SCM can be summarised as follows:

a) to increase efficiency and minimise costs across the entire supply chain.

b) to meet demand requirements, or, specifically, to satisfy end customers' requirements.

c) to monitor the supply chain using information systems.

Today there are many SCM definitions with a variety of conceptual frameworks. According to Gibson et al. (2005), these definitions have not yet been tested in the marketplace. Their research indicates that the existing definitions do not consistently represent SCM. The focus of the definitions varies, and includes strategies, activities, processes and a combination of all three. Based on Gibson et al.'s (2005) results, the primary role of SCM involves both strategy and activity. According to CSCMP, the important roles of SCM include:

a) Supplier and customer collaboration

b) Information technology

c) Marketing

d) Finance

e) Sales

f) Product design

Supplier and customer collaboration has been identified as a key component activity in SCM. In addition, Mentzer et al. (2001) listed a set of SCM activities to implement for good management. The activities are:

a) Integrated behaviour

b) Mutually sharing information

c) Mutually sharing risks and rewards

d) Collaboration

e) The same goal and the same focus on serving customers

f) Integration of processes (from sourcing, manufacturing, distribution across the supply chain)

g) Building and maintaining long-term relationship with partners

In addition to these, it is necessary to include collaboration in SCM definitions. CSCMP has excluded 'demand creation and fulfilment' from their official definition, which has contributed to continuous debate about what SCM actually is. Cigolini et al. (2004) summarised the key characteristics of SCM as follows:

a) Most of the definitions agree that the supply chain covers the materials from suppliers to end users.

b) The emphasis is on including all channel members, from the beginning to the end.

c) The definitions highlight the flow of materials rather than that of information.

In addition, Mentzer et al. (2001) proposed that SCM philosophy has to have the following characteristics:

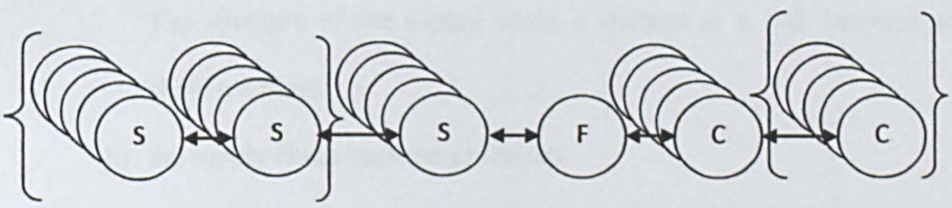
a) A system approach to viewing the supply chain as a whole, and to managing the total flow of goods inventory from the supplier to the ultimate customer
b) A strategic orientation toward cooperative efforts to synchronise intra-firm and inter-firm operational and strategic capabilities into a unified whole
c) A customer focus to create unique and individualised sources of customer value, leading to customer satisfaction.

Gibson et al. (2005) concluded that the definition of SCM should be revised and continuously examined by professional associations.

2.4 Evolution of SCM

In the 1950s and 1960s, mass production as the main operation strategy, was popular amongst most manufacturers, with a minimum of process flexibility and less variety of products, in order to minimise production costs. The work in process (WIP) inventory was problematic for the manufacturers as a result of 'bottlenecks' which disrupted the balanced line flow. During these periods, cooperation and shared technology received limited attention and was unacceptable in the buyer-supplier partnership. In the 1970s, the introduction of Manufacturing Resource Planning (MRP) received the attention of managers. Managers recognised the impact of WIP on manufacturing costs, quality, new product development and delivery lead time. The introduction of MRP resolved the problems. However, in the 1980s, global competition increased demand for value, quality, reliability and greater flexibility of design. Initiatives, such as just-in-time (JIT), were utilised to improve the efficiency of manufacturing and cycle time and to resolve scheduling problems. Manufacturers began to recognise the importance of strategic and cooperative buyer-supplier relationships. The involvement of procurement, physical distribution and transportation functions resulted in the integrated logistics called supply chain management (SCM) (Tan, 2001).

In the early 1990s, SCM practices became popular for further extending best practices in management of resources and included strategic suppliers and logistics functions in the system of supply chains. Improvement plans focused on operational issues, particularly in terms of cost competitiveness and inventory management. Good collaboration amongst the supply chain members involved only the closest partners and excluded second, third and n^{th}-tier suppliers and customers. The information collected from the customer was not delivered and shared with upstream supply chain members (Kemppainen and Vepsäläinen, 2003). Figure 2.1 shows a typical perception of a supply chain in the early 1990s.



Note: S = supplier, FC= focal company, C= customer

Figure 2.1: The emergent supply chain or how supply chains were first perceived in the early 1990s (Kemppainen and Vepsäläinen, 2003)

Increasing customer requirements and the involvement of information sharing and collaborative planning changed the concept of SCM. More recently, manufacturers and retailers have recognised the need for improved efficiency across the supply chain (Tan, 2001). SCM emphasises the need to view the supply chain as a single system (Lummus and Vokurka, 1999), and thus, become more competitive as a whole chain (Croom et al, 2000).

2.5 Obstacles in Managing Supply Chains

The supply chain and SCM definitions (sections 2.2 and 2.3 refer) indicate that the supply chain should be managed as a single chain with the same goal and focus on serving customers. However, the management of an entire supply chain is a more complicated and challenging task, which involves all levels of tiers, from suppliers to consumers (Lambert and Cooper, 2000). Management of the supply chain with consideration of the relationship with the end user is desirable, as the business environment has now become an end user-driven market. The SCM framework includes three main elements (Lambert et al., 1998):

a) the structure of the supply chain

   The structure of the supply chain is defined as a link between supply chain members.

b) the supply chain business processes

   The business processes are the activities that produce a specific output of value to the customer.

c) the supply chain management components

   The management components are the managerial variables by which the business processes are integrated and managed across the supply chain.

Competition should now not be among companies but among supply chains (Christopher, 1998; Christopher and Towill, 2001) in order to meet high-pressure demands. There are some obstacles in managing supply chains nowadays. The first obstacle arises from a misunderstanding of the SCM concept. Traditionally, the term 'supply chain' (Lummus and Vokurka, 1999, Lambert and Cooper, 2000; Milgate, 2001; Tan, 2001, Ballou, 2007) referred to:

- logistics
- distribution management purchasing
- inventory management
- supplier partnerships
- driven from the supply side
- a shipping strategy
- the logistics pipeline
- procurement management
- a computer system

The term, however, fails to integrate and treat all the firms involved as one entity (Sachan and Datta, 2005). Traditional supply chains have been driven by manufacturers, managing and controlling the pace at which products are developed, manufactured and distributed to customers (Stewart, 1997). SCM is not a standalone process but involves collaborative activities among the supply chain players.

The second difficulty is the complexity of the supply chain system, as shown in figure 2.2.

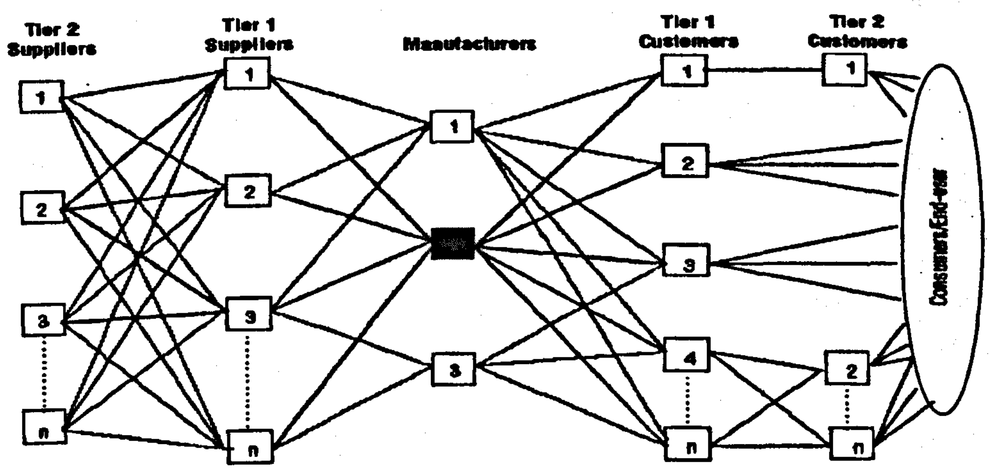


Figure 2.2: Supply chain complexity (Lambert et al, 1998)

The importance of incorporating SCM into the overall business planning process has been realised by many researchers (Harland et al, 1999; Beamon, 1999; Shin et al, 2000; Gunasekaran et al, 2001; Chan and Qi, 2003); however, it is not widely practised (Carter and Narasimhan, 1994). La Londe and Masters (1994) argued that a supply chain succeeds if all the members in the supply chain tiers have an identical goal and focus on serving customers. The complexity and overlapping of supply chains makes it difficult to manage and affects the whole supply chain (Lambert and Pohlen, 2001).

In recent years customers have played a major role in demanding more from manufacturers. These demands include fast delivery (Stewart, 1997; Christopher and Towill, 2002), quick order fulfilment (Stewart, 1997; Childerhouse and Towill, 2000), a wide variety of products (Childerhouse and Towill, 2000; Christopher et al, 2004; Kaipia and Holmstrom, 2007), high demand for specific products (Christopher et al., 2004), and shorter product life cycles (Jagdev and Browne; 1998; Childerhouse and Towill, 2000; Waller et al, 2000; Christopher et al, 2004). These make the supply chains more complex and challenging for effective management in today's markets (Christopher et al, 2004).

The fourth obstacle – the need to compete globally - makes the integration of SCM crucial. Therefore, willingness to share information among the supply chain members (Cooper et al., 1997) is needed. However, supply chain members are reluctant to share information, such as inventory levels, forecasts, sales promotion strategies and marketing strategies,, between other supply chain members across the chain. Transparency of information and gathering of data across supply chains is a sensitive issue. The concept of competing between supply chains rather than companies is still not well understood. In addition, a dyadic linkage, trust issues and low levels of partnership make the information level difficult to access. The integration of SCM among supply chain players has been decelerated for the following reasons (Lummus and Vokurka, 1999):

- Lack of guidelines for creating alliances with supply chain partners
- Failure to develop measures for monitoring alliances
- Inability to broaden the supply chain vision beyond procurement or product distribution to encompass larger business processes
- Inability to integrate the company's internal procedures
- Lack of trust inside and outside a company
- Organizational resistance to the concept
- Lack of buy-in by top managers
- Lack of integrated information systems and electronic commerce linking firms.

2.6 The Importance of SCM

The importance of good coordination among members of supply chains is summarised as follows:

a) To bring competitive advantage to businesses by integrating all the activities and linking all supply chain members into a seamless process (Fawcett and Mangnan, 2001, Duclos et al., 2003)

b) To achieve optimum supply chain performance (van Hoek, 1998, Lambert and Pohlen, 2001, Fawcett et al., 2008, Mehrjerdi, 2009)

c) To enhance delivery flexibility (Duclos et al., 2003, Fawcett et al., 2008)

d) To improve and facilitate the product innovation process throughout the supply chain (Fawcett and Magnan, 2001, Duclos et al., 2003, Crook et al., 2007, Fawcett et al., 2008)

e) To reduce cost throughout the whole supply chain (McLaren et al., 2002, Rahman, 2002, Folinas et al., 2004, Crook et al., 2007, Fawcett et al., 2008) and inventory cost (Fawcett and Magnan, 2001, Tan, 2002, McLaren et al., 2002)

f) To reduce information distortion (bullwhip effect) for the whole supply chain (Lee et al., 1997)

g) To enhance competitiveness and profitability (Smith and Lockamy, 2000)

h) To reduce cycle time (Fawcett and Magnan, 2001, McLaren et al., 2002, Fawcett et al., 2008)

Best practise in SCM is a key area of excellence for gaining competitive advantage through cost reduction, customer responsiveness and optimisation of asset utilisation (Christopher, 1988; Mehjerdi, 2009). The best SCM practices can lead to enhanced competitive advantage and help optimise organisational performance (Lummus and Vokurka, 1999; Li et al, 2006). Many organisations now recognise that SCM is a key feature in sustaining competitive advantage for their products or services due to the rapidly changing demands of the marketplace (Li et al, 2005; Li et. al., 2006). In order to achieve high performance in SCM, Lummus and Vokurka (1999) emphasised that a link between supply chain strategies and overall company strategies, and an overall view of the supply chain are needed to better understand and manage it. The issue and recognition of the challenge of supply chain strategy alignment is not new as researchers (Ellram and Carr, 1994, Harland et al., 1999) have noted its debate since the 1970s when the focus principally concerned purchasing strategy alignment. When the extended notion of SCM was conceptualised, research on the alignment of strategy became more conspicuous (Harland et al., 1999). The next section, therefore, concerns supply chain strategy literature.

2.7 Characteristics of Food Supply Chain

As mentioned in the background and motivation section (Chapter 1), food industry is unique and has their own additional characteristics. The characteristics are (van der Vorst et al., 2005, Vlajic et al., 2008):

a) Shelf life constraints, quality decay of products, and requirements regarded product freshness and food safety.

b) Long production throughput times, product dependent cleaning and processing times, production seasonality and (necessity) for quality testing time
c) Variability of product quality and supply quantity of farm-based input
d) High volume production systems and capital-intensive machinery
e) Specific requirements for logistics processes
f) Unpredictable consumer demands
g) Legislations concerning food production, food preservation, distribution, trade and quality of products.

Based on these characteristics, therefore food sector is important to be dynamic, cost minimisation, customer service improvement, product quality, speed delivery and flexible in order to maintain or improve the competitiveness in market demands.

2.8 Supply Chain Strategy

Supply chain strategy had been discussed by great authors (Farmer, 1978, Carr and Smeltzer, 1997, Farmer, 1997) since the early 1970s. Companies, and a number of scholars, often misused the term 'strategic' (Cousins and Spekman, 2003). According to Cousins and Spekman (2003), the meaning of strategic supply is related to an understanding of the pressures being faced by companies and how they react to those pressures. The key question is which supply method is most suitable for meeting the competitive market pressures and demands faced by the companies. According to Lowson (2003) and Chopra and Meindl (2007), supply chain strategy has previously been adopted in a narrow sub-class classified as either a logistics strategy or an operations strategy. These strategies have been clearly defined by the

Council of Supply Chain Management Professionals as parts of SCM. According to Chopra and Meindl (2007), a supply chain strategy determines what should be of special benefit in operations, distribution and service in order to satisfy customers. Schnetzler et al. (2007) defined supply chain strategy as:

"a set of prioritised SCM objectives, i.e strategic priorities, and a way to operationalise them, i.e. to determine appropriate measures, in order to build up and capitalise on so-called logistics success potentials that can potentially result in successful business performance"

A great many authors have contributed to the topic of supply chain strategy. These authors have undertaken both conceptual and empirical research, as shown in table 2.3. Table 2.3 depicts selected key literature on the development of supply strategies.

Author	Type of study	Description of study and findings
Burt and Soukup (1985)	Conceptual	Purchasing can have an impact on achieving success in new product development if purchasing is involved early in the new product development process
Caddick and Dale (1987)	Empirical case study	Purchasing must develop strategies and link purchasing and corporate strategy
Carlson (1990)	Empirical case study	Purchasing strategy importance to product development and long term goals of the firm
Ellram (1994)	Empirical	Level of strategic competence of supply
Fisher (1997)	Conceptual	SC strategy alignment based on matching the demand characteristics of product types (classified as functional or innovative) with the behavioural characteristics of SC types (classified as efficient or responsive).
Harland et al. (1999)	Conceptual	Proposed a conceptualisation of supply strategy and explained how organisation satisfies markets in the long and short terms.
Lee (2002)	Conceptual	The author expands Fisher's framework to consider the supply risk and uncertainty of demand. The author proposed demand and supply uncertainty reduction strategies.
Mason Jones et al. (2000(b))	Conceptual	The authors highlighted the need for supply chains to adopt a strategy that suits their particular product and marketplace. An analysis of the lean, agile and leagile paradigms was undertaken.
Towill and Christopher (2002)	Conceptual	The authors determined how to develop an appropriate supply chain strategy based on market characteristics. They also provide a time-space matrix for supply chain strategy selection.

Christopher et al. (2006)	Conceptual	The authors proposed a framework for an appropriate selection of supply chain strategies based on three dimensions: products (standard or special), demand (stable or volatile) and replenishment lead time (short or long) and analysed the characteristics of supply chain strategy: lean (plan and execute, continuous replenishment), leagile (postponement) and agile (quick response).
Olvera and Shunk (2006)	Conceptual	The authors proposed the rationale and principles of a customer-product-process-resources (CPPR) framework in order to determine the degree of supply chain strategy alignment. The framework includes a set of structural elements for simultaneous analysis in manufacturing, planning, marketing and customer dimensions.
Schnetzler et al. (2007)	Conceptual	The authors presented an application of the Axiomatic Design (AD) approach to SCM for the development of SC strategy.
Selldin and Olhager (2007)	Empirical study	The authors tested the relationship between product and supply chain designs as proposed by Fisher (1997) in Swedish companies. The results found the relationship between product and supply chain to be significant. The results also concern the impact of the alignment on the performance of supply chain.
Hilletofth (2008)	Empirical case study	The authors study on how differentiated supply chain strategies (make-to-stock, assembly-to-order, make-to-order) are used in manufacturing company in Sweden. The results highlighted supply chain collaboration is found to be a major issue followed by differentiated service price based on cost-to-serve and integrated information tools in order to differentiate supply chain strategy successfully.
Sun et al. (2009)	Empirical study	The authors tested Lee's (2002) framework on the impact of alignment between supply chain strategy and environmental uncertainty to SCM performance in Taiwan companies. The results verified that the SCM performance is influenced by the alignment of supply chain strategy and environmental uncertainties.
Lo and Power (2010)	Empirical study	The authors tested the Fisher's (1997) framework in Australian companies. The results contrasted with Fisher's theory. The majority of the strategies adopted by companies are hybrid type.

Table 2.3: Key authors on the supply chain strategies research

In Table 2.3, the development of a supply chain strategy has slowly shifted from purchasing to supply management. The supply chain strategy is considered to play a very important role in the organisation's long-term strategic planning and competitive positioning. From 1997 onwards, the research concerning supply chain strategy has focused more on the alignment of supply chain strategy in order to satisfy customer requirements. The main goal of a supply chain strategy is to achieve a highly profitable supply chain system that serves customers in a market efficiently (Hicks, 1999, Olvera and Shunk, 2006). Many companies often sell various types of products with varied characteristics in different markets (Fisher, 1997, Lee, 2002, Payne and Peters, 2004, Christopher et al, 2006, Kaipia and Holmstrom, 2007); yet they still utilise a single supply chain design that cannot meet a specific customer's needs (Payne and Peters, 2004). Customer satisfaction and the marketplace are the two key elements when attempting to set up a new supply chain strategy (Mason-Jones et al, 2000(b)); it is essential to get the right product, at the right price, and at the right time, to the consumer (Towill and Christopher, 2002).

In order to be competitive today, a company must consider its entire supply chain instead of solely applying an internal operations strategy (Christopher and Towill, 2001). The focus on strategic alignment becomes part of the competitive advantage that cultivates the success of the whole supply chain (Morash, 2001). Therefore, in the next section, supply chain strategy alignment is explained.

2.9 Importance of alignment

Strategic fit has been defined by Chopra and Meindl (2007) as both the competitive and supply chain strategies have aligned goals. The consistency between customer priorities that the competitive strategy is hope to satisfy and the supply chain capabilities that the supply chain strategy aims to build. The following keys may result the successful or failure of companies:

a) The competitive strategy and all functional strategies must fit together to form a coordinated overall strategy.

b) The different functions in a company must appropriate structure their processes and resources to be able to execute these strategies successfully.

c) The design of the overall supply chain and the role of each stage must be aligned to support the supply chain strategy.

Alignment between supply chain design and all of the core functional strategies with the overall competitive strategy is important to achieve strategic fit (Sunil and Meindl, 2007). There are three basic steps to achieving strategic fit as listed below:

a) Understanding the customer and supply chain uncertainty

A company must understand the customer requirements for each targeted segments and the uncertainty the supply chain faces to satisfy the needs.

b) Understanding the supply chain capabilities

There are many types of supply chains, each of which is designed to perform different task well.

c) Achieving strategic fit

The company will either need to restructure the supply chain to support competitive strategy or alter its competitive strategy if a mismatch exists between supply chain and customer requirement is contrasted.

From the three basic steps above, Fisher (1997) mooted the idea based on his experiences that the alignment between product type and supply chain type is a first step in order to understand customers and supply chain uncertainty. In the next section explained on how to align between product and supply chain strategy.

2.10 Alignment of Supply Chain Strategy

Alignment refers to the compatibility of the various elements with one another (Chorn, 1991). Supply chain strategy was suggested as the process of aligning marketplace requirements with product demand (Fisher, 1997, Christopher et al., 2006). However, despite the healthy number of articles published on supply chain strategy alignment (Fisher, 1997, Naylor et al., 1999, Ramdas and Spekman, 2000, Li and O'Brien, 2001, Towill and Christopher, 2002, Randall et al., 2003, Christopher et al., 2006, Selldin and Olhager, 2007, Sun et al., 2009, Lo and Power, 2010), the focus has been primarily concerned with dyadic relationships between a single manufacturer and a single customer, without taking into consideration the alignment factors for a multi-link, linear chain or network.

The entire supply chain network should be aligned with the same supply chain strategy to achieve the same goals and serve end customers' needs to the greatest extent possible. This enables the supply chain to gain competitive advantage and satisfy customers. Harland et al. (1999) proposed a conceptualisation for supply chains in order to satisfy markets in the long and short term in an holistic way. In this concept, a supply chain strategy relates to the integration and collaboration of supply activities to provide goods or service packages to satisfy end customers today and in the future (Harland et al., 1999).

Multiple scholars (Fisher, 1997, Childerhouse and Towill, 2000, Christopher and Towill, 2000, Mason-Jones et al, 2000(b), Huang et al, 2002, Lee, 2002, Cigolini et al, 2004, Payne and Peters, 2004, Christopher et al, 2006) have investigated the supply chain strategy alignment issue using different approaches. Fisher's study is a cornerstone in the supply chain philosophy of aligning the right supply chain with the right strategy in order to enable the optimisation of competitive advantage and the satisfaction of customers' requirements. The correct alignment of a supply chain strategy at all levels of the supply chain can reduce the uncertainty of demand in the process, so that the objective of SCM - to deliver products to the right customer at the right time in the right quantity - can be achieved (Harris and Componation, 2005). In the next section, previous research on the alignment of supply chain strategy is summarised.

2.10.1 Fisher's Framework (Fisher, 1997)

Fisher's (1997) work has become synonymous with supply chain strategy alignment. He proposed a two-dimensional matrix to align supply chain type with product type. Products are classified as functional if they serve a stable market demand, or innovative if the market demand is volatile. According to Fisher (1997), functional products include items made available at retail outlets with limited choices. Functional products have been characterised as not requiring frequent change over time, and having stable and predictable demand with long life cycles. Functional products often lead to low profit margins that motivate many companies to introduce innovative products to avoid these low profit margins and enable them to achieve higher ones. Traditional functional categories of food and drink products, such as those marketed by Ben & Jerry's, Mrs Fields and the Starbucks Coffee Company, have started to adopt innovative concepts by offering multi-flavour product choices to customers (Fisher, 1997).

Innovation can enable a company to achieve higher profit margins; however, the very introduction of innovation to a product in the market makes demand for it unpredictable and volatile. The life cycles of innovative products are shorter compared with functional products and require a different supply chain strategy for supplying them to customers. Product types are cross-referenced against physical efficient (analogous to lean) and responsive (analogous to agile) supply chain types, as shown in figure 2.3. Figure 2.3 articulates Fisher's conceptual ideal in which functional products with predictable demand are served by lean, low-cost supply chains, and innovative products with volatile demand are served by agile, responsive supply chains.

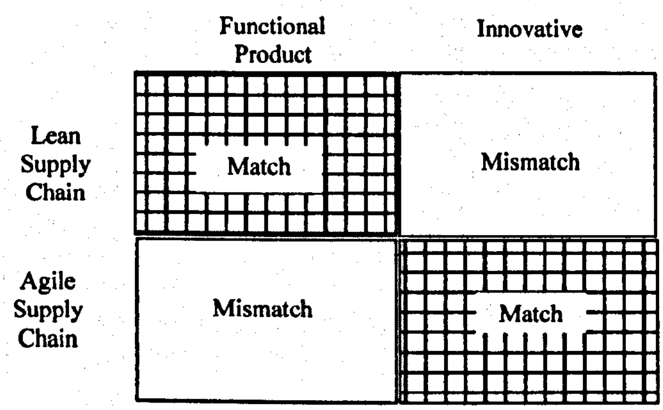


Figure 2.3: 2x2 matrix of matching products with supply chains (Fisher, 1997)

Fisher (1997) suggested that the critical factor in differentiating products is demand characteristics. He claimed that it is rare for a company to work under a functional-agile product-supply chain combination. Companies who introduced functional products realised that the lean supply chain is the best for supplying their products to customers. The mismatch cell for an innovative-lean product-supply chain combination does not make sense because the investment reward in the agile supply chain is better than that of the lean supply chain in terms of contribution margin and profit tradeoffs. However, Fisher's (1997) framework is the only conceptual work introduced from his own experience.

2.10.2 Mason-Jones et al. (2000a, 2000b)

In order to improve supply chain performance, the match between supply chain and demand becomes important for reducing cost and improving customer satisfaction. Mason-Jones et al. (2000(a)) adapted Fisher's (1997) supply chain classification and Hill's (1993) manufacturing strategy metrics. Mason-Jones et al., (2000(b)) also adapted the product classification from Fisher (1997) and combined it with Hill's (1993) manufacturing strategy metrics. The selected manufacturing strategies included are: price, quality, lead time and availability. The manufacturing strategy is divided into two parts: market winner and market qualifier. Supply chain or product must excel in market winner attributes, while being highly competitive and set as a minimum standard for the market qualifier attributes in order to compete in the marketplace. The authors determined that these factors influence the supply chain strategy in order to ensure that optimal performance and competitive priorities are established. The factors are product type, marketplace requirement and management challenges. The framework developed is shown in figure 2.4.

Product/supply chain type		**Market qualifiers**	**Market winners**
	Fashion goods/ Agile	• Quality • Price • Lead time	• Service level
	Commodities/ Lean	• Quality • Lead time • Service level	• Price

Figure 2.4: Classification matrix based on market winners and market qualifiers (Mason-Jones et al., 2000(a), 2000(b))

2.10.3 Waddington et al. (2001)

Waddington et al. (2001) researched the match and mismatch between the supply chain strategy and product demand characteristics, as suggested by Fisher (1997), in 59 supply chains. Appraisal of a product demand uncertainty is evaluated, based on questions in table 2.4.

Appraisal of a products demand uncertainty						
Self benchmarking questions	Units	Demand uncertainty			
		1-Low	2-Below average	3-Above average	4-High
How unstable are the customer schedules	1-month forecast average % error	0-10	11-30	31-50	>50
How many variants do your customers require?	Number of variants	1-3	4-10	11-20	>21
What is the customer delivery lead time?	Time	>1 month	1-4 weeks	1-7 days	1 day
How long is the duration of the product's life cycle?	Years	>5	2-5	1-2	<1

Table 2.4: Appraisal of a products demand uncertainty (Waddington et al., 2001)

Waddington suggested the matrix to improve match strategy and demand strategy for companies operating in a low demand uncertainty-agile supply chain and high uncertainty-lean supply chain combination, in order to improve performance to satisfy customers' requirements. The matrix is illustrated in figure 2.5.

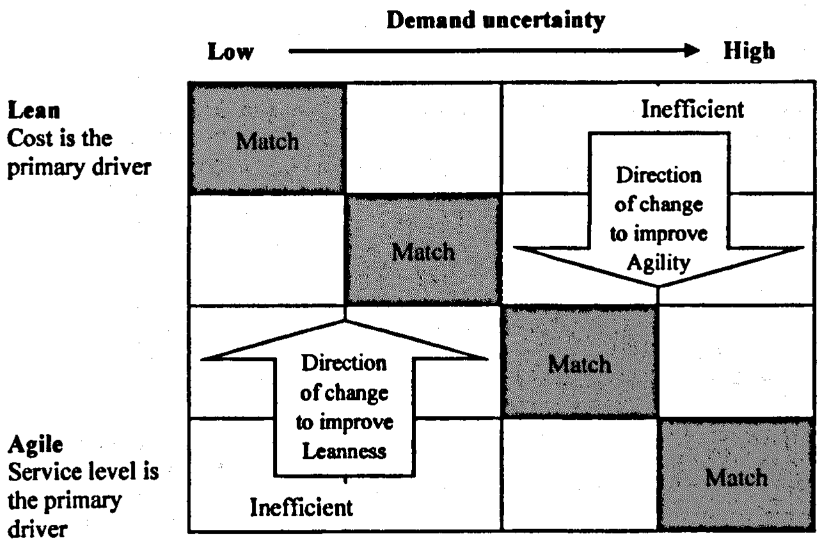


Figure 2.5: Matrix to match strategy and demand uncertainty (Waddington et al., 2001)

However, the case studies focus on a dyadic alignment between manufacturer and customer demand without considering supply chain network examination.

2.10.4 Huang's Framework (Huang et al., 2002)

Huang et al (2002) extended the classification of Fisher's Model from two categories to three categories, with the added notion of hybrid products between functional and innovative products. He argued that the 2x2 matrix did not concentrate sufficient attention on the intermediate stage of either postponement or speculation. Figure 2.6 represents the 3x3 matrix for matching products with supply chains, as suggested by Huang et al (2002).

	Innovative Product	Hybrid Product	Functional Product
Agile Supply Chain	Desired Application	Less Desired Application	Undesired Application
Hybrid Supply Chain	Less Desired Application	Desired Application	Less Desired Application
Lean Supply Chain	Undesired Application	Less Desired Application	Desired Application

Figure 2.6: 3x3 matrix matching product with supply chains (Huang et al, 2002)

Huang et al. (2002) highlighted the importance of intermediate or named hybrid products and the supply chain. Hybrid products is defined to work in both lean and agile supply chains where upstream supply is lean and downstream supply is agile respectively. By adopting the hybrid supply chain, companies can achieve cost minimisation, mass customisation and adaptability to future changes. Huang et al. (2002) introduced a questionnaire in order to categorise types of product. The questionnaire has three levels of importance:

a) Level 1 (highly related to the product feature)

b) Level 2 (significantly important)

c) Level 3 (important)

The questions are listed in table 2.5.

Level	Questions
1 (highly related to the product feature)	a) Is product demand predictable or unpredictable? b) What is the primary purpose of process? c) Is the competition circumstance stable with least change, or highly changing and turbulent? d) Is the customer requirement change stable with least change, highly changing and turbulent? e) How long is the product-life cycle?
2 (significantly important to the product feature)	a) What is the lead time required for made to order products? b) Is knowledge competent and empowered people (multi-skilled workers, who can shift from one product type to another in a short time) desirable or essential? c) Is the quickness and timeliness of the product and service delivery desirable or essential? d) What is the average stock-out rate of the product? e) What is the average margin of error in forecasting at the time production is committed? f) Is it desirable or essential to have a short time period to make available a new product in the market? g) Is short manufacturing throughput time essential or desirable? h) Does manufacturing focus on maintaining high average utilisation rate, or deploying excess buffer capacity?
3 (important to the product feature)	a) What is the profit margin? b) Is the product variety low or high?

Table 2.5: Questions to determine type of products (Huang et al., 2002)

The Huang's framework is based on a limited and single product introduced by the company.

2.10.5 Towill and Christopher (2002)

The authors combined the lean and agile supply chain concept and linked it to corporate strategy and marketplace requirements. They listed the four different combinations of the lean and agile paradigms based on space-time commonalities. The combinations are: same space - different times, different space - same times, different space - different times and same space - same times. However, same space - same times is categorised as invalid. The framework proposed is shown in figure 2.7.

		Time: Same	Time: Different
Space	Different	Separate processes	Decoupling strategies
	Same	Not viable	Differentiate 'base' from surge

Figure 2.7: The Time/Space matrix (Towill and Christopher, 2002)

In different time - same space combination, if the product has high volume and predictable demand, lean supply chain is preferable as it concentrates low cost and more efficient process. While for less predictable demand, agile supply chain is preferable. Therefore, the separate processes are based on volume evaluation. The companies can segregate agile and lean, depending on marketplace requirements.

Decoupling strategy is applicable when companies work at different time - different space. This situation enables companies to apply the postponement concept, where standardisation with lean supply is offered at the beginning of supply chains, with highly responsive towards the end of the supply chains. The concept of postponement enables products to be customised to individual customer requirements.

For the different time - same space category, demand is anticipated with a high degree of uncertainty. The close and flexible supplier is expected to be able to meet the capacity of surge demand by outsourcing strategy. Normally, the time separated refers to seasonal weather changes. The framework is based on a case study in a manufacturing company and relies on the manufacturing time-space matrix for selecting either lean or agile supply chains. A multi-tier supply chain is not considered in this framework.

2.10.6 Harris and Componation (2005)

Harris and Componation (2005) studied the alignment of appropriate supply chain structure to minimise demand uncertainty. They promote the idea of a continuum of product and supply chain alignment, adjusting Fisher's (1997) framework to include existing hybrid theories. The framework is based on the case study results of a bicycle company in the US. The framework is shown in figure 2.8.

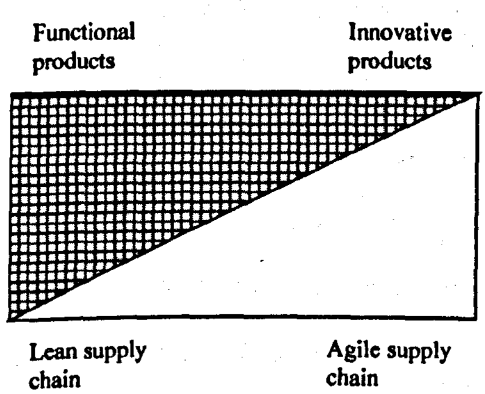


Figure 2.8: Product-supply chain continuum (Harris and Componation, 2005)

Harris and Componation (2005) supported Fisher's (1997) idea of aligning products with a low demand uncertainty (functional products) with a lean supply chain to focus on lower costs; while for unpredictable demand products (innovative products) an agile supply chain should be implemented in order to avoid the possibility of excess inventory. They also introduced '*more functional*' and '*more innovative*' products that suggested a match with a hybrid supply chain strategy. The hybrid supply chain was separated into two categories, named '*more lean*' and '*more agile*' supply chain strategies, which adopted a decoupling point and the push-pull concept. The solution by Harris and Componation (2005) required a 4x4 matrix in order to fit the appropriate supply chain strategy with the product type. However, the framework was not tested, having insufficient detailed explanation of product attributes to enable differentiation between '*more functional*' and '*more innovative*' products and '*more lean*' and '*more agile*' supply chain strategies.

2.10.7 Christopher's Framework (Christopher et al., 2006)

Christopher et al. (2006) studied the choice of supply chain strategies crucial to global operations. Based on the case-based research and survey, the authors developed a taxonomy demand-supply framework to assist companies to select suitable supply chain strategies. The authors include lead time as a critical attribute that affects response to demand, besides products and demand considerations. The taxonomy demand-supply framework is shown in figure 2.9.

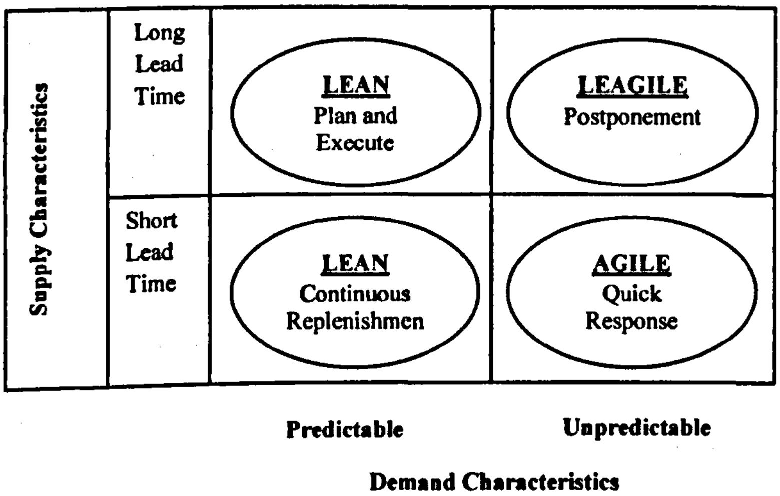


Figure 2.9: 2x2 matrix framework to determine supply chain strategy selection (Christopher et al., 2006)

The authors highlighted two challenges for global businesses: identifying appropriate solutions to meet different market requirements; and multiple supply chains. However, no research has been undertaken to discover the multiple supply chain empirically, especially for supply chain strategy adoption.

2.10.8 Wong et al., (2006)

The authors assessed the responsiveness of a volatile and seasonal supply chain based on a case study in an international toy company. The assessment is derived from Fisher's (1997) framework. The authors determined that there are four critical attributes suitable for assessing the responsiveness level of toy supply chains. The attributes are: forecast uncertainty, demand variability, contribution margin and time window of delivery. The results from the case studies showed that toy products were classified as 'mostly innovative' or 'intermediate' products rather than exact innovative or functional products. The authors had proposed extending Fisher's

(1997) framework, adding the notion of 'intermediate' products. The framework is shown in figure 2.10.

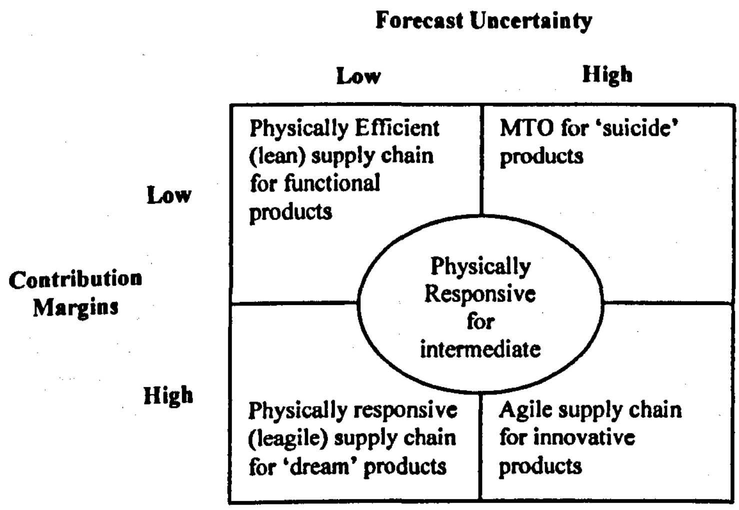


Figure 2.10: Extension of Fisher's Model for volatile supply chain (Wong et al., 2006)

However, this framework is only applicable to toy manufacturing companies adopting the supply chain strategy. The framework has not been tested in other industries or in multi-tier supply chains.

2.10.9 Roh et al. (2008)

Roh et al. (2008) developed a framework that links supply chain strategy and organisational culture using a relationship with competing value and demand uncertainty framework. The framework is based on exploratory research that has not been empirically tested. The alignment between organisational culture and supply chain strategy is found to be important in order to direct suppliers' behaviour (Chorn, 1991, Mello and Stank, 2005). The authors, therefore, integrated the supply chain strategy framework (Lee, 2002) and the competing value framework (Cameron and Quinn, 1999). The organisational culture and supply chain strategy framework is shown in figure 2.11.

Supply chain uncertainty (Organisational flexibility) \ Demand Uncertainty (External Orientation	Low	High
Low	Lean supply chains (Hierarchical culture) (Cost and quality)	Responsive supply chains (Rational culture) (Speed and flexibility)
High	Risk-hedging supply chains (Group culture) (Cost, flexibility)	Agile supply chains (Developmental culture) (Speed, flexibility and innovation)

Figure 2.11: Organisational culture and supply chain strategy framework (Roh et al., 2008)

The development of the framework is suggested for further examination and empirical research validation. Table 2.6 summarises further research relating to supply chain strategy and product type, including the latest empirical research.

Table 2.6(a)
Selected references for supply chain strategy alignment

Author(s)	Methodology	Region studied	Contribution
Naylor et al (1999)	Case study in PC supply chain (Berry, 1994; Berry et al, 1995)	Not specified	They demonstrated how agility and leanness have been combined into the le-agile paradigm. They concluded that lean and agile are complementary within the right supply chain strategy. They presented the key characteristics of leanness and agility as supply chain strategies. They also revealed that some characteristics are of equal importance to both lean and agile such as; use of market knowledge, integrated supply chain and lead time compression. However, characteristics with similar importance are waste elimination and rapid configuration.
Childerhouse and Towill (2000)	Case study in carpet maker and four case studies in electronic industry	UK	They outlined a route map for engineering supply chains to match customer requirements to avoid mismatches of supply chain strategy with product characteristics. They supported the findings by Fisher (1997) to align SCM paradigm and product characteristics via adoption of lean and agile for functional and innovative products respectively. They emphasised the need to work as a single unit among all members of supply chain to facilitate the re-engineering of each supply chain stream to fit with customer requirements.
Lamming et al (2000)	Conceptual model, conducted survey and semi-structured interviews to 16 major firms	Europe	They developed a new classification for supply networks and used type of product as a differentiator. They suggested two distinct types of supply network with different complexity of networks either high complexity or lower complexity for each innovative/unique products and functional products respectively.

Table 2.6(b)
Selected references for supply chain strategy alignment

Author(s)	Methodology	Region studied	Contribution
Ramdas and Spekman (2000)	Empirical studies and analytical model from 22 survey responses of six broad industries (life sciences, oil and gas, consumer products, agricultural and food processing, utilities, and manufacturing high tech electronics and automotive)	North America, South America and Europe	They classified supply chains based on the products as either functional or innovative by differentiating: availability of substitution, changes in market conditions, changes in technology, market maturity, and product life cycle length. They revealed that innovative products used work in process (WIP) and finished goods tracking and greater information sharing compared with functional products. They found innovative high performers significantly provide high customer satisfaction and high performers more likely to adopt tailored strategies to their specific products and markets
Li and O'Brien (2001)	Multiple objective optimisation model were used to detect variance of performance to three supply chain strategies (manufacturing –to-order, manufacturing –from-stocks and manufacturing-to-stoock).	Not specified	The analysis had done by matching product types to manufacturing strategies based on Fisher's theory (Fisher, 1997). The results found that when demand at low uncertainty level, manufacturing-to-stock always perform better than other strategies but reverse when demand uncertainty is increases. The results also differ from Fisher's suggestion when high demand uncertainty with low value adding capacity (low profit) is perform better in lean supply chain that contrast from Fisher that low demand uncertainty is suitable for lean supply chain. The innovative-agile supply is supported Fisher's suggestion.
Lee (2002)	Conceptual model	US	The author expands the Fisher's (1997) framework to consider the supply risk and uncertainty in upstream operations. He emphasises that supply chain uncertainties concern both demand and supply. He proposed demand uncertainty reduction strategies to stabilise the bullwhip effect and supply uncertainty reduction strategies to stabilise the unpredictable product demand.

Table 2.6(c)
Selected references for supply chain strategy alignment

Author(s)	Methodology	Region studied	Contribution
Randall et al (2003)	Empirical studies in bicycle industry. The data sources were from industry interviews and an annual sourcing guide published from 1995 to 1998 by Bicycle Retailer and Industry News.	North America	They characterise supply chain as either responsive or efficient supply. The characteristics that distinguish these types of supply chains are lead times, set up cost, and batch size. They used rate of market growth, relative product contribution margins, amount of product variety and level of uncertainty (demand and technological) to characterise product demand conditions. They examine a more comprehensive list of factors that characterise the nature of market demand and test the concept proposed by Fisher (1997). The responsive supply chain found correlated positively with higher technological demand uncertainty.
Cousins (2005)	Empirical survey to 243 project managers with 142 usable responses.	The samples consisted of automotive, aerospace, appliances, finance, public sector government, and process industry and household products in the UK.	The author found that companies who define their company's competitive priorities as being cost-focused, the supply chain selection also concern to cost reduction. While if the competitive advantage is concern to differentiation approach that focused on resources and capabilities, the company provide supply base effectively to make best use of the capabilities of its supply chain. The study only limit to buyers-suppliers in one country.
Selldin and Olhager (2007)	Empirical survey 128 companies (with 68 usable responses) to test Fisher's (1997) theory.	Swedish manufacturing companies	They found that there is a significant relationship between product type and supply chain type. The alignment between product type and supply chain type also impacts on a company's performance..
Sun et. al (2009)	Empirical survey of 243 companies and testing the impact of Lee's (Lee, 2002) framework on supply chain performance	Taiwan manufacturing companies	They supported the argument that supply chain alignment between strategy and demand requirement enhances SCM performance. The findings also contributed to the SCM literature by identifying the ideal profiles of supply chain strategy attributes for the integration of manufacturing and information system (IS) capabilities

Recent studies by Lo and Power (2010) investigated Fisher's theory (Fisher, 1997) by conducting a survey of 119 Australian manufacturing companies with 107 usable responses (of which response rate was 8%). The authors divided products into two types: functional and innovative, and supply chain strategies into four types: lean, hybrid, agile and no preferred strategy. The results indicate that the association between product type and supply chain strategy is not significant. The results opposed Fisher's theory (Fisher, 1997), and Selldin and Olhager's (2007) findings. The results also supported the existence of hybrid products, with 78.5% of the total respondents categorising their products as a mix of functional and innovative. The results also found that most of the companies with both functional and innovative products adopted a hybrid supply chain strategy rather than matching their strategy to either a lean or agile supply chain. However, the authors concentrated only on manufacturing levels in all types of industries. Therefore, because of the generalisation of the results, further research is required.

Comparison of works testing Fisher's (1997) and Lee's (2002) models are summarised in table 2.7.

Authors	Differentiating factors	Product/demand uncertainty types	Supply chain types
Li and O'Brien (2001)	Demand uncertainty (the probabilities of planned stocks failing to meet demands	Five different levels of demand uncertainty	MTO: lean MFS: agile MTS: physically responsive (leagile)
Wong et al. (2006)	Forecast uncertainty Demand variability Contribution margin Time window for delivery	Functional Innovative Suicide Dream Intermediate	Lean Agile MTO: physically responsive (leagile) Physically responsive (leagile)
Selldin and Olhager (2007)	Six of seven proposed by Fisher (1997) (except: average forced end-of-season markdown)	Functional Innovative	Lean Agile
Sun et al. (2009)	Price Flexibility Quality Delivery Service Operational support systems Market information systems Inter-organisational systems Strategic decision support systems	Low supply-low demand uncertainty Low supply-high demand uncertainty High supply-low demand uncertainty High supply-high demand uncertainty	Lean Responsive Risk-hedging Agile
Lo and Power (2010)	Product life cycle Contribution margin Product variety Average margin of error in the forecast at the time production is committed Average stockout rate Average forced end-of-season markdown as percentage of full price Lead time required for made-to-order	Functional Innovative	Lean Hybrid Agile No preferred strategy

Table 2.7: Summary of research testing product/demand uncertainty-supply chain strategy matrix

From the literature in this section, we can conclude that the supply chain strategy alignment as a whole, across multiple echelons of supply chains, remains un-researched. In spite of the extant research on supply chain strategy alignment, the focus is mainly on manufacturing companies and dyadic relationships between manufacturers and customer demand, without taking into consideration the alignment of supply chains and products across whole networks or chains. The literature is also limited to general manufacturing companies without a specific type of industry and relates to only one country.

2.11 Product Type

Product classification is defined as the ability to describe demand as either stable or volatile. Many researchers (Fisher, 1997, Christopher and Towill, 2002, Waddington et al., 2002, Aitken et al., 2003, Payne and Peters, 2004, Christopher et al, 2006, Harris et al, 2006) have accepted demand characteristics as a crucial factor in determining product classification. Type of product can be differentiated as functional, hybrid or innovative (Fisher, 1997, Christopher and Towill, 2000, Lamming et al, 2000, Ramdas and Spekman, 2000, Huang et al, 2002, Randall et al., 2003, Harris and Componation, 2005, Christopher et al., 2006); and may be associated with either a stable or a volatile market (Fisher, 1997, Christopher and Towill, 2002, Huang et al, 2002, Christopher et al., 2006, Harris et al., 2006, Kaipia and Holmstrom, 2007). Table 2.8 shows a summary of those demand characteristics established by previous researchers. The attributes listed in table 2.8 can be used to distinguish products as functional, hybrid or innovative; however, it was found in the review of relevant published work that there is no consensus of agreement among researchers on the demand attributes that justify product classification.

Table 2.8(a): Summary of literature on selection of demand attributes

No	Author(s)	Demand Attributes															
		Length of product life cycle	Lead time	Volume	Variety	Variability	Stage of product life cycle	Substitutability of a product	Number of customers buying each product	Volatility	Predictability	Complexity	No of SKUs	Contribution margin	Forecasting error	Average stock out	End of sale mark down
1	Fisher (1997)	✓	✓		✓									✓	✓	✓	✓
2	Childerhouse and Towill (2000)	✓	✓		✓									✓	✓	✓	✓
3	Christopher and Towill (2002)		✓							✓							
4	Huang et al. (2002)						✓				✓						
5	Aitken et al. (2003)	✓	✓	✓	✓	✓	✓										
6	Cigolini et al. (2004)						✓					✓					
7	Christopher et al. (2006)		✓							✓							
8	Harris and Componation (2005)	✓	✓		✓									✓	✓	✓	✓
9	Harriss et al. (2006)			✓		✓				✓	✓						
10	Kaipia and Holmstrom (2007)									✓	✓						

Table 2.8(b): Summary of literature on selection of demand attributes

No	Author(s)	Demand Attributes															
		Length of product life cycle	Lead time	Volume	Variety	Variability	Stage of product life cycle	Substitutability of a product	Number of customers buying each product	Volatility	Predictability	Complexity	No of SKUs	Contribution margin	Forecasting error	Average stock out	End of sale mark down
11	Lamming et al. (2000)	✓										✓					
12	Mason –Jones et al. (2000(a))	✓	✓		✓	✓				✓							
13	Mason-Jones et al. (2000(b))									✓						✓	
14	Ramdas and Spekman (2000)						✓	✓									
15	Li and O'Brien (2001)		✓							✓				✓			
16	Lee (2002)				✓					✓	✓		✓	✓		✓	
17	Waddington et al. (2002)	✓	✓		✓										✓		
18	Randall et al. (2003)	✓	✓	✓	✓					✓				✓			
19	Payne and Peters (2004)	✓		✓				✓	✓	✓							
20	Selldin and Olhager (2007)	✓	✓		✓									✓	✓	✓	
21	Sun et al. (2009)										✓						
22	Lo and Power (2010)	✓	✓		✓									✓	✓	✓	✓

Functional products are defined as commodity products with attributes that meet a stable demand with a low forecast uncertainty, low demand variability, long delivery lead times, long product life cycles, and which have limited complexity (Fisher, 1997, Huang et al., 2002, Lee, 2002, Wong et al., 2006), as shown in Table 2.9. A crucial goal for this type of product is price sensitivity or cost (Fisher, 1997), probably along with the establishment of a long-term relationship with the supplier in terms of material, quality, delivery times and quantity discounts (Huang et al., 2002). The feature of functional products is lack of product innovation (Fearne and Hughes, 1999).Demand of functional products is predictable. Most of functional products can be categorised as commodity products includes flour of maize, grain, sugar (centrifugal, raw), sugar refined, groundnut in shell, oranges, apples, pineapples canned, and the whole grape chain for agribusiness products (Rooyen et al., 2000). Fisher (1997) provides an archetype - the Campbell Soup Company -, which satisfies over 98% of its customer demand from an inventory of immediately available finished goods from which adequate stock supplies are assured to fulfil demand requirements. They have been in the market for many years and find this easy to manage even for new products. They deploy enough stock to cover the first month following the introduction of a new product. If demand is high, more supplies will be made available before stock runs out; however, if demand is low, the long life cycle of the product ensures it can still, eventually, be sold. These type of products need efficient production planning, thus improved customer service, reduced lost sales and product return (Rooyen et al., 2000).

In contrast, innovative products are typically trendy, fashionable and high-tech, exhibiting highly variable and difficult to predict demand patterns (Fisher, 1997, Huang et al., 2002, Wong et al., 2006). Product life cycles for innovative products are short and a high level of product variety is to be expected. New products are also categorised as innovative, because demand for these products is often unpredictable. The core rationale for inventory differs from a functional product inventory in that it is not price sensitive; rather, it provides the customer with a responsive and high service level. An excess of inventories result in losses on styles that do not sell or are out of season. Cost reduction efforts are directed at increased speeds and flexibility (Fisher, 1997, Huang et al., 2002). According to Fisher (1997), some products, such as ice cream, coffee and biscuits, may be classified as either functional or innovative, depending upon the characteristics of their demand patterns. Innovative products may created and innovated from functional products. The product has innovated to add value to be a new product for example biscuits shortcakes that manufactured with high variety of flavour during celebration seasons such as Christmas or Easter. Production of products only market for particular season and celebration. For biscuit shortcake is not available during low peak season. Besides, ice cream Ben and Jerry also can categorise as innovative products. The ice cream which has variety choices of flavour during summer season. The profit lost when sales are missed due to stock outs that never be recaptured (Lee, 2002, Yang et al., 2004).

Hybrid or intermediate products are defined as different combinations of standard components or a mix of standard and innovative components (Huang et al., 2002). Based on the definition, criteria for hybrid or intermediate products can be either more functional or more innovative as classified by Harris and Componation (2005). The products are expected to have a medium forecast uncertainty, medium demand variability and short time window delivery (Wong et al., 2006). Hybrid products are considered to include low cost and fast response (Christopher and

Towill, 2000, Stratton and Warburton, 2003), however, literature on hybrid products is still limited. Functional and innovative products are two extreme categories of products, therefore the product that classified between these two types of product, neither functional nor innovative is categorised as hybrid products. During early new product introduction to market, product is categorised as innovative products. According to Aitken at el., (2003), when the product progressing along its lifecycle, the category of products is changed from innovative to hybrid products. When the demand is stable, product can be categorised as functional product (Aitken et al., 2003). For example, initially rice is categorised as functional product but it can be innovative when firstly introduced to market as rice with chicken in box. When customers' demand getting stable, chicken rice is categorised as hybrid products. However, when it comes to be commodity product the chicken rice therefore categorised as functional. As same as biscuit that having variety of flavour, in the early stage of new product introduction to market is categorised as innovative, but biscuit cannot be commodity product, therefore it turn to be hybrid product when the demand is volatile but still predictable.

A list of product attributes for functional, innovative and hybrid products is shown in table 2.9.

Attributes	Type of product (Fisher, 1997; Christopher and Towill, 2000; Lamming et al., 2000; Ramdas & Spekman, 2000; Huang et al., 2002; Randall et al., 2003; Harris & Componation, 2005; Christopher et al., 2006)		
	Functional	Hybrid	Innovative
Pattern of demand (Mason-Jones, 2000(a); 2000(b); Li & O'Brien, 2001; Christopher & Towill, 2002; Huang et al., 2002; Lee, 2002; Randall et al., 2003; Payne & Peters, 2004; Christopher et al., 2006; Harris et al., 2006; Kaipia & Holmstrom, 2007)	Stable with minimal change	Volatile but still predictable	Erratic, highly changing and turbulent
Typical demand forecast accuracy (%) (Fisher, 1997; Childerhouse & Towill, 2000; Waddington et al., 2001; Harris & Componation, 2005; Wong et al. 2006; Selldin & Olhager, 2007)	80-100	60-80	0-60
Number of SKUs/variants (Fisher, 1997; Waddington et al., 2001; Huang et al. 2002; Lee, 2002; Aitken et al., 2003)	<20/ Low	High	>80/High
Product lifecycle stage (Ramdas & Spekman, 2000; Huang et al, 2002; Aitken et al., 2003; Cigolini et al., 2004; Wang et al., 2004)	Introduction/Growth/	Introduction/Growth/ Mature/Decline	Introduction/Growth

Table 2.9(a): List of product attributes to distinguish product types

Attributes	Type of product (Fisher, 1997; Christopher and Towill, 2000; Lamming et al., 2000; Ramdas & Spekman, 2000; Huang et al., 2002; Randall et al., 2003; Harris & Componation, 2005; Christopher et al., 2006)		
	Functional	Hybrid	Innovative
Total lead time (Fisher, 1997; Childerhouse and Towill, 2000; Mason-Jones et al., 2000(a); Waddington et al., 2001; Christopher and Towill, 2002; Aitken et al., 2003; Randall et al., 2003; Harris and Componation, 2005; Christopher et al., 2006; Selldin and Olhager, 2007;	>6 months	Not specified	< 2 weeks
Length of product life cycle (Fisher, 1997; Childerhouse and Towill, 2000; Mason-Jones et al., 2000(b); Ramdas and Spekman, 2000; Waddington et al., 2001; Lee, 2002; Aitken et al., 2003; Harris and Componation, 2005; Selldin and Olhager, 2007)	>2 years	Not specified	< 1 year

Table 2.9(b): List of product attributes to distinguish product types

2.11.1 Product Variables

a) Pattern of demand

Pattern fo demand can be divided into three types that are stable and predictable, fluctuate but still predictable and fluctuate and unpredictable (Fisher, 1997, Huang et al., 2002, Lee, 2002).

b) Forecast accuracy

Forecasting is the art and science of predicting future events (Heizer and Render, 2006). Demand forecasts are projections of demand for a company's products or services. Forecast accuracy is a measurement of the accuracy of the expected demand (Logic Tools, 2005). All forecast have errors. Functional products tend to have high accuracy of forecast when their demand pattern is stable and vice versa for innovative products, while hybrid products has a medium accuracy of demand (Fisher, 1997, Childerhouse & Towill, 2000, Waddington et al., 2001, Harris & Componation, 2005, Wong et al. 2006, Selldin & Olhager, 2007).

c) Number of SKUs/variants

A *product variant* is a specific item that is grouped with related variants that together form a product. Variants usually vary from each other in one or more properties. For example, a medium-sized, cookies with a stock-keeping unit (SKU) of 14678 is one product variant of the snack product; together size, weight, flavour and SKU form one variant. A product variant always includes a unique identifier, such as an SKU, and a price. Each product variant is based on the same product definition (Commerce Server, 2007). Functional products, with long life cycles, have low variations. The short life cycles associated with innovative products and lead to variety of products as the frequency of introduction to new product is compressed (Fisher, 1997).

d) Product life cycle stage

According to Heizer and Render (2006), strategies change as products move through their life cycle. Product life cycle stage can divide into four phases (Ramdas & Spekman, 2000, Huang et al, 2002, Aitken et al., 2003, Cigolini et al., 2004, Wang et. al, 2004, Heizer and Render, 2006):

i. Introductory phase

Introductory phase are still new in a market named 'fine-tuned', therefore, they may results unusual expenditures for research, product development, process modification and enhancement (taste) and supplier development. Demand during this stage is not stable and to attract consumer is quite difficult.

ii. Growth phase

In the growth phase, product design has started began to stabilise and the capacity supply of demands are required to be effective. The increasing of demand might results to add capacity and enhance existing production.

iii. Maturity phase

Once the product in mature stage, competitors are established. At this stage, high-volume and innovative production may be appropriate. However, demand would be stable and predictable.

iv. Decline phase

Dying products are typically poor products to invest and use the resources due to unpredictable demand and low demand.

e) Total lead time

Total lead time is defined as the elapsed time between customer inquiry and the receipt of the goods ordered. Lead time needs to be minimised in lean manufacturing that align with the definition of lean, excess time is waste and leanness are to eliminate all wastes (Mason-Jones et al., 2000(a)). Due to the long make-to-order cycles and lowest possible cost for functional products, flexibility is not practical to provide in lean supply chain (Fisher, 1997). The key characteristics for agile supply chain is lead time. The lead-time is influence the dynamic response of supply chain (Mason-Jones and Towill, 1999). Innovative products bring make-to-order products to market quickly (Fisher, 1997). Lead time for food and beverages sector is the least (Mason-Jones and Towill, 1999) among other type of sectors.

f) Length of product life cycle

Duration of product life cycle influences the demand of products. The length of product life cycle also influences the new product introduction and the supply chain. Shorter life cycle requires rapid time to market and require short pipeline from end to end that enables demand to be continuously replenished during the life cycle (Christopher and Towill, 2000).

2.12 Supply Chain Type

Naylor et al. (1999) have offered the following definition of the development of a lean supply chain: '*developing a value stream to eliminate all waste, including time, and to ensure a level schedule*'. The sources of waste include unnecessary operations, inefficient operations or excessive buffering in operations (Narasimhan et al., 2006). A lean approach is generally regarded as being appropriate for stable demand and is, therefore, compatible with functional products. There is an overwhelming consensus (Fisher, 1997, Naylor et al., 1999, Mason-Jones et al., 2000 (b), Christopher and Towill, 2001, Huang et al., 2002, Lee, 2002) that lean is most suited to high volume, low variety, predictable demand environments with a focus on value (Hines et al., 2004) and reduced costs.

An agile supply chain utilises '*market knowledge and a virtual corporation to exploit profitable opportunities in a volatile market place*' (Naylor et al., 1999). An agile approach is appropriate for a volatile demand and is, therefore, compatible with innovative products, such as fashion or seasonal goods (Fisher, 1997, Lee, 2002, Wong et al., 2006), where the requirement is to respond quickly to meet unique customer demands (Christopher, 2000). The key to an agile supply chain is its flexibility (Aitken et al., 2002, Goldsby, 2006) and its ability to cope with a variety of tasks as dictated by demand (Goldsby, 2006).

In order to distinguish between a lean and an agile supply chain, a list of attributes was summarised, as shown in tables 2.10 (a) and (b). Naylor et al. (1999) identified *equal* importance, *similar* importance and *different* importance characteristics to provide lean and agile supply chains. Equal importance refers to use of market knowledge, an integrated supply chain and lead time compression, while similar importance refers to elimination of waste and rapid configuration. The authors also emphasised the importance of flexibility for market responsiveness in terms of robustness and smooth demand between a lean and an agile supply chain.

A leagile supply chain is introduced by Naylor et al., (1999), also known as a 'hybrid' supply chain (Huang et al., 2002, Wang et al., 2004). According to Goldsby et al. (2006), the hybrid strategy includes three distinct hybrids. The first hybrid method relates to the 80/20 Pareto rule, which maintains that 80% of a company's revenue is based on 20% of its products. The dominant 20% of its products is described as using a lean supply chain with make-to-stock strategy, while the remaining 80% uses the agile supply chain and employs a make-to-order strategy to supply the products. The second hybrid strategy supports seasonal demands. The base level of demand is accommodated using a lean supply chain, however, when demand increases (heavy promotion or peak season) an agile supply is used. The third hybrid is called postponement. This approach is adopted when common materials are produced to a near-finished state and then finished to meet the diverse needs of different customers. Lean supply chains are used for the semi-finished products, while the customisation process uses an agile supply chain.

Tables 2.10, 2.11 and 2.12 provide definitions of lean, agile and leagile supply chains respectively. Table 2.13 shows a list of supply chain attributes, distinguishing between lean, agile and leagile. Table 2.14 shows the characteristics of each type of supply chain.

No	Authors	Definition: lean/efficient physical
1	Fisher (1997)	Lean purpose is to supply predictable demand efficiently at the lowest possible cost.
2	Naylor et al. (1999)	Developing a value stream to eliminate all waste, including time, and to ensure a level schedule.
3	Christopher (2000)	Lean emphasises the pursuits of process efficiency-generating the greatest outcome from the least input through the minimisation of wastes.
4	Christopher and Towill (2000)	The lean paradigm requires 'fat' be eliminated, associated with level scheduling, desirable information transparency and forecasting is algorithmic.
5	McCullen and Towill (2001)	The strategic intent of lean manufacturing is to eliminate waste and focus on quality and efficient use of all resources, while agile manufacturing goes a step further by seeking to achieve competitive advantage through rapid response and mass customisation with selective resource efficiency.
6	Huang et al. (2002) Wang et al. (2004)	Lean supply chain focuses on cost reduction, flexibility and incremental improvements for already available products. Lean supply employs a continuous improvement process to focus on the elimination of waste or non-value added activities across chain.
7	Lee (2002)	In a stable (lean) supply chain the manufacturing process and underlying technology is mature and the supply base is well established. Stable supply processes tend to have low manufacturing complexity. Stable manufacturing processes tend to be highly automated and long-term supply contracts are prevalent.
8	Stratton and Warburton (2003)	Lean focusses on waste elimination and is closely associated with reduced inventory and one of the key concepts is enforced problem solving. Lean paradigm focuses on eliminating waste and achieving low cost delivery of a standard and stable product.
9	Narasimhan et al. (2006)	Production is lean if it is accomplished efficiently with minimal waste and no unnecessary operations or excessive buffering.
10	Vonderembse et al. (2006)	Lean supply chain employs continuous improvement to focus on the elimination of waste or non-value added steps in the supply chain. It is supported by reduction of setup times to allow for the economic production of small quantities, thereby achieving cost reduction, flexibility and internal responsiveness. It does not have the ability to mass customise or be easily adapted to future market requirements.
11	Roh et al. (2008)	A lean supply chain aims at achieving the highest cost efficiencies in the supply chain through the elimination of waste or non-value-added process.

Table 2.10: Summary of the references for lean supply chains

No	Authors	Definition: agile/market-responsive
1	Fisher (1997)	Agile's purpose is to respond quickly to unpredictable demand in order to minimise stock-outs, forced markdowns and obsolete inventory.
2	Naylor et al. (1999)	Agility means using market knowledge and a virtual corporation to exploit profitable opportunity in a volatile market place.
3	Christopher and Towill (2000)	Agile paradigm must be 'nimble' since sales lost are gone forever, reserving capacity to cope with volatile demand, information transparency is obligatory and forecast requires shared information on current demand captured as close to the marketplace as possible.
4	Christopher (2000)	Agility refers to effective, flexible accommodation of unique customer demands.
5	Hoek et al. (2001)	Four dimensions of agile supply chain are: customer sensitivity, virtual integration, process integration and network integration.
6	Huang et al. (2002), Wang et al. (2004)	The purpose of the agile supply chain is to understand customer requirements by interfacing with the market and being adaptable to future changes. It aims to produce in any volume and deliver into a wide variety of market niches simultaneously. It also provides customised products at short lead times (responsiveness), by reducing the cost of variety.
7	Lee (2002)	An evolving (agile) supply chain is where the manufacturing process and the underlying technology are still under early development and are rapidly changing, and as a result, the supply base may be limited in both size and experience. The manufacturing process requires a lot of fine-tuning and is often subject to breakdowns and uncertain yields.
8	Stratton and Warburton (2003)	Agile supply chain is more pragmatically defined and closely associated with 'quick response', but is commonly referred to as a distinctly different paradigm to lean supply. Agile paradigm focuses on the need to deliver a variety of products with uncertain demand.
9	Narasimhan et al. (2006)	Production is agile if it efficiently changes operating states in response to uncertain and changing demands placed upon it.
10	Vonderembse et al. (2006)	Agility relates to the interface between a company and the market. Agile supply chains profit by responding to rapidly changing, continually fragmenting global markets by being dynamic and context-specific, aggressively changing, and growth oriented. They are driven by customer designed products and services.
11	Wong et al. (2006)	Agile (market responsive) supply chain responds quickly to unpredictable demand to minimise stock-out, forced markdown and obsolete inventory.
12	Roh et al. (2008)	An agile supply chain aims at being responsive and context-specific to customer needs, while the risks of supply shortages or disruptions are hedged by pooling inventory or other capacity resources.

Table 2.11: Summary of the references for agile supply chains

No	Authors	Definition: leagile/hybrid
1	Naylor et al. (1999)	Leagile is the combination of lean and agile paradigms within a total supply chain strategy by positioning the decoupling point to best suit the need for responding to a volatile demand downstream yet providing level scheduling upstream from the marketplace.
2	Hoek (2000)	Upstream from the decoupling point and the postponement application, operations are push driven and might be organised for efficiency using lean principles. Downstream from the decoupling point and in the postponed supply chain operations, a pull and customisation system is in place, which is centred on responsiveness.
3	Huang et al. (2002) Wang et al. (2004)	Hybrid supply chain interfaces with the market to understand customer requirements, maintaining future adaptability. It tries to achieve mass customisation by postponing product differentiation until final assembly and adding innovative components to the existing products.
4	Vonderembse et al. (2006)	A hybrid (leagile) supply chain generally involves 'assemble to order' products where demand can be accurately forecast. The supply chain helps to achieve some degree of customisation by postponing product differentiation until final assembly. Lean or agile supply chains are utilised for component production. The agile part of the chain establishes an interface to understand and satisfy customer requirements by being responsive and innovative.
5	Wong et al. (2006)	Leagile (physical responsive) supply chain maintains an adequate inventory in order to provide a high service level and lead time.

Table 2.12: Summary of the references for leagile supply chains

Based on the definitions, in summary, the key words for a lean supply chain are cost reduction and elimination of waste to promote efficiency. An agile supply chain supports a fast response and a high level of service. A leagile supply chain is a combination of lean and agile in a supply chain system separated by a decoupling point.

Table 2.13(a): Summary of literature on selection of supply chain attributes

No	Author(s)	Supply chain attributes																		
		Marketplace demand	Product variety	Product life cycle	Customer drivers	Profit margin	Dominant cost	Stock out penalties	Purchasing policy	Information enrichment	Forecasting mechanism	Lead time	Product introduction	Consumers durables	Postponement/ Order penetration point	Speculation	Use of market knowledge	Integrated SC	Eliminate waste	Rapid configuration
1	Fisher (1997)											✓								
2	Pagh and Cooper (1998)														✓	✓				
3	Mason-Jones and Towill (1999)											✓								
4	Naylor et al (1999)											✓					✓	✓	✓	✓
5	Childerhouse and Towill (2000)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									
6	Mason Jones et al (2000(a))	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									
7	Christopher and Towill (2002)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									
8	Waddington et al (2002)											✓						✓	✓	
9	Wang et al (2004)											✓								
10	Christopher et al (2006)											✓								
11	Wong et al (2006)											✓			✓					
12	Kaipia and Holstrom (2007)		✓	✓																
13	Selldin and Olhager (2007)											✓								

Table 2.13(b): Summary of literature on selection of supply chain attributes

No	Author(s)	Supply chain attributes																			
		Robustness	Smooth demand/level scheduling	Purpose	Approach to choosing suppliers	Inventory strategy	Manufacturing focus	Product design strategy	Manufacturing process	Breakdown rate	Yield rate	Quality problem	Supply sources	Supplier's reliability	Process change	Capacity constraint	Changeover rate	Flexibility	Space/Time
14	Fisher (1997)			✓	✓	✓	✓	✓											
15	Naylor et al (1999)	✓	✓																
16	Huang et al (2002)			✓	✓	✓	✓	✓											
17	Lee (2002)									✓	✓	✓	✓	✓	✓	✓	✓	✓	
18	Towill and Christopher (2002)																		✓
19	Waddington et al (2002)		✓												✓			✓	
20	Cigolini et al (2004)			✓														✓	
21	Wang et al (2004)			✓	✓	✓	✓	✓											
22	Wong et al (2006)			✓		✓	✓		✓										
23	Selldin and Olhager (2007)			✓	✓	✓	✓	✓											

Attributes and SC characteristics	Supply chain classification (Fisher, 1997; Naylor et al., 1999; Childerhouse and Towill, 2000; Christopher and Towill, 2000; Mason-Jones et al., 2000(a); Mason-Jones et al., 2000(b); Christopher and Towill, 2002; Huang et al., 2002; Lee, 2002; Towill and Christopher, 2002; Waddington et al., 2002; Harris and Componation, 2005; Christopher et al., 2006; Goldsby et al., 2006; Narasimhan et al., 2006; Selldin and Olhager, 2007)		
	Physical efficient (Lean)	Hybrid (Le-agile)	Responsive (Agile)
Key aim of SC (Fisher, 1997; Naylor et al., 1999; Mason-Jones et al., 2000(a); Huang et al., 2002; Wang et al., 2004; Narasimhan et al., 2006; Wong et al., 2006; Selldin and Olhager, 2007)	Low cost	Balanced focus between low cost and high service level, apply postponement to achieve mass customisation	High service level and fast response to minimise stock outs
Manufacturing focus (Fisher, 1997; Huang et al., 2002; Wang et al., 2004; Wong et al., 2006 Selldin and Olhager, 2007)	Maintain high average plant utilisation rate	Balance asset utilisation and inventory quantity to deal with demand changes	Availability of raw material to manufacture is most important and utilise inventory to fulfil demand fluctuation
Inventory strategy (Fisher, 1997; Huang et al., 2002; Wang et al., 2004; Wong et al., 2006; Selldin and Olhager, 2007)	High turns and minimises inventory to avoid wastage and cost	Keep intermediate stock to cover the demand fluctuation and minimise inventory of raw material	Ensure the stock level of all types of inventory is significant to deal with erratic demand and tide over unpredictable market requirements
Lead time focus (Fisher, 1997; Huang et al., 2002; Wang et al., 2004; Wong et al., 2006 Selldin and Olhager, 2007)	Shorten lead time without investment	Invest moderately to reduce lead time	Invest aggressively in ways to reduce lead time
Approach to choosing suppliers (Fisher, 1997; Huang et al., 2002; Wang et al., 2004; Selldin and Olhager, 2007)	Primarily low cost and high quality	Primarily low cost and high quality, but capability for speed and flexibility as and when required	Primarily speed, flexibility and quality

Table 2.14: Characteristics of different types of supply chains

2.12.1 Supply chain attributes

a) Key aim of supply chain

Key aim of supply chain is a primary focus of the supply chain in order to supply products or services to customer. The main focus of the physically efficient or lean supply chain is the reduction of cost and efficient use of resources. The physical efficient or lean supply chain attempt to terminate all non-value added activities (Naylor et al., 1999) and pursuing economies of scale and optimisation of resources (Harris and Componation, 2005). The physical efficient or lean supply chain will emphasise on producitivity improvement that directly affect cost reduction and efficiency (Naylor et al., 1999, Lee, 20002, Ramdas and Spekman, 2000). In contrast, responsive or agile supply chain focuses on customer service include speed delivery (Fisher, 1997, Huang et al., 2002, Lee, 2002), flexibility (Huang et al., 2002) and agility (Fisher, 1997, Lee, 2002). The aim for the agile supply chain includes to minimise stock out rates, forcemarkdown and obsolete inventory (Fisher, 1997). Hybrid supply chain is defined to balance between lean and agile strategy with placing decoupling point to divide the strategy. In the upstream supply chain is expected to utilise lean strategy while downstream supply chain adopted the agile strategy in order to achieve mass customisation (Huang et al., 2002, Wang et al., 2004).

b) Manufacturing focus

In lean supply chain, high average utilisation rate need to maintain in order to keep cost at a minimum level. However, agile supply chain deploys excess buffer capacity to ensure that raw material or components are available to manufacture the product according to market needs (Fisher, 1997, Huang et al., 2002, Wang et al., 2004). While, hybrid or leagile supply chain has been defined as a combination of lean and agile supply chain (Naylor et al., 1999), therefore in the beginning part of supply chain is similar to lean and the later part is similar to agile supply chain (Huang et al., 2002, Wang et al., 2004).

c) Inventory strategy

Physical efficient or lean supply chain generates high turns and minimises inventory throughout the chain in order to reduce cost (Fisher, 1997, Huang et al., 2002, Wang et al., 2004). Inventory needs space thus increase cost for warehouse, production, excess inventory etc. In contrast, agile supply chain deploys significant stocks of parts to tide over unpredictable demand requirements (Huang et al., 2002, Wang et al., 2004). Hybrid or leagile supply chain is defined to postpone product differentiation till as late as possible. Hybrid/leagile supply chain try to minimise functional components inventory. If possible, functional components has been ready at the decoupling point, and postponement for innovative components only.

d) Lead time focus

Due to cost constraint, physical efficient or lean supply chain focus to shorten lead time as long as it does not increase cost (Fisher, 1997, Lee, 2002, Wang et al., 2004). In other words, the aggressive investment to shorten lead time will not be taken into consideration. However, agile supply chain is required to reduce lead times aggressively to avoid losing market demands. Hybrid strategy is a combination of lean and agile strategy in order to reduce lead time where at component level lean strategy is used but at product level, agile strategy is utilises (Huang et al., 2002, Wang et al., 2004).

e) Approach to choosing suppliers

According to Selldin and Olhager (2007), approach to choosing suppliers have the same meaning with key aim of supply chain. When the product demand is uncertain, the potential for stock outs is highly expected. In this scenario, company will choose suppliers who can provide speed, flexibility and high quality to meet customers demand. The opposite scenario is happened to product that have stable and predictable demand. Lean strategy is adopted which concern to cost reduction, therefore, suppliers who are able to involve low cost but remain the quality of products are the main criteria of suppliers (Huang et al., 2002, Lee, 2002, Wang et al., 2004). While, hybrid supply chain will choose upstream suppliers as same as lean strategy and downstream suppliers similar to agile strategy. For the holistic view of supply chain, speed and flexibility criteria are needed as when its supply chain required (Huang et al., 2002, Wang et al., 2004).

2.13 Competitive priorities

Satisfying customers' needs, facilitating business growth and out-performing competitors ultimately determines the success of a strategy. Supply chain strategy and competitive advantage are mutually dependent (Cousins, 2005). For example, if a competitive priority is cost, companies will generally align their supply chain strategy with cost reduction to remain competitive in the market. Competitive priorities have been defined as strategic preferences or the ways in which an organisation chooses to compete in the marketplace (Hayes and Wheelwright, 1984). Other terms are used to refer to competitive priorities, such as organisational priorities and generic capabilities (Ferdows and Meyer, 1990), dimensions of competition (Fitzsimmons et al., 1991), content variables (Adam and Swamidass, 1989), manufacturing tasks (Skinner, 1969), external performance measures (Fine and Hax, 1985), production competence (Vickery et al., 1993) and order winners and qualifiers (Hill, 1993).

Market winners for different types of supply chains were highlighted by Mason-Jones et al. (2000 (a)) - lean supply chains should be cost-focused, whereas an agile supply chain is expected to facilitate the attainment of high service levels. Roh et al. (2008) proposed a framework that combined supply chain strategy and competitive priorities. This can be seen in figure 2.12.

	Market qualifiers	Market winners
Functional product/ Lean Supply Chain	- Quality - Lead time - Service level	- Cost
Innovative product/ Agile Supply Chain	- Quality - Cost - Lead time	- Service level

Figure 2.12: Market winners and qualifiers for each supply chain (Mason-Jones et al., 2000 (a), Mason-Jones et al., 2000 (b))

The different market needs met by lean and agile supply chains are explained in Sections 2.7 and 2.8. High service level is the vital factor to be achieved in an agile supply chain, whereas sales price or cost is the crucial need in a lean supply chain. Customer service level is defined by the speed with which customers take delivery of orders (Watson-Gandy and Christofides, 1974) and whether they receive them on time. In order to better understand a company's market, Hill (1993) has introduced the concept of competitive priorities being useful for manufacturing strategy determination. Mason-Jones (2000(a)) and Christopher and Towill (2000) have adapted this to form conceptual relationships between competitive priorities, product types and supply chain strategies.

It is generally agreed that competitive priorities have four basic components (Hayes and Wheelwright, 1984, Adam and Swamidass, 1989, Cleveland et al., 1989, Ferdows and Meyer, 1990, Vickery et al., 1993, Ward et al., 1995):

a) Cost

b) Quality

c) Delivery performance

d) Flexibility

Leong et al. (1990) have included a fifth competitive priority, i.e. innovation, which is increasingly noteworthy and gaining recognition. The basic components of competitive priorities listed above can be expanded (Hill, 1983, Ward et al., 1998, Krajewski and Ritzman, 2001, Quesada et al., 2008) for inclusion in this research as follows:

a) Price – have a lower selling price

b) Delivery – offer faster deliveries and reliable deliveries

c) Reliability – the ability to meet delivery schedules or promises

d) Customer service – have superior after-sales and/or technical support

e) Quality – offer superior product design, quality and standard (brand)

f) Flexibility – provide a greater order size variation

g) Product variety – provide a wider product range

h) Product design – the ability to satisfy unique needs of customers by changing products or service design

The relationships between competitive priorities, product type and supply chain strategies are shown in Tables 2.15 and 2.16.

Authors	Order winner/competitive priorities for lean supply chain or functional products						
	Quality	Cost	Availability	Lead time	Service level	Speed and flexibility	Innovation
Christopher and Towill (2000)	✓	✓					
Lamming et al. (2000)	✓	✓			✓		
Mason-Jones et al. (2000(a)		✓					
Mason-Jones et al. (2000(b)		✓					
Roh et al. (2008)	✓	✓					

Authors	Order winner/competitive priorities for le-agile supply chain or hybrid products						
	Quality	Cost	Availability	Lead time	Service level	Speed and flexibility	Innovation
Christopher and Towill (2000)			✓				
Lamming et al. (2000)							
Mason-Jones et al. (2000(a)			✓				
Mason-Jones et al. (2000(b)			✓				

Authors	Order winner/competitive priorities for agile supply chain or innovative products						
	Quality	Cost	Availability	Lead time	Service level	Speed and flexibility	Innovation
Christopher and Towill (2000)							
Lamming et al. (2000)	✓					✓	✓
Mason-Jones et al. (2000(a)			✓				
Mason-Jones et al. (2000(b)			✓				
Aitken et al. (2003)							
Yusuf et al. (2004)		✓					
Roh et al. (2008)						✓	✓

Table 2.15: Order winner and competitive priorities based on product and supply chain type

Product life cycle	Order winner/competitive priorities based on product life cycle						
	Quality	Cost	Availability	Lead time	Service level	Speed and flexibility	Design capability
Introduction			✓				✓
Growth stage			✓				
Mature		✓					
Decline			✓				

Table 2.16: Order winner and competitive priorities based on product life cycle

Roh et al. (2008) proposed a 2x2 framework that presented competitive priorities between product-supply chain strategy combinations. Figure 2.13 show the framework.

	Functional product	Innovative product
Lean Supply Chain	- Cost - Quality	- Speed of delivery - Flexibility
Agile Supply Chain	- Cost - Flexibility - Quality	- Speed of delivery - Flexibility - Innovation

Figure 2.13: Competitive priorities for product-supply chain strategy (Roh et al., 2008)

Christopher and Towill (2000) recognised that lean supply chains are now under pressure to become more agile and more customer-orientated. They concluded that real world supply chains are cyclical, in that the market winner for this year will become a market qualifier for next year. This market trend will be cyclical, depending on the market driven by customers. In fact, average customer demand is constantly varying because of climate changes and changing customer preferences (Vorst et al., 1998).

2.14 Organisational culture

This sub-section compares organisational culture in the UK and Malaysia, including the differences in supply chain practices in Asian and Western environments. According to Sheu et al. (2004), factors such as different countries and national differences, including national cultures, language and management style, can affect how business is done. This statement is supported by the findings of Sheu et al. (2006), which confirm the effects of social constructs on supplier-retailer collaboration. Since the issue of supplier-retailer collaboration effects remains to be investigated, this study tries to fill the gap by embarking on a comparison study of Malaysia/Asia and UK/Western countries, which may show differences in the adoption of supply chain strategies in order to collaborate between supplier-retailer aspects to meet demand. Hofstede (1980) and Pheysey (1993) found that the UK has a strong culture of individual accountability, while Malaysian culture emphasises inter-organisational collaborative practices and hierarchical culture (Abdullah, 1992).

2.15 UK/West

The UK food industry is the country's largest manufacturing sector, accounting for 15% of overall manufacturing industry with a total annual turnover of £70 billion (Boothby et al., 2007). The Office for National Statistics recently published results showing that the UK food and drink industry was the only manufacturing sector to record an increase in production throughout January 2010. In fact, over the last two years, food and drink producers have maintained the most consistently steady levels of manufacture of all the industrial divisions, as well as currently demonstrating the top index level, as shown in Figure 2.14. While all other sectors have struggled in 2010, food and drink is growing and its track record demonstrates an industry that is reliable and capable of growth in adverse conditions.

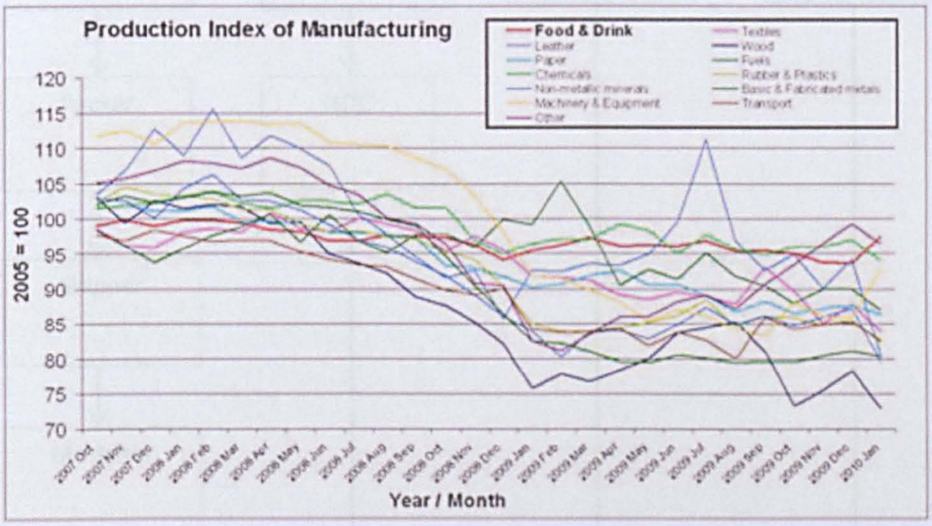


Figure 2.14: Production Index of Manufacturing
Source: ONS Time Series Data: Detailed Index of Production (2007-2010)

A typical food supply chain process is shown in Figure 2.15.

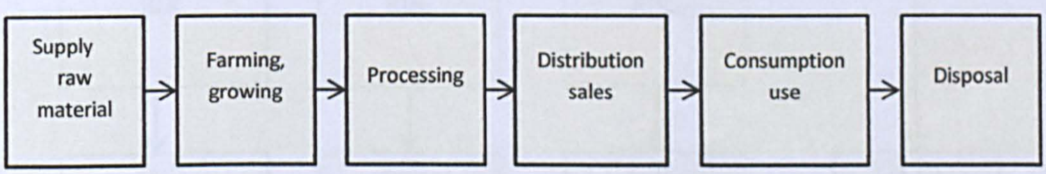


Figure 2.15: Typical food supply chain processes

Distribution chains for different types of food products are shown in Figure 2.16.

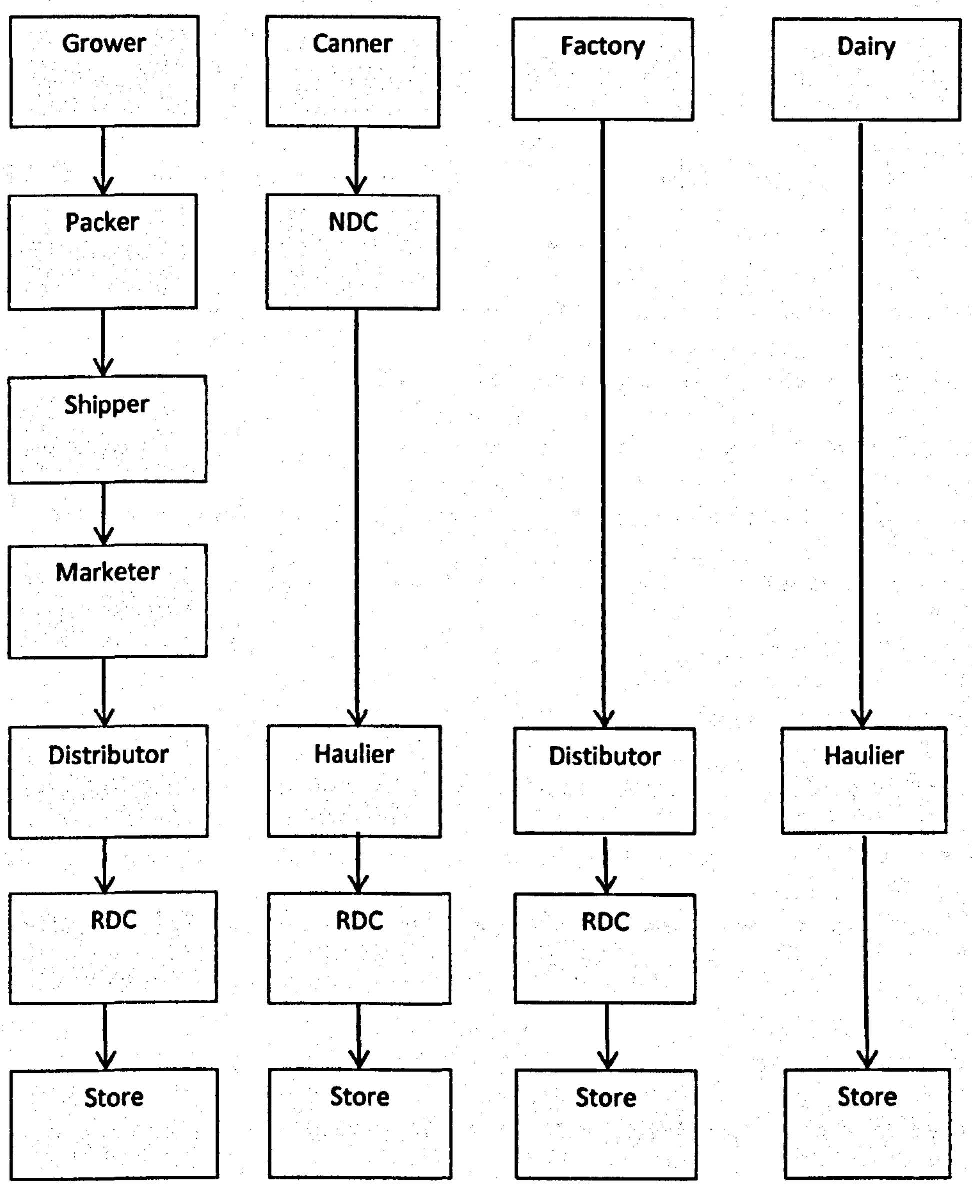


Figure 2.16: Distribution chains for different types of food products (Stephen and Wright, 2002)

Although, majority of the food supply chain have adopted similar distribution models, a solution of one size fits all is still required for different product groups (Stephen and Wrights, 2002).

2.15.1 Food supply chain in the UK

UK food retailers are among the most sophisticated in the world. Nature of retailer in the UK are they supply their own label product with demands they place on their supply chain players are one of the most efficient and innovative in the world. Major supermarkets in the UK have changed their strategies dramatically over a decade ago. There is intense competition between major supermarkets such as Tesco, Sainsbury's, Asda and Safeway that accounted to almost two-thirds of grocery sales (Fearne and Hughes, 1999). Transformation of strategy being replaced based on differentiation, product range and price competitiveness. UK supermarkets trends contributed to the change of competitiveness of food supply chain that seen as competing head-to-head with major manufacturers' brands in the same quality market.

The 1990 Food Safety Act emphasis driven backwards from retailer rather than forwards from the grower/processor, that called vertical co-ordination. Therefore, the need to improve supply chain in terms of diligence and tighter control become crucial. The 1990 Food Safety Act requires foods that receive from upstream suppliers must be safe. Upstream suppliers need to be very particular in terms of handling, diligence and stringent to the quality assurance. Besides, Food Standard Agency required that traceability is important for different stakeholders include industry, government and consumers to improve human health through food safety

(Wognum et al., 2011). The EU General Food Law (GFL) Regulation contains clear requirements for traceability, stating in Article 18 (Food Standard Agency, 2002) as listed below:

a) The traceability of food, feed, food-producing animals, any other substance intended to be, or expected to be, incorporated into a food or feed shall be established at all stages of production, processing and distribution.
b) Food and feed business operators shall be able to identify any person from whom they have been supplied with a food, a feed, a food producing animal, or any substance intended to be, or expected to be, incorporated into a food or feed. To this end, such operators shall have in place systems and procedures, which allows for this information to be made available to the competent authorities on demand.
c) Food and feed business operators shall have in place systems and procedures to identify the other businesses to which their products have been supplied. This information shall be made available to the competent authorities on demand.
d) Food or feed which is placed on the market or is likely to be placed on the market in the community shall be adequately labelled or identified to facilitate its traceability, through relevant documentation or information in accordance with the relevant requirements of more specific provisions.
e) Provisions for the purpose of applying the requirements of this Article in respect of specific sectors may be adopted in accordance with the procedures laid down in Article 58 (2).

2.16 Malaysia

Food processed based Small and Medium Enterprises (SMEs) has been recognised as one of the most important contributors for the economic development of many countries (Lamprinopoulou et al., 2006). The Malaysian food industry contributes 10% of the country's overall manufacturing output (Malaysian Industry Development Authority, 2008, Shah Alam et al., 2011). The industry is also predominantly Malaysian-owned and dominated by small and medium-sized enterprises (SMEs). The total number of food processing companies in Malaysia is 6,019, which consisting of 80% the total numbers (5,925) are SME companies. In the Ninth Malaysia Plan (9MP), between the years 2006-2010, the Government of Malaysia introduced a new policy to strengthen agriculture and agro-based industry, with a focus on total supply chains to increase the value added and expand agro-based activities. The 9MP also includes a plan to become a net food exporter, particularly for 'halal' foods. In addition, the Malaysia Plan is parallel with the aims of the Third Industrial Master Plan (2006-2020), IMP3, in which food processing in Malaysia will be expanded and diversified towards making Malaysia a '*halal*' regional food production and distribution hub (Malaysian Industry Development Authority, 2008). According to Shah Alam et al. (2011), the processed of food products demand has been changed due to the increasing trend of Malaysians standard of living and purchasing power. The changes of Malaysian lifestyle have resulted to the increasing of demand for convenience food and health food. Food processing companies are exported to more than 80 countries with amounting to two-thirds of the total Malaysian food exports that value of more than RM6 billion (Malaysian Industry Development Authority, 2008). Some of the characteristics of food industry in Malaysia that may affect the growth and its supply chain are listed below (SMIDEC, 2009):

a) Increasing value of halal markets, estimated at USD547 billion a year
b) Substantial number of global Muslim population, approximately 3 billion, or 30% of the total world population
c) Potential market of in the Asian region, amounting USD3.7 billion
d) Expansion of consumers including the non-Muslims
e) Similarity of the taste of products in particular among the middle east nations and neighbour countries
f) Increase of disposal income and buying power among Muslim countries such as Middle East, West Asia, North Africa, Europe and North America.
g) Effect from the economic integration, such as AFTA.

2.17 Importance of competence index

Competence index is used to measure the level of competence for each tier of the supply chain. According to Allio (2006), once strategy has been developed, firms have to recalibrate their performance measurement systems to track and reward strategic behaviour. One of the ways to measure the performance of SCM is strategy perceives SCM as a mean to vary certain competencies in a chain in order to maximise profits (Gadiesh and Gilbert, 1998, Otto and Kotzab, 2003). Therefore, in this research competence index is used to measure the efficiency and effectiveness of strategy used based on the selection of competitive priorities as suggested by Cleveland et al., (1989). Effectiveness means 'doing the right things' while efficiency means 'doing things right' (Zokaei and Simons, 2006). Competence variables are not fixed attributes, it can be measured by how well supply chain's strengths and weaknesses complement the priorities of the supply chain strategy. Since performance is a measure of how well that strategy works, there should be a definable relationship between competence and performance. Therefore, the importance of competence index are listed as follows:

a) As the essential ingredient of the relationship that unleashes the value creating ability of the supply chain (Spekman et al., 2002)
b) Improves the overall effectiveness of the supply chain as well as the abilities of the individual members (Spekman et al., 2002)
c) Benchmark to improve overall supply chain's competitive position (Spekman et al., 2002)
d) Leads to increase in end-use customer satisfaction (Spekman et al., 2002)
e) Measure the efficiency of output level (Wang et al., 2007).
f) Measure something about the direction of the business for ensuring that resources are allocated to where they can make a benefit (Charles, 2008).

2.18 Summary

This chapter provides a review of the literature for this study, covering supply chains, supply chain management, supply chain strategies, alignment of supply chains, product classification, supply chain classification, competitive priorities and food industries for both the UK and Malaysia. Several important points have been identified and are summarised as follows:

a) Most supply chain alignment research comprises conceptual works based on a theoretical basis and researchers' experience.
b) Supply chain strategy alignments are widely accepted as ways of increasing business performance and remaining competitive in markets.
c) Empirical studies concern dyadic alignment (manufacturing-customer demand) in Western-developed countries, while developing countries have received limited interest.
d) Product and supply chain characteristics listed by previous researchers do not show a rigid agreement that allows them to be categorised into functional, innovative, lean or agile.
e) Hybrid product and leagile supply chain characteristics are not yet established and have received little thought.
f) The review also included a summary of product and supply chain characteristics that helps to distinguish products and supply chains.
g) Competitive priorities appear to have cyclical rotations following demand changes.

h) Food industries in both the UK and Malaysia are the main contributors to economic growth in both countries.

Chapter 3 METHODOLOGY

3.1 Introduction

This chapter discusses the research approach undertaken to achieve the research objectives. Figure 3.1 articulates the overall approach used in this research in order to accomplish the research objectives.

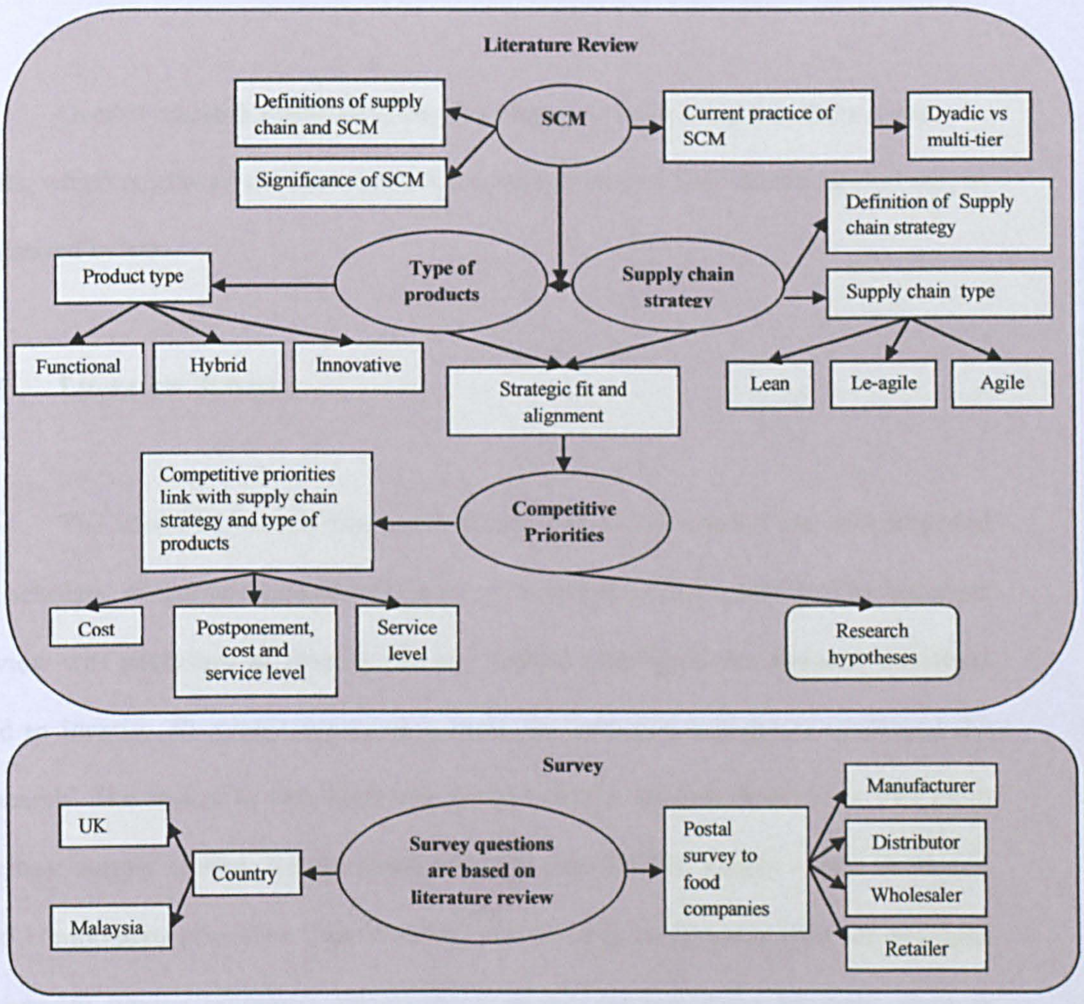


Figure 3.1(a): Overall research approaches

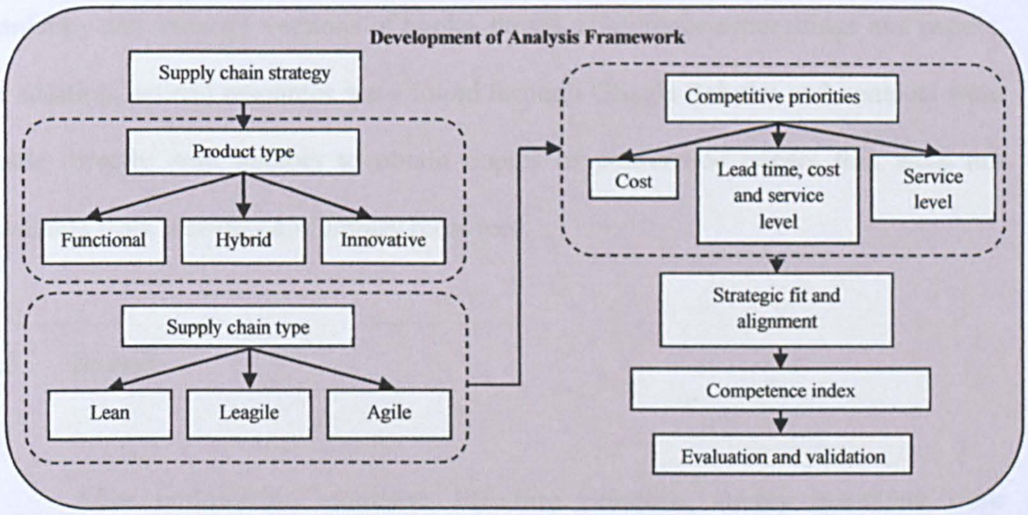


Figure 3.1(b): Overall research approaches

Overall research approaches for this study can be divided into three main parts, which consist of the literature review, survey method and statistical analysis, as discussed below.

3.2 Literature Review

The literature review examined studies previously carried out and proposed by scholars, researchers and practitioners on the topic of this research. The literature review was necessary to identify the key factors relating to the research questions and to identify all related topics as a basis for informed arguments to defend the research. The topics in this literature review can be broken down into five main themes: supply chains, supply chain management (SCM), supply chain strategies, and competitive priorities. The literature review was undertaken with all available university library resources, including electronic databases for journals, such as Emerald, Science Direct, Scopus, JStor, Informaworld (Taylor and Francis), and both hardcopy and softcopy versions of books, theses, conference proceedings and papers. In addition, several resources were found through Google Scholar and contacts were made directly with authors to obtain copies of conference papers that were not available from websites and library resources.

3.3 Survey

After undertaking extensive literature searches, survey questions were researched, structured and based on the topics examined, as shown in Figure 3.1. The survey method was selected because it contributes to the advancement of knowledge in different ways. According to Forza (2002), survey research is useful for exploratory, confirmatory (theory testing or exploratory) and descriptive research. The survey method is particularly suitable for this research in that it can provide empirical findings to prove or otherwise, previous conceptual theories. Figure 3.2 shows the process of the survey methodology with careful consideration being given to the prevention of errors (Synodinos, 2003) to ensure the final version of the questionnaire would be understandable by the respondents.

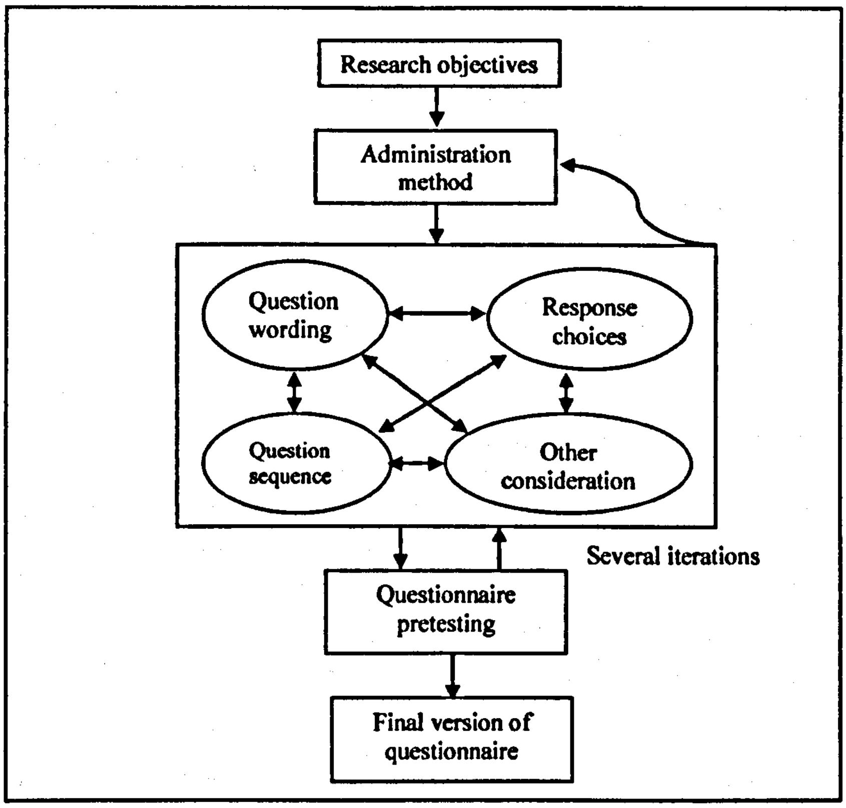


Figure 3.2: Questionnaire construction process (Synodinos, 2003)

Research objectives: Research objectives are set, based on the research questions, literature reviews and knowledge gap.

Administration method: Postal mail was used to collect data in both the UK and Malaysia due to its popularity as a method of obtaining adequate data. Comparisons of data collection by postal surveys, personal interviews and telephone surveys have found that postal surveys are the cheapest (Forza, 2002; Cooper and Schindler, 2006) and the easiest way of securing information from participants (Forza, 2002). In addition, they provide highly accurate information and the overall reliability and validity of responses are acceptable (Forza, 2002).

Question wording: The language usage was reviewed several times to ensure consistency with the respondent's level of understanding. The questions were designed to avoid any slang or jargon words; in fact, the questions were simple, well-structured and used familiar words.

Response choices: Multiple response choices were used depending on the questions, including close-ended listed choices, a five-Likert scale and 'YES' or 'NO' response choices.

Question sequence: Question sequences were based on the four steps of the research questions, consisting of product type, supply chain type and competitive priorities.

Other considerations: The questionnaire was tailored to manufacturers, distributors, wholesalers and retailers and was aimed at operations managers or supply chain managers.

Questionnaire pre-testing: Once the questionnaire had been designed, pre-testing was carried out by submitting the 'final' questionnaire to three types of people: colleagues, industry experts and target respondents. The response and feedback from pre-testing questionnaires was incorporated into amendments and the final version of the questionnaire.

Final version of questionnaire: After all of the above steps had been completed, the final version of the questionnaire was ready to send to respondents.

3.4 Research Hypotheses

Research hypotheses were developed based on the literature and conceptual model discussed in the literature review section. This study aims to examine whether the supply chain strategies and competitive priorities for functional, innovative or hybrid products are aligned with the lean, agile or leagile strategies respectively to meet demand requirements. There are many hypotheses developed due to the investigation of each category of product types and supply chain types. Therefore, for each product and supply chain type has its own attributes to be tested. Each of hypothesis developed according to the characteristics of food sector as explained in Chapter 2 (Literature Review). Table 3.1 shows the proposed hypotheses and relevant justifications.

Table 3.1(a): Proposed hypotheses and relevant justifications

Hypotheses for supply chain strategy alignment	Justification
H_0: Product and supply chain type are directly related.	Fisher (1997) proposed that in order to determine an effective supply chain strategy, nature of demand product is essential. Researchers include Lamming et al. (2000), Lee (2002), Huang et al. (2002), Wong et al. (2006) who extended Fisher's theory. Lo and Power (2010) tested the relationship between supply chain and product type and indicated the results were not supported for manufacturer level.
H_1: Food companies with a functional product adopt lean supply chain characteristics as opposed to agile supply chain characteristics.	In Fisher's model, a functional product is matched with a lean supply chain. Such a proposition is also supported by Huang et. al (2002) and Lee (2002). Selldin and Olhager (2007) showed empirically that correctly aligning product with supply chain produces better performance than when compared with mismatched supply chain-product strategies.
H_2: Food companies with an innovative product adopt agile supply chain characteristics as opposed to lean supply chain characteristics.	Fisher's model requires innovative products, with volatile and unpredictable demand, be supplied by agile supply chains. This is supported by Huang et al. (2002) that requires matching innovative products and agile supply chain.
H_3: Food companies with a hybrid product adopt leagile supply chain characteristics as opposed to lean and agile supply chain characteristics.	Huang et al. (2002) suggested that leagile supply chain should be matched with the hybrid type of products in order to achieve the optimal performance.

Table 3.1(b): Proposed hypotheses and relevant justifications

Hypothesis for competitive priorities alignment	Justification
H_{1a}: Food companies with a functional-lean combination adopt a low selling price as a key competitive priority.	Studies have shown that cost is a market winner for lean supply chains (Mason-Jones et. al., (2000(a)). Fisher (1997) suggested that low cost is a concern of functional products, which suggested supplying with lean, which also rated cost as a key metric (Naylor et al., 1999).
H_{1b}: Food companies with a functional-lean combination adopt quality as a key competitive priority.	Studies have shown that quality is one of the main priorities when choosing suppliers for functional products (Fisher, 1997, Lamming et al., 2000, Huang et al., 2002) and as a market qualifier for lean supply chains (Mason-Jones et. al., 2000(a)).
H_{2a}: Food companies with an innovative-agile combination adopt high product variety as a key competitive priority.	Fisher (1997) suggested a key characteristic of innovative products is very high product variety. An innovative product is defined as having high demand uncertainty. Waddington et al. (2001) highlighted that product variety contributes to demand uncertainty. Hence, the higher the demand uncertainty, the greater the product variety.
H_{2b}: Food companies with an innovative-agile combination adopt large order size flexibility as a key competitive priority.	A key priority for choosing suppliers of innovative products is flexibility (Fisher, 1997; Huang et. al., 2002; Wang et. al., 2004).
H_{2c}: Food companies with an innovative-agile combination adopt quality as a key competitive priority.	Previous studies have shown that quality is one of the main priorities for choosing suppliers of innovative products (Fisher, 1997) and a market qualifier for agile supply chain (Mason-Jones et. al., 2000(a)).
H_{2d}: Food companies with an innovative-agile combination adopt delivery speed as a key competitive priority.	Quick delivery is a primary goal of agile supply chains (Fisher, 1997).
H_{2e}: Food companies with an innovative-agile combination adopt delivery reliability as a key competitive priority.	Service level is a main concern of innovative and agile supply chains (Mason-Jones et al., 2000(a), 2000(b)). The innovative products focus on speed of delivery due to the seasonal demand, therefore delivery reliability support the needs to meet the customers' demand.
H_{2f}: Food companies with an innovative-agile combination adopt product design as a key competitive priority.	One of the innovative products' competitive priority is innovation with either high complexity or low complexity of products (Lamming et al., 2000).
H_{3a}: Food companies with a hybrid-lean combination adopt quality as a key competitive priority in upstream supply chain.	Huang et al. (2002) pointed out that quality is important when choosing the suppliers for hybrid products.
H_{3b}: Food companies with a hybrid-lean combination adopt a low selling price as a key competitive priority in upstream supply chain.	Hybrid products consist of either different combinations of standard components, or a mix of standard and innovative components. Therefore, the cost importance is similar to functional products (standard products) in

	upstream supply chain (Huang et al., 2002).
H_{3c}: Food companies with a hybrid-agile combination adopt quality as a key competitive priority in downstream supply chain.	Huang et al. (2002) pointed out that quality is important when choosing the suppliers for hybrid products.
H_{3d}: Food companies with a hybrid-agile combination adopt delivery speed as a key competitive priority in downstream supply chain.	Huang et al. (2002) stated that hybrid products are capable of delivery speed to meet customer requirements.

Table 3.1(c): Proposed hypotheses and relevant justifications

Hypothesis for competitive priorities alignment and performance relative to the fit between product-supply chain strategy	Justification
H_{3e}: Food companies with a hybrid-agile combination adopt flexibility as a key competitive priority in downstream supply chain.	Flexibility is required from suppliers of hybrid products - ability to postpone product differentiation to meet demand (Huang et al., 2002).
H_{4a}: Food companies with a functional-lean product-supply chain strategy combination perform better in terms of cost and quality.	Selldin and Olhager (2007) found that cost is significantly better in matching cases (functional-lean and innovative-agile) compared with mismatched cases for manufacturers. Quality was found to be important for any type of product without considering matched or mismatched strategies (Selldin and Olhager, 2007).
H_{4b}: Food companies with an innovative-agile product-supply chain combination strategy perform better in terms of service level and quality.	Mason-Jones et al (2000(a), 2000(b)) suggested that service level is important to win orders for innovative or agile supply. Naylor et al. (1999) and Narasimhan et al. (2006) also characterised agile supply in terms of focusing on service level to deal with volatile demand. In addition, Fisher (1997) suggested that innovative products should be focused on speed delivery and flexibility.
H_{4c}: Food companies with a hybrid-leagile product-supply chain strategy perform better in terms of cost, service level and quality.	Huang et al. (2002) proposed that hybrid products focus on low cost and high quality along with the capability of speed and flexibility to meet unexpected demand patterns.
H_{5a}: Food supply chains for functional products adopt lean characteristics throughout the tiers of the chain.	Fisher (1997) and Huang et al. (2002) suggested that functional products should be aligned with lean supply chain to optimise performance. They also suggested that innovative products should be aligned with agile supply chain. Huang et al. (2002) proposed the addition of product called hybrid should work in lean in the upstream supply chain and agile in downstream supply chain. The whole supply chain is called 'leagile' supply chain.
H_{5b}: Food supply chains for innovative products adopt agile characteristics throughout the tiers of the chain.	
H_{5c}: Food supply chains for hybrid products adopt leagile characteristics throughout the tiers.	

Other than providing empirical evidence of Fisher (1997) and Huang et al., (2002), the implication of these hypotheses on supply chain strategy is able to specifies what process is intended or focuses in order to accomplish better supply chain capability. The SCM benefits can be unlocked through the alignment of supply chain strategy and its competitive priorities as they are ideally articulates on how it will compete in marketplace (Fisher, 1997). Thus, the objective to maximise the firm's performance and satisfy customer needs can be increased company's profit.

3.5 Questionnaire design

In this study, a questionnaire is employed as the main approach for collecting data, as survey research is commonly used for exploratory, descriptive or confirmatory research (Malhotra and Grover, 1998, Forza, 2002). The survey research is sufficient for this study due to the norm of this study taken by Selldin and Olhager (2007), Sun et al. (2009) and Lo and Power (2010). From survey, the objective of research can be achieved in order to obtain an overview from different perspectives of supply chain members. Therefore, the survey research is sufficient based on the nature of the study and it is achieved the objective of research according to the explanation below. In addition, the survey questions have been tested its reliability and validity.

Exploratory survey research is usually appropriate at the beginning of the research process to gain initial insight into a research topic. Typically, for exploratory survey research, there is no previous model; thus, the preliminary stage helps to create the concept and sets out how to resolve a new facet in the research area (Malhotra and Grover, 1998, Forza, 2002).

Descriptive survey research aims to describe facts that provide useful hints for theory building and refinement. It also aims to comprehend the pertinence of a certain phenomenon and illustrate the distribution of the population for the phenomenon, thereby ascertaining the facts (Malhotra and Grover, 1998, Forza, 2002).

Confirmatory survey research is suitable when knowledge of a phenomenon has been well conveyed in a theoretical form using well-defined concepts, models and propositions. This kind of survey research is adapted to this study where data collection is executed to assess the proficiency of the theories developed.

3.5.1 Survey instrument

The study is based on a survey instrument designed after careful review of the literature. The survey was undertaken using the postal system in both the UK and Malaysia. The postal survey is regarded as an efficient method of collecting data from participants (Forza, 2002). The advantages of using postal surveys (Forza, 2002, Saunders et al., 2009) are:

a) minimal staff required
b) adequate time to think about the questions
c) lowest cost
d) ease of securing information
e) size of sample is high and geographical coverage is wide

The questionnaire was sent to respondents with a stamped addressed envelope for returns. This was suggested by Dillman (2007) in order to increase response rates.

3.5.2 Instrument assessment and validation

In order to assess and validate the survey instrument, the following steps were taken. Once the questionnaire had been designed, pre-testing was undertaken by submitting a final draft to three groups of people, consisting of colleagues, industrial experts and target respondents. The responses and feedback from the pre-test questionnaires were analysed in order to improve and produce the final version, which was then used to collect data from companies operating in the UK and Malaysian food sectors. The questionnaire was sent to 100 manufacturers, distributors, wholesalers and retailers in the UK for the pilot run, out of which 16 usable questionnaires were returned. According to Gill (2005), Asmah Omar, in 1996, noted that business and corporate language in Malaysia is more often English than Malay, Malaysia's official language. Therefore, the same sets of questionnaires were used for Malaysia and the UK. A copy of the questionnaire is shown in Appendix A. The questionnaire consists of five main sections as follows:

a) Respondent details

   The first section provided respondent details, including name, position and company's address.

b) Background of company

   This section contained three types of questions, including type of goods produced and size of company. Size of company can be categorised based on two factors; number of employees and annual turnover (Loecher, 2000).

c) Product type

The third section focussed mainly on the product type. A list of product types and answer options for each question were based on the literature review. The attributes within a specific numerical range proposed by previous researchers were selected to determine the demand characteristics used in this research. Attributes such as volume, which is classified subjectively as low, medium, high, were not selected to simplify the categorisation. In addition, characteristics for hybrid products are limited in the literature. Therefore, the list of product types was screened, using the most conspicuous and highly referenced attributes prior to product types. In addition, a list of product attributes was chosen within a specific range to categorise hybrid product classification. The questions include type of products, based on UKSIC2003 classification, forecast error, pattern of demand, number of stock keeping units (SKUs), stage of product life cycle, lead time and length of product life cycle. Respondents were asked to tick the range of each product's attributes.

d) Supply chain type

Fisher (1997) and Huang et al. (2002) provide a list of supply chain attributes in order to determine the supply chain type. This section gave respondents a close-ended choice of key aims of supply chains, manufacturing focus, inventory strategy, lead time focus, approach to choosing suppliers were included. Respondents were asked to tick the schematic diagram that best describes their supply chain structure, a point for strategic stock and operations strategy adopted.

e) Competitive priorities

The final section has a different structure of questions from the previous questions. Eight competitive priorities were listed in this section. Respondents were asked to provide a rating of the main competitive priorities relative to the company's competitors. The rating used a five-point Likert scale that indicates '1= highly insignificant' to '5=highly significant'.

3.5.3 UKSIC 2003 Classification

The UK Standard Industrial Classification of Economic Activities 2003 (SIC2003) is used to categorise the type of food industry involved in this study. Some food processing industries do not lead to a real transformation and are classified to section G (wholesale and retail trade). A list of UKSIC 2003 categories is shown in Appendix B. The food product category in survey developed was based on the UKSIC 2003 category.

3.5.4 Sample

The survey was conducted from December 2008 to the end of March 2009 (during winter season) for companies in the UK, and from the end of December 2008 to the end of April 2009 (during summer season) for companies in Malaysia. The difference in weather season is expected to see the influence of food demand as discovered by MacDonald (2000). For the UK study, which included the pilot survey, the questionnaires were sent out to 1,000 companies; 116 were returned out of which 89 were usable, providing a response rate of 8.9%. For Malaysia, 745 companies were mailed; 97 were returned out of which 81 were usable, resulting in a usable response rate of 10.9%. The targeted participants in the study were supply chain managers, operations managers, directors and executives. This response rate is low but not abnormal. Managers from SMEs, which dominate the sector, may not be used to responding to research questionnaires and also, the information sought may possibly have contributed to the overall low response rate due to its sensitive and confidential nature. Previous researchers experienced a similar response,, for example, Waddington et al. (2001) studied 59 companies, Selldin and Olhager (2007) received 128 responses with 68 responses usable for analysis, Lo and Power (2010) received 119, of which 107 were usable).

3.6 Reliability and validity

3.6.1 Reliability test

Reliability signifies dependability, stability, predictability, consistency and accuracy, and refers to the degree to which a measuring process produces identical results on reiterated trials (Forza, 2002). It is also defined as an appraisal of the degree of consistency between several measurements of a variable (Hair et. al., 2006). There are four common methods for reliability testing (Litwin, 1995, Forza, 2002, Hair et al., 2006), comprising:

a) test-retest

b) alternate form

c) split halves

d) internal consistency

The test-retest method is the most commonly employed as an indicator for survey instrument reliability (Litwin, 1995). It determines the correlation between responses acquired through the identical appraisal pertaining to the same respondents at least two points in time to perceive how stable the responses are across time periods (Litwin, 1995, Forza, 2002). The alternative method measures the same attributes and constructs using differently worded items. One common way to test is by changing the order of the response set without changing the content and wording (Litwin, 1995, Forza, 2002). The split halves method assesses the equivalence of different sets of items for measuring the same construct by dividing the items into two subsets (Forza, 2002).

The final method is internal consistency by calculating a statistic known as '*Cronbach's coefficient alpha*' to determine the homogeneity and inter-correlation of the items used. This means that the items should hang together as a set, as no single item is a perfect measure of a concept. Cronbach's alpha can be expressed in the following way:

$$\alpha = \frac{n\overline{p}}{1 + (n - 1)\overline{p}}$$

Where;

n = number of items

$\overline{p}$ = average inter-item correlation

The acceptable level of reliability is $\alpha \geq 0.6$, while $\alpha \geq 0.7$ represents good reliability (Nunnally, 1978, Litwin, 1995, Forza, 2002, Hair et. al., 2006, Pallant, 2007). In this research, test-retest and internal consistency reliability were used to determine the questionnaire's reliability. The alternative form and split halves were not considered.

3.6.2 Validity test

Validity must be assessed in addition to survey reliability. Validity tests how well something measures what it sets out to measure. For example, to measure the importance levels of competitive priorities, a list of competitive priorities should be measured, and not some related variable. Typically, validity can be divided into four types (Litwin, 1995):

a) Criterion

Criterion validity can be broken down into two components: concurrent and predictive. The aim is to measure how well one instrument compares with another instrument or predictor. It presents a quantitative verification of the accuracy of the survey instruments.

i. Concurrent

Concurrent validity requires measurement against some other method, known as a 'gold standard', to assess the same variable. The statistic is used to either measure the correlation between current research data used and gathered a decade ago, or that of a more standard measure. The decade research data, or the more standard and well-known data, is called the 'gold standard'. The highest correlation indicates the highest concurrent validity for the items.

ii. Predictive

Predictive validity is the ability of a survey instrument to forecast future events, behaviours, attitudes or outcomes. For example, it measures possible election winners, intervention success, or other objective criteria. Correlation between the initial test and secondary outcome is performed.

b) *Construct*

Construct validity is the most complex, and yet the most valuable, way to test and assess survey instruments. It measures the meaningfulness of the scale in practical use, and is not calculated as a quantifiable statistic.

c) *Face*

Face validity is a casual assessment of the items by untrained judges. Most researchers do not consider face validity to be a measured validity.

d) *Content*

Content validity is a subjective measure by reviewers who have some knowledge of the subject matter of whether the items are an appropriate set of measures. Content validity is the overall opinion of trained judges and not quantified with statistics.

In this research, content validity is performed in order to assess the validity of the survey instrument. The survey instrument was assessed through a theoretical review and pilot test. Questions were constructed based on the literature review and reassessed together with the supervisor.

3.7 Selection of the sample

For the UK, 1,000 companies were identified from the FAME database, which consists of 400 manufacturers, 200 distributors, 200 wholesalers and 200 retailers. In Malaysia, lists of companies were obtained from two main directory websites (Malaysia Food Business Directory, 2008, Malaysia Manufacturers Directory, 2008). 745 companies were used within the survey, involving 350 manufacturers, 150 distributors, 120 wholesalers and 125 retailers.

3.8 Selection of statistical tools

In this study, multivariate statistical analysis is the main method of analysis for grouping the product and supply chain types as functional, hybrid or innovative, and lean, leagile or agile respectively.

Figure 3.2 shows the main analytical steps taken to analyse the data in order to answer the research questions and hypotheses.

3.8.1 Product and supply chain attributes

The range of measures included in this study is shown in Table 3.2, which was adapted from previous literature (refer to Tables 2.6 and 2.8 for product and supply chain attributes). Practical expediency prevented all possible attributes being included in the survey questionnaire. Those selected were chosen because of their high frequency of use and citation by researchers and because they involved the criteria of hybrid product and supply chain. The attributes were also selected because of their quantitative nature; for example, forecast accuracy and total lead time, and were used to distinguish and classify products or supply chain types into different groups. An exploratory analysis using a two-tailed correlation was executed to identify significant attributes before classifying products and supply chains. All analyses shown in flowchart figure 3.3, were used SPSS software include Spearman rho correlation, both cluster analysis, hierarchical and non-hierarchical K-means and cross-tabulation.

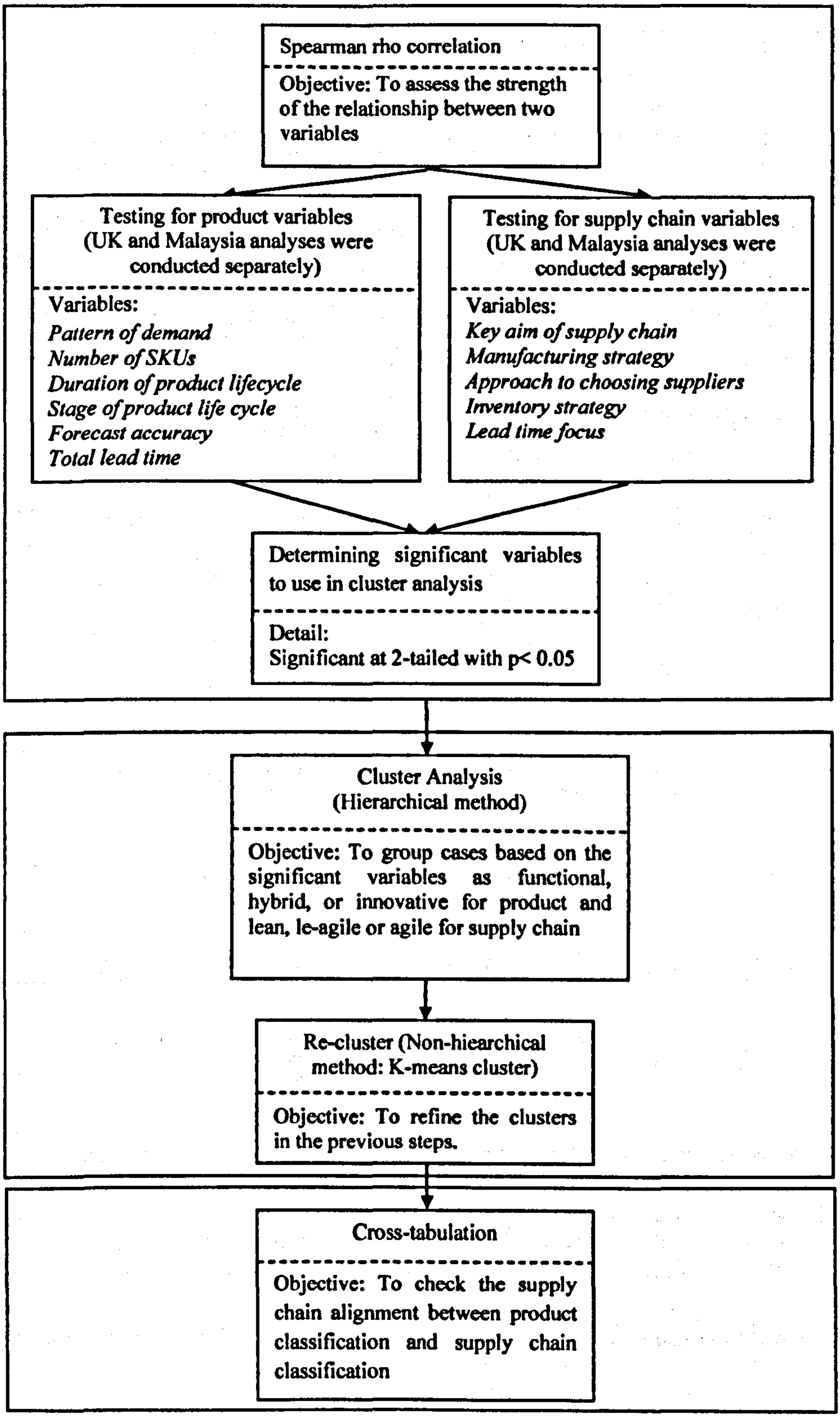


Figure 3.3: Flowchart of the main analytical steps

Table 3.2 Product and supply chain attributes

Product attributes	***Supply chain attributes***
Pattern of demand	Key aim of the supply chain
Number of SKUs	Operations/manufacturing strategy
Length of product life cycle	Approach to choosing suppliers
Stage of product life cycle	Inventory strategy
Forecast accuracy	Lead time focus
Total lead time	

3.8.2 Correlation analysis

Correlation analysis aims to assess the strength of a relationship between two variables (Saunders et al., 2009). A correlation coefficient enables the quantification of the strength of numerical variables through a linear relationship. The values of the correlation coefficient, usually represented by the letter ***r***, can be anywhere between negative 1 (-1) and positive 1 (+1), as shown in Figure 3.4.

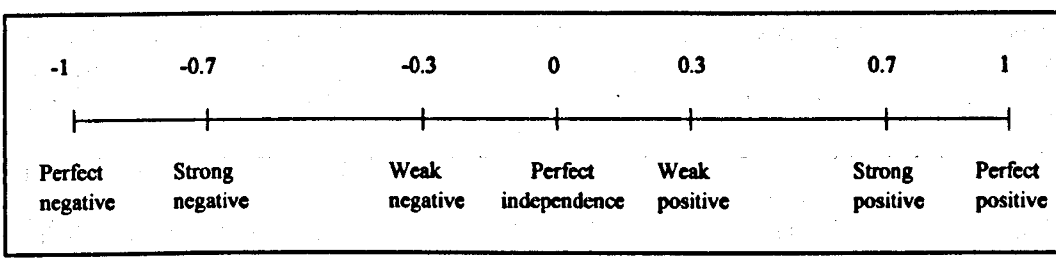


Figure 3.4: Values of the correlation coefficient

In this analysis, the probability of the correlation is measured with 95% confidence level. This means that if the probability value (*p-value*) is less than 0.05 the correlation is considered statistically significant, while if the probability value (*p-value*) is greater than 0.05 the relationship between two variables is not statistically significant.

3.8.3 Clustering product and supply chain type

Next, a cluster analysis was undertaken to deduce patterns and classify products as either functional or innovative, and supply chains as either lean or agile. Cluster analysis is an important tool for recognising patterns and grouping similar objects together (Lu et. al, 2008). The hierarchical cluster method was chosen due to the reliability of its clustering through an iterative process that associates object by object. The agglomerative procedure was used to cluster the object where it started with each object in a separate cluster and then combine the objects until the number of combined clusters achieves the required cluster (Almeida et al. 2007). The agglomerative method (bottom-up) is the most common technique. An alternative is the divisive method (top-down) (Almeida et al., 2007; Lu et. al., 2008). Agglomerative clustering starts with one-point (singleton) clusters and recursively merges two or more most appropriate clusters. Divisive clustering starts with one cluster of all data points and recursively splits the most appropriate cluster. The procedure continues until a stopping criterion is achieved at the requested number k of cluster. According to Hair et al. (2006), cluster analysis aims to maximise the homogeneity of the objects within the cluster while also maximising the heterogeneity between the clusters.

The main objectives of using cluster analysis are any combination of three basic research purposes as follows (Hair et al., 2006):

a) Taxonomy description

Cluster analysis is used for exploratory purposes and the formation of taxonomies. Cluster analysis is also used for confirmatory purposes to classify features based on theory.

b) Data simplification

Cluster analysis can be used to develop a simplified view by clustering objects for further assessment. The simplification helps to generalise characteristics instead of scrutinising them individually.

c) Relationship identification

Cluster analysis is also able to reveal the relationships within the simplified structure, and whether there are similarities or differences that cannot be seen through individual observations.

There are two main steps to the performance of cluster analysis (Narasimhan et al., 2006, Hair et al., 2006, Lu et al., 2008):

a) Select a similarity

Similar objects can be obtained by several measures, including correlational measures, distance measures and association measures. Correlational and distance measures are suitable for metric data, while association measures are suitable for non-metric data. The most commonly used measure is distance, which demonstrates similarity as the closeness between the objects across the variables.

b) Select a cluster algorithm

The cluster algorithm can be divided into two techniques: the hierarchical and non-hierarchical methods. The hierarchical method involves a tree-like structure and either an agglomerative or a divisive approach. The non-hierarchical method only assigns objects into specified clusters.

In this research, cluster algorithm is used as set of attributes for product or supply chain type is identical. The concept for cluster algorithm is shown in Figure 3.5.

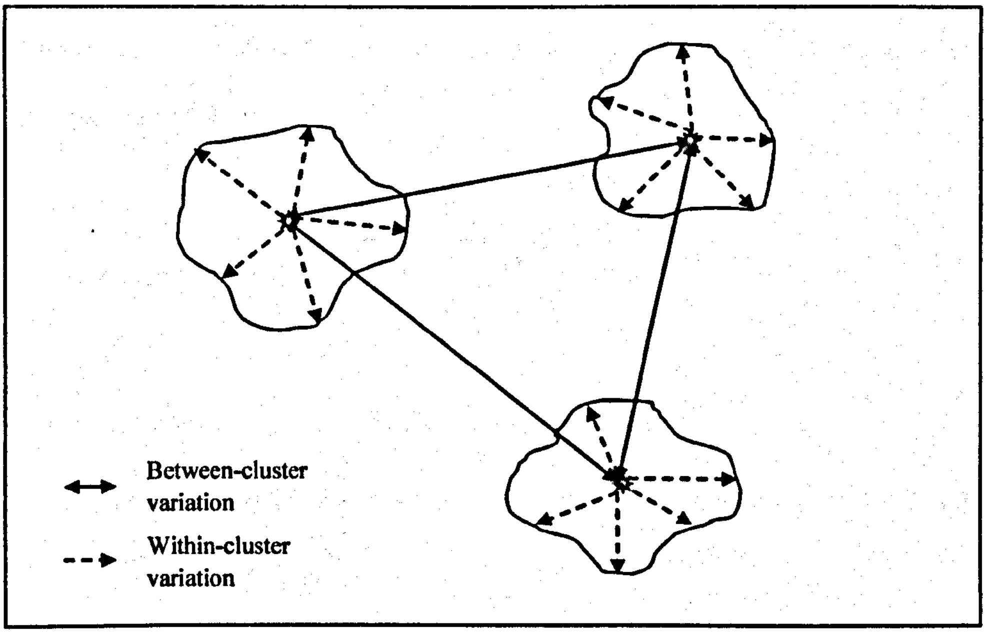


Figure 3.5: The concepts for cluster algorithm
(Source: Hair et al., 2006)

There are several methods for determining distance measures for selecting similarity, including Euclidean distance, squared Euclidean distance, Ward method, city-block (Manhattan) and Chebychev. The most common are Euclidean distance and squared Euclidean distance. The hierarchical cluster analysis method was selected, using average between-groups linkage and the Euclidean distance metric to determine the appropriate product and supply chain type. According to Hair et al., (2006), Euclidean distance, referred to as straight-line distance, is the most common distance measurement used for measuring the similarity of objects. Euclidean distance is also recommended when clustering more than two variables into similar groups. Distance measurement is important in a fundamental cluster analysis in order to group similar objects together into clusters. By using similarity measurement, the objects can be grouped by similar characteristics based on their distance. The formula for calculating the points of the functional, hybrid or innovative product is generalised as follows:

$$\text{Distance (Product): } \sqrt{\Sigma \quad (X_i - I_{if})^2}$$

Where X_i= normalised score for the product attributes

I_{if}= the ideal normalised score for a functional, hybrid or innovative product attribute.

Distance analysis for supply chain attributes uses the same formula with substitution of the product attributes or supply chain attributes for X_i, and lean, leagile or agile supply attributes for I_{if}. The shorter the distance to the ideal attributes, the closer it is to the ideal classification. However, the distances of product or supply chain attributes have been calculated by SPSS software. Thus, the cluster analysis performed with a help of SPSS software.

Number of cluster is determined based on Fisher's (1997) and Huang et al.'s (2002) classification for product and supply chain types. Narasimhan et al. (2006) have suggested a two-stage approach to refining the initial hierarchical clusters method by adopting the K-means clustering method. The hierarchical clustering method is useful for initialising a K-means algorithm (Lu et. al, 2008) and producing the final solution (Narasimhan et al., 2006). This two-stage approach was suggested by Narasimhan et al., (2006) in order to obtain better results in clustering groups.

3.8.4 Validate cluster analysis using t-test and ANOVA

In order to validate cluster analysis, the differences between two or three groups is shown by adopting t-test analysis and ANOVA respectively. The t-test is only performed for a 2x2 matrix to validate group differences. A t-test can be performed to check the differences between more than two groups; however, repeating the t-test will increase 'Error Type 1' (rejecting null hypothesis when actually true) and reduce confidence levels. In addition, repeating a t-test initiates the inability to detect differences among combinations of the dependent variables. Therefore, in order to check the differences between three groups, ANOVA is used to avoid the error.

ANOVA is useful for testing the differences between three or more groups (Saunders et al., 2009). ANOVA is the analysis, that is, the spread of data values, within and between groups of data by comparing means (Saunders et al., 2009, Hair et al., 2006). The F statistic represents these differences. If the likelihood of any difference between groups occurring by chance alone is low, this will be represented by a large F value with a probability of less than 0.05. This is termed statistically significant. Both ANOVA and t-test were performed using available analysis software in SPSS.

3.8.5 Cross-tabulation for product-strategy alignment

Cross-tabulation aims to show the interdependence between two or more variables so that any specific value or category can be recognised easily. The results of the alignment between the product and supply chain types were determined using cross-tabulation and then tested by Fisher exact/chi-square. SPSS software is used to perform cross-tabulation between the variables. From the cross-tabulation, each category can be read as either functional-lean, functional-agile, innovative-lean or innovative-agile for the 2x2 matrix. Functional-leagile, innovative-leagile, hybrid-lean, hybrid-leagile and hybrid-agile are additional relationships for the 3x3 matrix.

3.8.6 Chi-square/ Fisher exact test

The association between product type and supply chain strategy was examined by Fisher's exact test. Fisher's exact test is similar to Chi-square analysis and is used to examine the significance of association between two kinds of classifications (Shasha and Wilson, 2008). The Fisher exact test is suitable and preferable if the sample size is small in each classification, for example less than 10. Chi-square enables investigation of whether the two distributions are dependent or entirely independent of each other. In other words, both Fisher's exact test and chi-square were used to check the association between each product type and supply chain strategy in terms of whether they are dependent or completely independent. Therefore, in this study, Fisher's exact test is used to analyse the association between product and supply chain strategy for the 2x2 matrix, whereas chi-square test is used for the 3x3 matrix. Chi-square and Fisher exact test were performed by using SPSS software.

3.8.7 Alignment of competitive priorities

Competitive priorities were assessed using a five-point Likert scale (where 1 is not important and 5 is the most important) as shown in Appendix A3. Based on the mean values of the competitive priorities, the alignment between each supply chain tier was banded as follows:

1- Very weak alignment
2- Weak alignment
3- Moderate alignment
4- Strong alignment
5- Very strong alignment

Each product-supply chain strategy combination was assessed in order to examine the alignment of competitive priorities, whereby a functional-lean combination was expected to be more cost driven, while innovative-agile was expected to be more service, speed and flexibility driven (Fisher, 1997, Naylor et al., 1999, Mason-Jones et al., 2000 (a), Mason-Jones et al., 2000(b), Lee, 2002, Roh et al., 2008). While, hybrid-lean is expected for upstream supply chains with cost concern, hybrid-agile is expected for downstream supply chains with speed and flexibility focus (Mason-Jones et al., 2000(a), 2000(b), Roh et al., 2008). In other words, as a whole chain, hybrid product is expected to pair with leagile supply chains strategy which prioritise a combination of cost, speed delivery and flexibility. Mean analysis and competitive index for each competitive priority are calculated using Microsoft Excel 2007. Competence index is calculated using formula given in section 3.8.8.

3.8.8 Comparison between matched and mismatched product-strategies

A competence index analysis was performed to analyse the level of competence for each tier of the supply chain within matched and mismatched relationships. The competence index analysis was adapted from a theory of production competence by Cleveland et al. (1989). The competence index is a measure of the combined effects of a supply chain tier's strengths and weaknesses in terms of certain key performance issues (Cleveland et al., 1989).

According to Cleveland et al. (1989), the competence index can be calculated as:

$$C_j = \sum \{W_i \, Log \, K_i\}$$

Where: C_j = the competence index for a product,

i = the competitive priority issue,

R = the rank of the competitive priority issue,

K_i = the inverse rank (if $R=1$, $K=7$)

Wi = the weight of the competitive priority issue, based on the percentage score of the highest and lowest means of the competitive priority score, shown as follows:

$$W_i = \begin{cases} +1\ (strength) - when\ percentage\ score > 60\% \\ 0\ (neutral) - when\ percentage\ score\ is\ between\ 40\%\ and\ 60\% \\ -1\ (weakness) - when\ percentage\ score < 40\% \end{cases}$$

The competence index can be divided into four different indexes, which are:

a) cost and quality

b) cost, flexibility and quality

c) speed delivery and flexibility

d) speed delivery, flexibility and product design

Previous researchers (Fisher, 1997, Naylor et al., 1999, Mason-Jones et al., 2000 (a), Mason-Jones et al., 2000 (b), Lee, 2002, Roh et al., 2006) classified the categories in order to distinguish the competitive priorities/order-winning criteria in each product-supply chain combination for functional and innovative products. Literature reviews for competitive priorities/order-winning criteria for hybrid products are still limited. The example of calculation is shown as follows:

Table 3.3: Example on how to calculate competence index

Competitive priority	Mean	Rank, R	Inverse rank, K	Log K	W_i	C_j
Delivery	3.57	3	6	0.778	1	
Reliability	4.29	1	8	0.903	1	
Variety	3.52	5	4	0.602	0	
Flexibility	2.71	8	1	0.000	-1	2.92
Design	3.52	6	3	0.477	0	
Quality	4.00	2	7	0.845	1	
Warranty	3.38	7	2	0.301	-1	
Brand	3.57	4	5	0.699	1	

Note: Before determining the W_i, mean scores for all the product-supply chain strategy combinations were ranked. Then, +1 is given for percentage score >60%, 0 for percentage score between 40-60% and -1 for percentage score <40%.

3.9 Summary

The main aim of this chapter was to explain the methodology chosen to obtain and analyse the data used for this research. In summary, this chapter includes a summary of the literature review, research flow, research hypotheses, questionnaire design, data collection, validity and reliability, selection of the sample and the selection of statistical tools for analysis.

The knowledge gap was identified by reviewing related literature and selecting the attributes needed to classify products and supply chains. After this, questionnaires were designed and validated using validity tests, reviewed by experts and a pilot run. The main methodology used to obtain data was a postal questionnaire in both the UK and Malaysia. Correlation coefficient analysis was performed to screen for significant attributes before clustering the classifications of products and supply chains. Then, cluster analysis was undertaken, corresponding to functional, hybrid or innovative for products, and lean, leagile or agile for supply chains. A t-test was then employed to validate the cluster analysis for the 2x2 matrix, while ANOVA was performed for the 3x3 matrix. Cross-tabulation was used to check the contingency category for the supply chain alignment according to demand and product behaviour. Competitive priorities ranking was undertaken to check whether the strategy was aimed at the right competitive priority. Lastly, competence index analysis was examined in order to compare the performance of each combination of product-strategy. The detailed analysis steps of the methodology are shown in Figure 3.5. The analyses and results are presented in chapters 4, 5 and 6 for the general findings, 2x2 and 3x3 matrix respectively. Each chapter for the matrix includes the analysis for the UK and Malaysia.

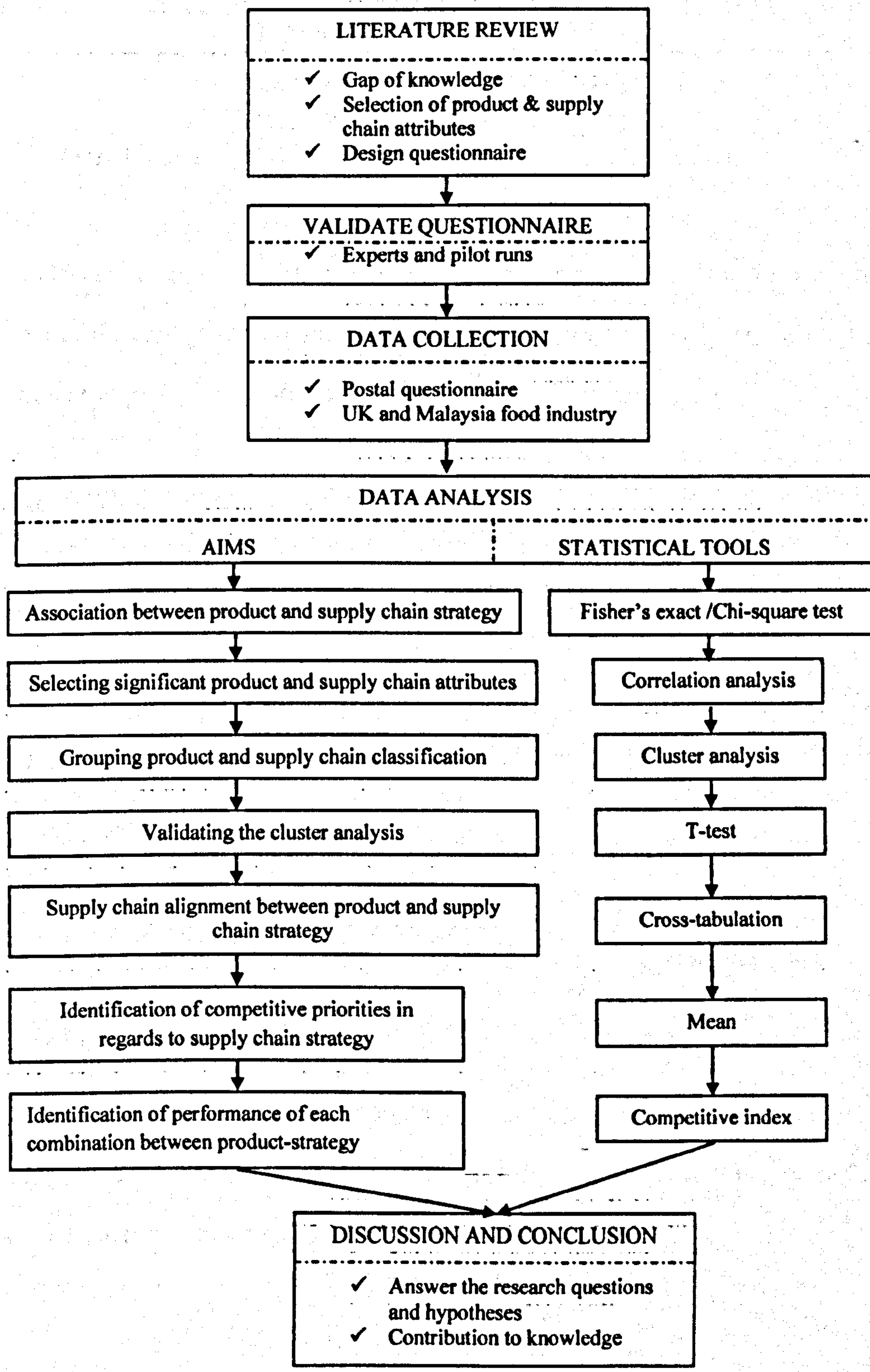


Figure 3.6: Flow chart for the entire research methodology

4.1 Introduction

This chapter presents the general findings from the survey analysis and reliability testing of the survey results. The general analysis for the UK and Malaysia can be split into two parts: the 2x2 matrix and the 3x3 matrix.

4.2 Reliability test

An internal consistency test was used to determine the questionnaire's reliability. The variables for service level included delivery, reliability, customer service, quality, flexibility, product variety and product design. Using the formula given in section 3.6.1, the results of the reliability test are shown in Table 4.1.

Table 4.1 Reliability test for competitive priorities

Variable	Number of items	Cronbach's alpha
Service level	8	.658

The reliability for service level attributes was considered acceptable, with a good internal consistency of 0.658 Cronbach's alpha. For cost, a reliability test is not required due to the use of a single variable.

4.3 Missing Data Analysis

Missing data means one or more variables are not available due to a shortage of responses. According to Hair et al. (2006), there is a four-step process for recognising missing data and the appropriate remedies. This comprises:

a) determining the type of missing data
b) determining the extent of the missing data
c) diagnosing the randomness of the missing data processes
d) selecting the imputation method

   Imputation can be carried out using several methods, consisting of imputation using only valid data or replacement values (mean substitution or regression imputation)

However, if the missing data accounts for less than 10% of an individual case, it can generally be ignored. Therefore, in this study, missing data is not calculated.

4.4 Demographic information

The participants were chosen from four supply chain tiers: manufacturers, distributors, wholesalers and retailers. Table 4.2 summarises the characteristics of the respondents for both the UK and Malaysia, based on product categories according to UKSIC2003 classification (Statistics, 2002), and company size determined by annual turnover and number of employees (Loecher, 2000).

Table 4.2 Characteristics of the respondents

	Percentage	
	UK	Malaysia
Respondent		
Manufacturer	60.0	57.5
Distributor	12.5	20.5
Wholesaler	16.2	11.0
Retailer	11.2	11.0
Category of product		
Meat	8.86	6.85
Fruit and vegetables	11.39	5.48
Dairy products	10.13	2.74
Fish	10.13	9.59
Margarine, edible oil, vegetable, animal oils and fats	1.26	1.37
Grain and starch products	15.19	9.59
Beverages, tea and coffee	22.78	24.66
Cake, biscuits and confectionery	6.33	13.70
Macaroni, noodles, couscous or similar farinaceous products	1.26	4.11
Bread	8.86	5.48
Condiments and seasonings	3.80	13.70
Others	0.00	2.74
Annual turnover		
<£1M	10.2	18.1
£1M-£10M	24.0	34.8
£20M-£50M	33.0	22.2
£50M-£500M	26.6	20.8
>£500M	6.4	4.2
Number of employees		
0-19	29.1	28.8
20-49	24.1	19.2
50-249	17.7	43.8
>250	29.1	8.2

4.5 Correlation analysis

The correlation analysis was used to determine the significant attributes for both the product and the supply chain. Details of correlation explanation is discussed in Chapter 3 (section 3.8.2). The significant attributes will be used to cluster the product into functional, innovative or hybrid categories, and the supply chain into lean, agile or leagile categories. Correlation analyses were undertaken to verify the homogeneity of the attributes. In order to facilitate correlation analysis, lists of characteristics, deemed as having equal importance by Naylor et al. (1999), are excluded in order to distinguish between lean and agile. In addition to this, only the most frequently quoted attributes were selected for the study as discussed in section 2.9 and 2.10 for product and supply chain attributes respectively. SPSS software is used as a tool to correlate the product and supply chain attributes.

4.5.1 Correlation between product attributes

This section discusses results of correlation between product attributes that selected for this research (refer section 2.9). Referring to the correlation matrix in Table 4.3, there is strong correlation between "pattern of demand" with "forecast accuracy" and "number of SKUs" at the 95% and 99% confidence levels respectively ($p \leq 0.05$ and $p \leq 0.01$) in the UK. Similarly, in Malaysia (referring to Table 4.4), the "pattern of demand" has a strong correlation with "forecast accuracy" at the 0.05 significance level. "Number of SKUs" and "forecast accuracy" have a significant correlation at the 95% confidence level. Furthermore, "total lead time" also has a significant correlation with "length of product life cycle", "number of SKUs" and "stage of product life cycle" with a confidence level of 95% at $p \leq 0.05$.

These results are consistent with Selldin and Olhager (2007), who found that "forecast accuracy", "product variety (number of SKUs)", "length of product life cycle" and "lead time" can be used to differentiate products. For "number of SKUs" and "pattern of demand", the correlation is significant, implying that an increasing number of SKUs correlates positively with the volatility level of the demand pattern. This result is also consistent with Fisher (1997) and Selldin and Olhager's (2007) work. Consequently, only three product attributes were selected to formulate the cluster analyses. The attributes that were not significant for both countries were eliminated. The selected attributes were "pattern of demand", "forecast accuracy" and "number of SKUs".

Table 4.3 Correlation between product attributes in the UK

	Pattern of demand	Stage of product lifecycle	Total lead time	Length of product life cycle	Number of SKUs	Forecast Accuracy
Pattern of demand	1.000	.089	.091	-.009	.404**	-.215*
	.	.411	.407	.939	.000	.048
Stage of product lifecycle		1.000	.129	.112	.000	-.011
		.	.238	.317	.997	.922
Total lead time			1.000	-.055	-.132	.009
			.	.629	.231	.933
Length of product life cycle				1.000	-.219	.153
				.	.051	.176
Number of SKUs					1.000	.067
					.	.547
Forecast accuracy						1.000
						.

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

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

Table 4.4 Correlation between product attributes in Malaysia

	Pattern of demand	Stage of product lifecycle	Total lead time	Length of product life cycle	Number of SKUs	Forecast accuracy
Pattern of demand	1.000	.134	-.071	.005	.111	-.247*
	.	.244	.537	.966	.345	.031
Stage of product lifecycle		1.000	.238*	.225	.181	.046
		.	.035	.053	.117	.687
Total lead time			1.000	.384**	.239*	.152
			.	.001	.037	.185
Length of product life cycle				1.000	.058	.143
				.	.629	.226
Number of SKUs					1.000	-.251*
					.	.029
Forecast accuracy						1.000
						.

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

4.5.2 Correlation between supply chain design criteria

This section discusses results of correlation between supply chain design criteria that selected for this research (refer section 2.10). The correlation between supply chain design criteria was established in order to facilitate cluster analysis and identify the supply chain as either lean or agile. The correlations for supply chain characteristics are shown in tables 4.5 and 4.6 for the UK and Malaysia respectively. Referring to table 4.5, the relationships between the "approach to choosing suppliers" and "key aim of the supply chain", "inventory strategy" and "lead time focus", have a high significant correlation at the 0.05 level for the UK.

Table 4.6 indicates that all supply chain characteristics in Malaysia have significant correlations, except for the relationship between "manufacturing focus" and "lead time focus". Since the meaning of "key aims of the supply chain" is similar to "approach to choosing suppliers", the "key aim of the supply chain" was excluded from the final selection of attributes. Therefore, in order to ease the supply chain characteristic comparison process between the UK and Malaysia, the characteristics of these two countries were included in the cluster analysis. The characteristics selected were "approach to choosing suppliers", "inventory strategy" and "lead time focus".

Table 4.5 Correlation between supply chain attributes in the UK

	Key aim of supply chain	Mfg. Focus	Inventory strategy	Lead time focus	Approach to choosing suppliers
Key aim of supply chain	1.000	.100	.169	-.020	.261*
	.	.423	.122	.853	.015
Manufacturing focus		1.000	.184	.046	-.028
		.	.141	.710	.822
Inventory strategy			1.000	.180	.263*
			.	.098	.016
Lead time focus				1.000	.219*
				.	.044
Approach to choosing suppliers					1.000
					.

*. Correlation is significant at the 0.05 level (2-tailed).
Mfg = manufacturing

	Key aim of supply chain	Mfg. Focus	Inventory strategy	Lead time focus	Approach to choosing suppliers
Key aim of supply chain	1.000	.100	.169	-.020	.261*
	.	.423	.122	.853	.015
Manufacturing focus		1.000	.184	.046	-.028
		.	.141	.710	.822
Inventory strategy			1.000	.180	.263*
			.	.098	.016
Lead time focus				1.000	.219*
				.	.044
Approach to choosing suppliers					1.000
					.

Table 4.6 Correlation between supply chain attributes in Malaysia

	Key aim of supply chain	Mfg. Focus	Inventory strategy	Lead time focus	Approach to choosing suppliers
Key aim of supply chain	1.000	.431**	.477**	.292**	.428**
	.	.000	.000	.009	.000
Manufacturing focus		1.000	.624**	.173	.441**
		.	.000	.172	.000
Inventory strategy			1.000	.227*	.486**
			.	.044	.000
Lead time focus				1.000	.401**
				.	.000
Approach to choosing suppliers					1.000
					.

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

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

Mfg = manufacturing

4.6 Alignment of supply chain strategy

The association between product and supply chain type was analysed using Fisher's exact test for 2x2 matrix and Chi-square test for 3x3 matrix. The results are shown in tables 4.7 and 4.8 for both the UK and Malaysia.

	Exact Sig.	
	UK	Malaysia
Fisher's Exact Test	.330	.047

Table 4.7: Fisher exact test result (2x2 matrix)

	Asymp.Sig. (2-sided)	
	UK	Malaysia
Chi-square	6.130	11.220
df	4	4
Asymp. Sig. (2-sided)	.190	.024

Table 4.8: Chi-square test result (3x3 matrix)

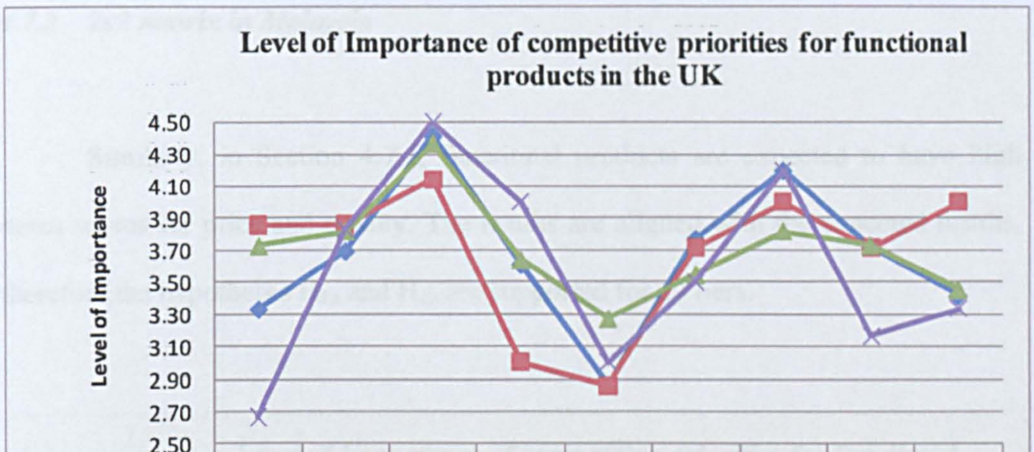
The results for Fisher's exact test produced *p* values of 0.330 and 0.047 for the UK and Malaysia respectively. The results for Chi-square test produced p values of 0.190 and 0.024 for the UK and Malaysia respectively. The results of these analyses imply that the association between product and supply chain strategy in the UK food industry is not significant in the UK. However, product and supply chain strategy is found to have a significant association in the Malaysian food industry. Thus, hypothesis H_0 is not supported for the UK but is supported for Malaysia.

4.7 Alignment between product type and competitive priorities

4.7.1 2x2 matrix in the UK

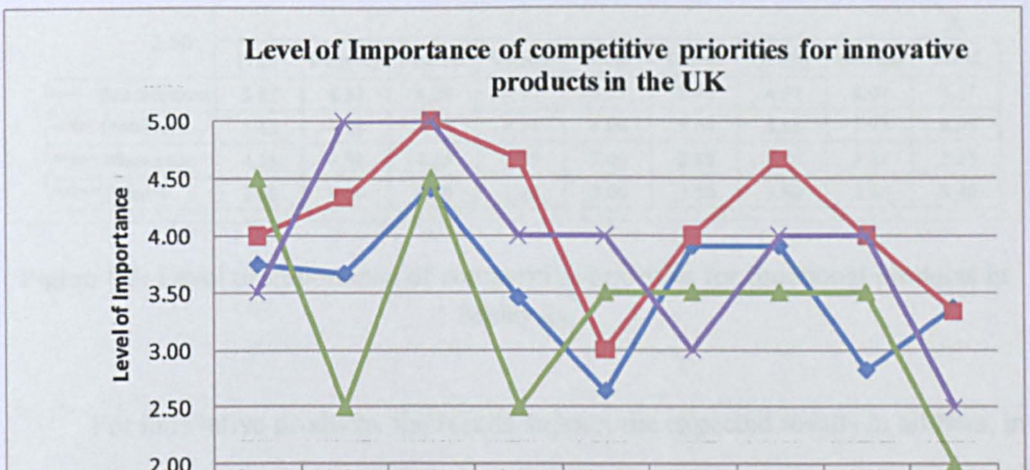
The results for the level of importance of competitive priorities for functional and innovative products are shown in figures 4.1 and 4.2 respectively. Numbers in the figures indicate the average means for each competitive priority assessed, using a five-point Likert scale (where 1 is not important and 5 is the most important). Functional products are expected to show a high importance for price and quality. From figure 4.1, quality has a high priority level for the purpose of winning orders, with perceived mean scores all over 3.50. However, price is not perceived to be important for retailers in the UK, having a 2.67 mean; while manufacturers, distributors and wholesalers perceived price to be of medium importance, with scores at a minimum of 3.00. Thus, hypothesis H_1 is not supported for retailers, but is supported for manufacturers, distributors and wholesalers.

Figure 4.2 illustrates the level of importance of competitive priorities for innovative products. Innovative products are expected to have high importance levels for speed of delivery, delivery reliability, product variety, order flexibility, product design, quality and warranty. From the results it can be seen that manufacturers do not prioritise order flexibility (mean score=2.67) and warranty (mean=2.82) as the most important competitive attributes. The results provided by wholesalers relating to speed of delivery (mean=2.50) and product variety (mean=2.50) were not as expected. However, the distributor and retailer results are aligned with those expected, prioritising speed of delivery, delivery reliability, product variety, order flexibility, product design, and quality.



	Price	Delivery	Reliable	Variety	Order	Design	Quality	Warranty	Brand
Manufacturer	3.33	3.69	4.42	3.61	2.86	3.77	4.20	3.72	3.42
Distributor	3.86	3.86	4.14	3.00	2.86	3.71	4.00	3.71	4.00
Wholesaler	3.73	3.82	4.36	3.64	3.27	3.55	3.82	3.73	3.45
Retailer	2.67	3.83	4.50	4.00	3.00	3.50	4.20	3.17	3.33

Figure 4.1: Level of importance of competitive priorities for functional products in the UK

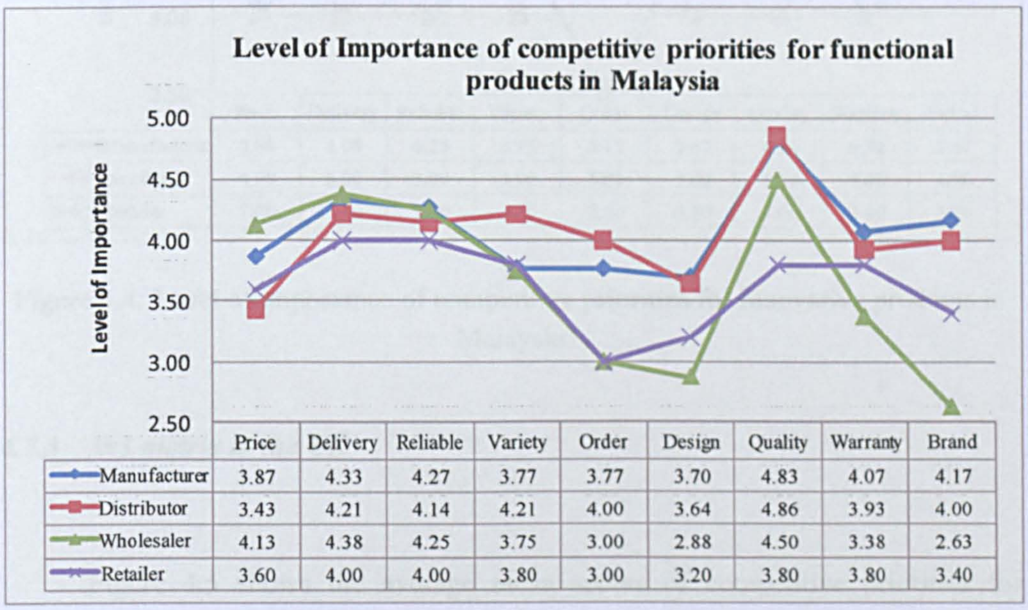


	Price	Delivery	Reliable	Variety	Order	Design	Quality	Warranty	Brand
Manufacturer	3.75	3.67	4.42	3.45	2.64	3.91	3.91	2.82	3.36
Distributor	4.00	4.33	5.00	4.67	3.00	4.00	4.67	4.00	3.33
Wholesaler	4.50	2.50	4.50	2.50	3.50	3.50	3.50	3.50	2.00
Retailer	3.50	5.00	5.00	4.00	4.00	3.00	4.00	4.00	2.50

Figure 4.2: Level of importance of competitive priorities for innovative products in the UK

4.7.2 2x2 matrix in Malaysia

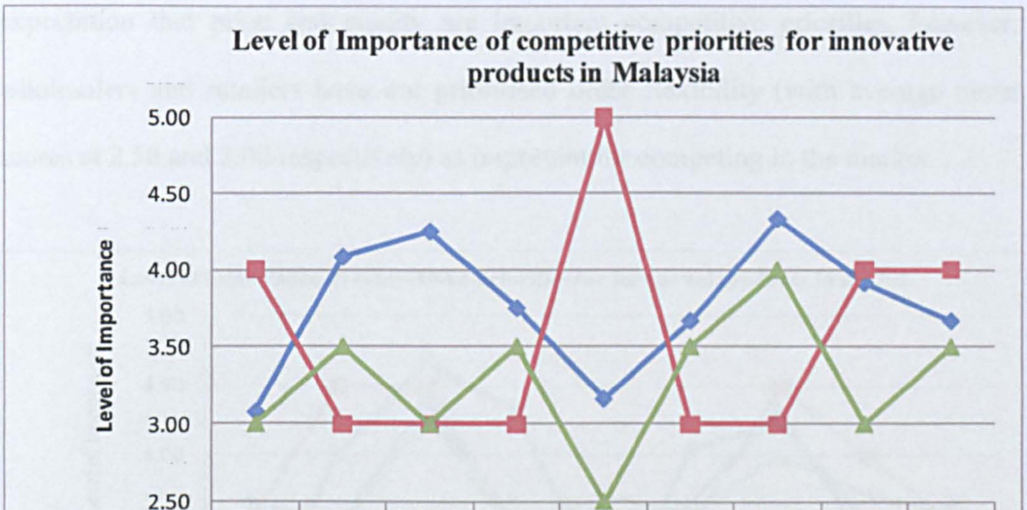
Similarly, in Section 4.7.1, functional products are expected to have high mean scores for price and quality. The results are aligned with the expected results, therefore the hypotheses H_{1a} and H_{1b} are supported for all tiers.



	Price	Delivery	Reliable	Variety	Order	Design	Quality	Warranty	Brand
Manufacturer	3.87	4.33	4.27	3.77	3.77	3.70	4.83	4.07	4.17
Distributor	3.43	4.21	4.14	4.21	4.00	3.64	4.86	3.93	4.00
Wholesaler	4.13	4.38	4.25	3.75	3.00	2.88	4.50	3.38	2.63
Retailer	3.60	4.00	4.00	3.80	3.00	3.20	3.80	3.80	3.40

Figure 4.3: Level of importance of competitive priorities for functional products in Malaysia

For innovative products, the results support the expected results in all tiers, in that speed of delivery, delivery reliability, product variety, product design, and quality are all high priorities. However, order flexibility is not as expected at the retailer level (mean=2.50), where it is not considered crucial for winning orders. The result contrasts with that of Mason-Jones et al. (2000(a) and 2000(b)). Due to limited responses, data for wholesalers is not available for innovative products in Malaysia.



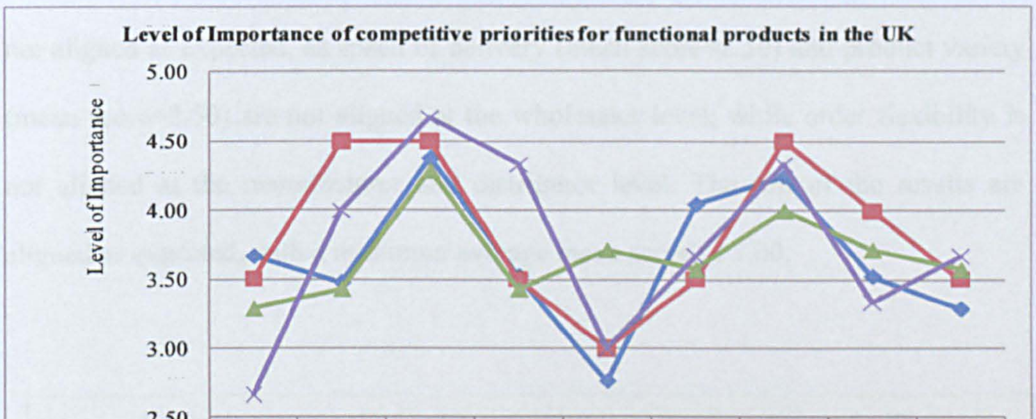
	Price	Delivery	Reliable	Variety	Order	Design	Quality	Warranty	Brand
Manufacturer	3.08	4.08	4.25	3.75	3.17	3.67	4.33	3.92	3.67
Distributor	4.00	3.00	3.00	3.00	5.00	3.00	3.00	4.00	4.00
Retailer	3.00	3.50	3.00	3.50	2.50	3.50	4.00	3.00	3.50

Figure 4.4: Level of importance of competitive priorities for innovative products in Malaysia

4.7.3 3x3 matrix in the UK

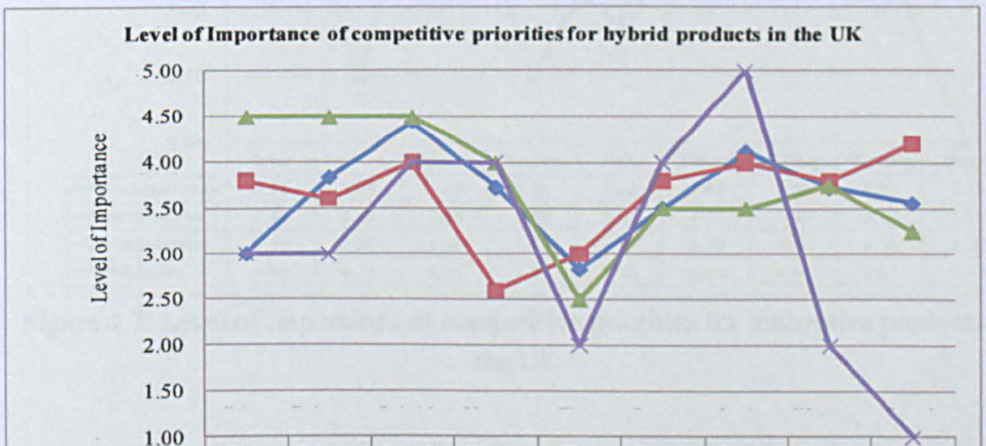
Figure 4.5 shows the average mean scores of competitive priorities for functional products. The results indicate that price and quality are aligned with Fisher (1997) and Mason-Jones et al. (2000(a) and 2000(b)) across all tiers except for the retailers. The results for the 3x3 matrix are similar to the results for the 2x2 matrix, in that retailers do not prioritise price (with average mean scores of 2.67 – low importance) as a competitive priority for winning orders from customers.

For hybrid products, a high priority was expected to be given to price and quality for the upstream supply chain, while speed of delivery, delivery reliability, product variety and product design were expected to be rated as important priorities for winning orders at the downstream supply chain (with a minimum average mean scores of 3.00). From figure 4.6, results for manufacturers are aligned with the expectation that price and quality are important competitive priorities, however, wholesalers and retailers have not prioritised order flexibility (with average mean scores at 2.50 and 2.00 respectively) as important for competing in the market.



	Price	Delivery	Reliable	Variety	Flex.	Design	Quality	Warranty	Brand
Manufacturer	3.67	3.48	4.38	3.52	2.76	4.05	4.25	3.52	3.29
Distributor	3.50	4.50	4.50	3.50	3.00	3.50	4.50	4.00	3.50
Wholesaler	3.29	3.43	4.29	3.43	3.71	3.57	4.00	3.71	3.57
Retailer	2.67	4.00	4.67	4.33	3.00	3.67	4.33	3.33	3.67

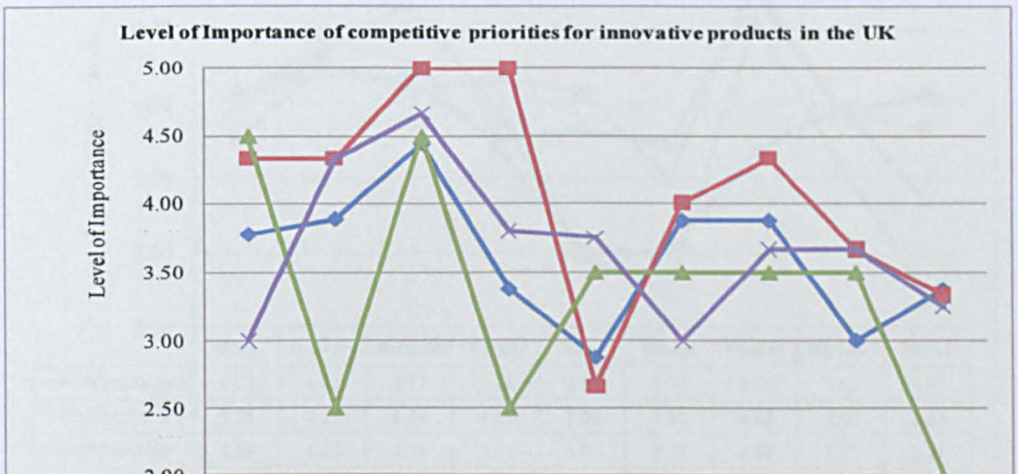
Figure 4.5: Level of importance of competitive priorities for functional products in the UK (3x3 matrix)



	Price	Delivery	Reliable	Variety	Flex.	Design	Quality	Warranty	Brand
Manufacturer	3.00	3.83	4.44	3.72	2.83	3.50	4.11	3.72	3.56
Distributor	3.80	3.60	4.00	2.60	3.00	3.80	4.00	3.80	4.20
Wholesaler	4.50	4.50	4.50	4.00	2.50	3.50	3.50	3.75	3.25
Retailer	3.00	3.00	4.00	4.00	2.00	4.00	5.00	2.00	1.00

Figure 4.6: Level of importance of competitive priorities for hybrid products in the UK (3x3 matrix)

The level of importance of competitive priorities for innovative products is shown in figure 4.7. Innovative products are expected to have high average mean scores for speed of delivery, delivery reliability, product variety, order flexibility, product design, and quality. The results indicate that the competitive priorities are not aligned as expected, as speed of delivery (mean score=2.50) and product variety (mean score=2.50) are not aligned at the wholesaler level, while order flexibility is not aligned at the manufacturer and distributor level. The rest of the results are aligned as expected, with a minimum average mean score of 3.00.

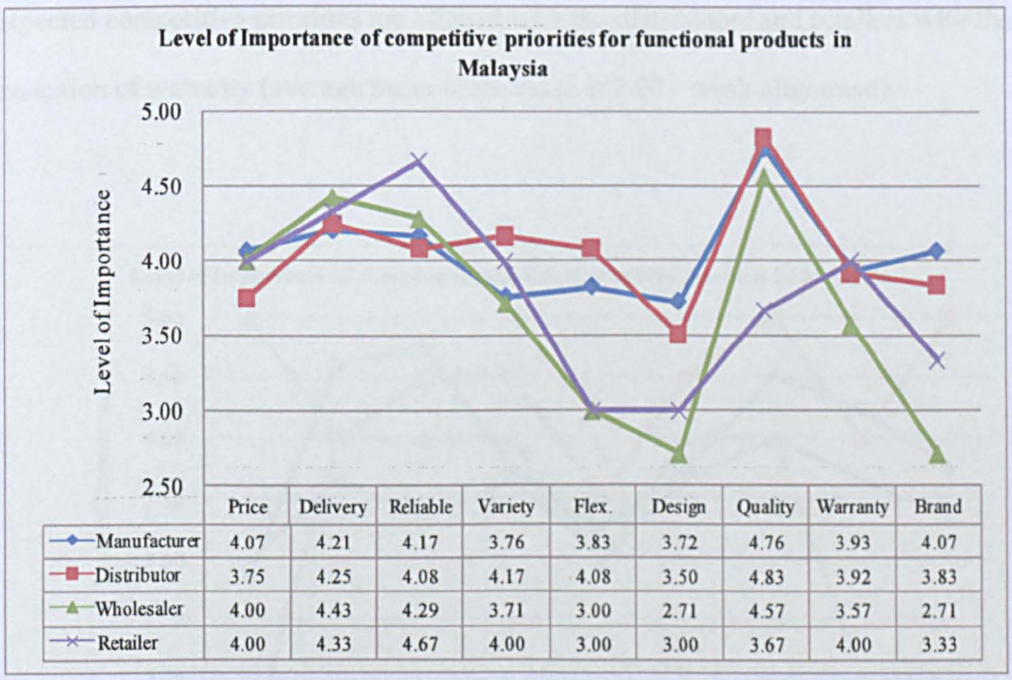


	Price	Delivery	Reliable	Variety	Flex.	Design	Quality	Warranty	Brand
Manufacturer	3.78	3.89	4.44	3.38	2.88	3.88	3.88	3.00	3.38
Distributor	4.33	4.33	5.00	5.00	2.67	4.00	4.33	3.67	3.33
Wholesaler	4.50	2.50	4.50	2.50	3.50	3.50	3.50	3.50	2.00
Retailer	3.00	4.33	4.67	3.80	3.75	3.00	3.67	3.67	3.25

Figure 4.7: Level of importance of competitive priorities for innovative products in the UK

4.7.4 3x3 matrix in Malaysia

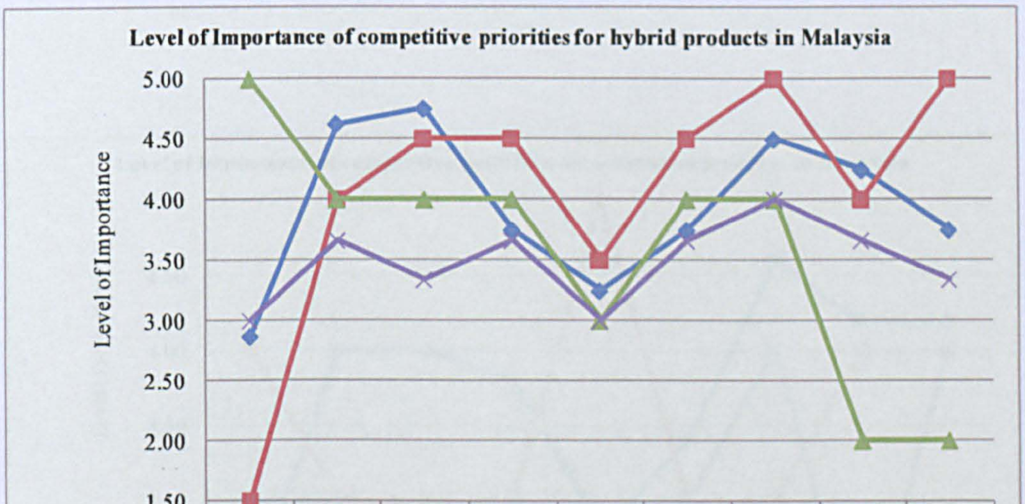
Figure 4.8 illustrates the importance level of competitive priorities for functional products in Malaysia. In terms of price and quality, the results show that there is a good alignment across tiers, with the minimum average mean score being at least 3.67 (medium importance).



	Price	Delivery	Reliable	Variety	Flex.	Design	Quality	Warranty	Brand
Manufacturer	4.07	4.21	4.17	3.76	3.83	3.72	4.76	3.93	4.07
Distributor	3.75	4.25	4.08	4.17	4.08	3.50	4.83	3.92	3.83
Wholesaler	4.00	4.43	4.29	3.71	3.00	2.71	4.57	3.57	2.71
Retailer	4.00	4.33	4.67	4.00	3.00	3.00	3.67	4.00	3.33

Figure 4.8: Level of importance of competitive priorities for functional products in Malaysia

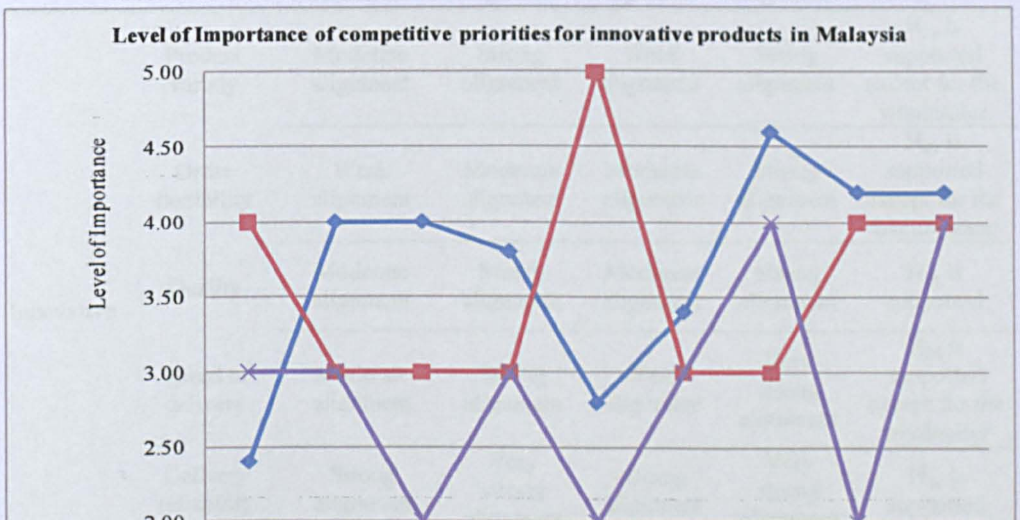
Hybrid products are expected to show a high importance level in price and quality for the upstream level of supply chain, while downstream supply chain is expected to show a high importance level in speed of delivery, delivery reliability, product variety, order flexibility, product design and warranty. However, the results (see figure 4.9) differ from the expectation, as manufacturers and distributors have not prioritised price as being important for winning orders, indicating 2.88 (of little importance) and 1.50 (unimportant) average scores respectively. A possible reason for distributors rating price at such a low level might be due to the position of the decoupling point and they may have located distributors downstream of the decoupling point rather than upstream. Therefore, the competitive priorities for the distributors and retailers are aligned with speed of delivery, delivery reliability, product variety, order flexibility, and product design. For the wholesalers, the expected competitive priorities are aligned with the distributors and retailers with the exception of warranty (average mean score value is 2.00 - weak alignment).



	Price	Delivery	Reliable	Variety	Flex.	Design	Quality	Warranty	Brand
Manufacturer	2.88	4.63	4.75	3.75	3.25	3.75	4.50	4.25	3.75
Distributor	1.50	4.00	4.50	4.50	3.50	4.50	5.00	4.00	5.00
Wholesaler	5.00	4.00	4.00	4.00	3.00	4.00	4.00	2.00	2.00
Retailer	3.00	3.67	3.33	3.67	3.00	3.67	4.00	3.67	3.33

Figure 4.9: Level of importance of competitive priorities for hybrid products in Malaysia

Figure 4.10 demonstrates the level of importance of competitive priorities for innovative products in Malaysia. Price is not expected to be considered important in innovative products. The results show that only manufacturers do not prioritise price, but other tiers, including distributors and retailers, are concerned about price. Order flexibility to win orders is also not prioritised by manufacturers and retailers, which indicates a below 3.00 average mean score. In addition, retailers do not prioritise warranty in order to be market winners. With the exception of delivery reliability, order flexibility and warranty, a good alignment of priorities has been reached, at medium importance levels across tiers for speed of delivery, product variety, product design and quality. The result cannot be confirmed for wholesalers due to limited response.



	Price	Delivery	Reliable	Variety	Flex.	Design	Quality	Warranty	Brand
Manufacturer	2.40	4.00	4.00	3.80	2.80	3.40	4.60	4.20	4.20
Distributor	4.00	3.00	3.00	3.00	5.00	3.00	3.00	4.00	4.00
Retailer	3.00	3.00	2.00	3.00	2.00	3.00	4.00	2.00	4.00

Figure 4.10: Level of importance of competitive priorities for innovative products in Malaysia

All the above results have been transferred and summarised in tables 4.9, 4.10, 4.11 and 4.12 based on a mean value description banded as follows:

1- very weak alignment

2- weak alignment

3- moderate alignment

4- strong alignment

5- very strong alignment

Table 4.9: Summary of results of competitive priorities alignment in the UK 2x2 matrix

Product	Competitive priority	Manufacturer	Distributor	Wholesaler	Retailer	Hypothesis testing
Functional	Price	Moderate alignment	Moderate alignment	Moderate alignment	Weak alignment	H_{1a} is supported except for the retailer
	Quality	Strong alignment	Strong alignment	Moderate alignment	Strong alignment	H_{1b} is supported
Innovative	Product variety	Moderate alignment	Strong alignment	Weak alignment	Strong alignment	H_{2a} is supported except for the wholesaler
	Order flexibility	Weak alignment	Moderate alignment	Moderate alignment	Strong alignment	H_{2b} is supported except for the manufacturer
	Quality	Moderate alignment	Strong alignment	Moderate alignment	Strong alignment	H_{2c} is supported
	Speed of delivery	Moderate alignment	Strong alignment	Weak alignment	Very strong alignment	H_{2d} is supported except for the wholesaler
	Delivery reliability	Strong alignment	Very strong alignment	Strong alignment	Very strong alignment	H_{2e} is supported
	Product design	Moderate alignment	Strong alignment	Moderate alignment	Moderate alignment	H_{2f} is supported

Table 4.10: Summary of results of competitive priorities alignment in Malaysia 2x2 matrix

Product	Competitive priority	Manufacturer	Distributor	Wholesaler	Retailer	Hypothesis testing
Functional	Price	Moderate alignment	Strong alignment	N/A	Moderate alignment	H_{1a} is supported
	Quality	Strong alignment	Moderate alignment	N/A	Strong alignment	H_{1b} is supported
Innovative	Product variety	Moderate alignment	Moderate alignment	N/A	Moderate alignment	H_{2a} is supported
	Order flexibility	Moderate alignment	Very strong alignment	N/A	Weak alignment	H_{2b} is supported except for the retailer
	Quality	Strong alignment	Moderate alignment	N/A	Strong alignment	H_{2c} is supported
	Speed of delivery	Strong alignment	Moderate alignment	N/A	Moderate alignment	H_{2d} is supported
	Delivery reliability	Strong alignment	Moderate alignment	N/A	Moderate alignment	H_{2e} is supported
	Product design	Moderate alignment	Moderate alignment	N/A	Moderate alignment	H_{2f} is supported

Table 4.11: Summary of results of competitive priorities alignment in the UK 3x3 matrix

Product	Competitive priority	Manufacturer	Distributor	Wholesaler	Retailer	Hypothesis testing
Functional	Price	Moderate alignment	Moderate alignment	Moderate alignment	Weak alignment	H_{1a} is supported except for the retailer
	Quality	Strong alignment	Strong alignment	Strong alignment	Strong alignment	H_{1b} is supported
Hybrid (upstream supply chain)	Price	Moderate alignment	Moderate alignment	Strong alignment	Moderate alignment	H_{3a} is supported
	Quality	Strong alignment	Strong alignment	Moderate alignment	Very strong alignment	H_{3b} is supported
Hybrid (downstream supply chain)	Quality	Strong alignment	Strong alignment	Moderate alignment	Very strong alignment	H_{3c} is supported
	Speed of delivery	Moderate alignment	Moderate alignment	Strong alignment	Moderate alignment	H_{3d} is supported
	Delivery reliability	Strong alignment	Strong alignment	Strong alignment	Strong alignment	H_{3e} is supported
	Order flexibility	Weak alignment	Moderate alignment	Weak alignment	Weak alignment	H_{3f} is not supported except for the distributor
Innovative	Product variety	Moderate alignment	Very strong alignment	Weak alignment	Moderate alignment	H_{2a} is supported except for the wholesaler
	Order flexibility	Weak alignment	Weak alignment	Moderate alignment	Moderate alignment	H_{2b} is supported for the downstream supply chain
	Quality	Moderate alignment	Strong alignment	Moderate alignment	Moderate alignment	H_{2c} is supported
	Speed of delivery	Moderate alignment	Strong alignment	Weak alignment	Strong alignment	H_{2d} is supported except for the wholesaler
	Delivery reliability	Strong alignment	Very strong alignment	Strong alignment	Strong alignment	H_{2e} is supported
	Product design	Moderate alignment	Strong alignment	Moderate alignment	Moderate alignment	H_{2f} is supported

Table 4.12: Summary of results of competitive priorities alignment in Malaysia 3x3 matrix

Product	Competitive priority	Manufacturer	Distributor	Wholesaler	Retailer	Hypothesis testing
Functional	Price	Strong alignment	Moderate alignment	Strong alignment	Strong alignment	H_{1a} is supported
	Quality	Strong alignment	Strong alignment	Strong alignment	Moderate alignment	H_{1b} is supported
Hybrid (upstream supply chain)	Price	Weak alignment	Weak alignment	Very strong alignment	Moderate alignment	H_{3a} is not supported for upstream supply chain
	Quality	Strong alignment	Very strong alignment	Strong alignment	Strong alignment	H_{3b} is supported
Hybrid (downstream supply chain)	Quality	Strong alignment	Very strong alignment	Strong alignment	Strong alignment	H_{3c} is supported
	Speed of delivery	Strong alignment	Strong alignment	Strong alignment	Moderate alignment	H_{3d} is supported
	Delivery reliability	Strong alignment	Strong alignment	Strong alignment	Moderate alignment	H_{3e} is supported
	Order flexibility	Moderate alignment	Moderate alignment	Moderate alignment	Moderate alignment	H_{3f} is supported
Innovative	Product variety	Moderate alignment	Moderate alignment	N/A	Moderate alignment	H_{2a} is supported
	Order flexibility	Weak alignment	Very strong alignment	N/A	Weak alignment	H_{2b} is not supported for manufacturer and retailer
	Quality	Strong alignment	Moderate alignment	N/A	Strong alignment	H_{2c} is supported
	Speed of delivery	Strong alignment	Moderate alignment	N/A	Moderate alignment	H_{2d} is supported
	Delivery reliability	Strong alignment	Moderate alignment	N/A	Weak alignment	H_{2e} is supported except for the retailer
	Product design	Moderate alignment	Moderate alignment	N/A	Moderate alignment	H_{2f} is supported

4.8 Summary

This chapter has summarised food industry information from the UK and Malaysia and general findings for these two countries, including reliability testing, correlation analysis and initial analysis of the survey results. The main points to conclude from this chapter are summarised below:

a) Table 4.13 shows a summary of the product and supply chain attributes that were selected. Only significant attributes, that were the same for both the UK and Malaysia, were selected, to ease the analysis.

Table 4.13 Summary of the selected product and supply chain attributes

Country	UK	Malaysia	Same variables for both countries
Product characteristics	Pattern of demand Number of SKUs Forecast accuracy	Pattern of demand Total lead time Duration of product life cycle Number of SKUs Forecast accuracy Stage of product life cycle	Pattern of demand Number of SKUs Forecast accuracy
Supply chain characteristics	Key aim of the SC (excluded) Approach to choosing suppliers Inventory strategy Lead time focus	Key aim of the supply chain (excluded) Manufacturing focus Approach to choosing suppliers Inventory strategy Lead time focus	Approach to choosing suppliers Inventory strategy Lead time focus

b) The reliability test for the questionnaire in this study was calculated using consistency reliability, with a result of 0.658, which is considered good reliability. Cost reliability was not calculated due to it being a single measure.

c) The significant product attributes for the UK are pattern of demand, number of SKUs and forecast accuracy in order to distinguish between functional, hybrid and innovative products. However, for Malaysia there are additional significant product attributes; total lead time, length of product life cycle and stage of product life cycle.

d) The association between product and supply chain strategy in the UK food industry is not significant but it is found to have a significant association in the Malaysian food industry.

e) The empirical results and analysis of competitive priorities alignment are summarised in tables 4.14 and 4.15.

Generally, for the 2x2 matrix, functional products are aligned across tiers in terms of cost for both countries, the UK and Malaysia, except for the retailer in the UK. Both functional and innovative products are aligned in terms of quality across the supply chain tiers. The results show that wholesalers are not aligned, and rated speed of delivery and product variety is not important in the UK, while speed of delivery and product variety are aligned well across tiers in Malaysia. For innovative products it was found that there is no alignment in order flexibility at the manufacturer level in the UK, however, this contrasts with Malaysia, where retailers are not aligned with other tiers of the supply chain. Warranties are aligned in both countries, with the exception of the manufacturer level in the UK.

Most of the results between 2x2 and 3x3 matrices are identical and parallel with the 2x2 findings. For example, functional products are aligned in their focus on cost across the supply chain tiers, except for retailers in the UK. Speed of delivery and product variety also indicate the same results as the 2x2 matrix. However, the conclusion for innovative products, in terms of order flexibility in the UK, shows that not only are the manufacturers not aligned, but the upstream supply chain is also not aligned and does not focus on order flexibility, while in Malaysia, order flexibility is not supported at the two ends of supply chain, which includes manufacturers and retailers. Order flexibility for hybrid products in the UK shows that downstream, which includes wholesalers and retailers, are not supported. This contrasts with order flexibility in Malaysia, where they are aligned across tiers. Warranties are found to be unimportant to retailers and wholesalers in the UK and Malaysia.

Table 4.14: Summary of results of competitive priorities alignment for 2x2 matrix

Product	Competitive priority	2x2 matrix	
		UK	Malaysia
Functional	Price	H_{1a} is supported except for the retailer	H_{1a} is supported
	Quality	H_{1b} is supported	H_{1b} is supported
Innovative	Product variety	H_{2a} is supported except for the wholesaler	H_{2a} is supported
	Order flexibility	H_{2b} is supported except for the manufacturer	H_{2b} is supported except for the retailer
	Quality	H_{2c} is supported	H_{2c} is supported
	Speed of delivery	H_{2d} is supported except for the wholesaler	H_{2d} is supported
	Delivery reliability	H_{2e} is supported	H_{2e} is supported
	Product Design	H_{2f} is supported	H_{2f} is supported

Table 4.15: Summary of results of competitive priorities alignment for 3x3 matrix

Product	Competitive priority	UK	Malaysia
Functional	Price	H_{1a} is supported except for the retailer	H_{1a} is supported
	Quality	H_{1b} is supported	H_{1b} is supported
Hybrid (upstream supply chain)	Price	H_{3a} is supported	H_{3a} is supported for the downstream SC
	Quality	H_{3a} is supported	H_{3a} is supported
Hybrid (downstream supply chain)	Quality	H_{3c} is supported	H_{3c} is supported
	Speed of delivery	H_{3c} is supported	H_{3d} is supported
	Delivery reliability	H_{3e} is supported	H_{3e} is supported
	Order flexibility	H_{3d} is not supported except for the distributor	H_{3f} is not supported except for the distributor
Innovative	Product variety	H_{2a} is supported except for the wholesaler	H_{2a} is supported
	Order flexibility	H_{2b} is supported for the downstream SC	H_{2b} is not supported for manufacturer and retailer
	Quality	H_{2c} is supported	H_{2c} is supported
	Speed of delivery	H_{2d} is supported except for the wholesaler	H_{2d} is supported
	Delivery reliability	H_{2e} is supported	H_{2e} is supported except for the retailer
	Product Design	H_{2f} is supported	H_{2f} is supported

5.1 Introduction

This chapter focuses on the empirical analysis and results for the investigation of the alignment of supply chain strategies and competitive priorities. This chapter comprises five sections: cluster analysis, alignment of supply chain strategy, alignment of competitive priorities, competence index and summary of the results for both the UK and Malaysia. Cluster analysis details how the product grouping was made to classify products as either functional or innovative. The second section explains the product-supply chain array using cross-tabulation that represents Fisher's matrix for both countries. The third section describes an analysis used to portray the alignment of competitive priorities for each product-supply chain strategy combination. The fourth section then presents the analysis of the competence index, which combines the strengths and weaknesses of competitive priorities. In the final section, a summary of the findings and comparative findings for both countries are presented.

5.2 2x2 matrix analysis in the UK

5.2.1 Cluster analysis

A cluster analysis was performed to group products and supply chains using the significant attributes analysed in Sections 4.5.1 (correlation between product attributes) and 4.5.2 (correlation between supply chain design criteria) respectively. There are two types of cluster methods; namely, hierarchical and non-hierarchical procedures. Two-stage approaches to cluster analysis were suggested by Narasimhan et al. (2006). In this analysis, firstly, the hierarchical approach was carried out, using the average between-groups linkage method and the Euclidean distance metric, to determine the appropriate product and supply chain group. According to Narasimhan et al. (2006), K-means clustering (non-hierarchical clustering) is able to refine the hierarchical clustering output solution. After going through the iterative process, K-means clustering is able to determine the most appropriate groups for product and supply chain types. The percentage of response differences in the classification between hierarchical and non-hierarchical clustering results are shown in table 5.1 below.

Table 5.1: Percentages of differences in classifications between hierarchical and non-hierarchical (K-means) cluster analysis

Percentage of differences	UK
Product classification	= 16/78 x 100% = **20.51%**
Supply chain classification	= 2/78 x 100% = **2.56%**

The difference in category groupings between the hierarchical method and the non-hierarchical method is approximately 15% to 20%, which is acceptable (Narasimhan et al., 2006). The supply chain classification is found to be an excellent categorisation. There is a change of only 2.56% between the hierarchical and non-hierarchical methods. The K-means method procedure produced the final solution for this analysis. In order to classify products and supply chains, tables 5.2 and 5.3 illustrate the details of each attribute and classify them as either functional or innovative products, and either lean or agile supply chains respectively. The differences between clusters have been tested using a t-test, which has provided good interpretability regarding group definition.

Table 5.2: Means profile for each product cluster in the UK (2x2 matrix)

KmeansUKProFinal2		Pattern of demand	Forecast accuracy	Number of SKUs	Stage of product life cycle	Total Lead Time	Length of product life cycle
Cluster 1	Mean	1.72	1.15	2.22	1.58	2.46	1.90
	Std. Deviation	.585	.360	.804	.497	.795	.810
Cluster 2	Mean	1.95	2.90	1.65	1.47	2.50	1.84
	Std. Deviation	.686	.308	.813	.697	.688	.765

Table 5.3: Means profile for each supply chain cluster in the UK (2x2 matrix)

KmeansUKSCFinal2		Key aim of supply chain	Manufacturing focus	Inventory strategy	Lead time focus	Approach to choosing suppliers
Cluster 1	Mean	2.14	2.51	1.46	1.24	1.44
	Std. Deviation	.495	1.121	.503	.431	.501
Cluster 2	Mean	2.41	2.47	2.14	1.83	2.41
	Std. Deviation	.501	.964	.639	.468	.568

Based on the figures and scores for the demand pattern, forecast error, SKU numbers, stage of product life cycle, lead time, inventory and choosing suppliers, Cluster 1 was classified as a functional and lean supply chain, while Cluster 2 was classified as an innovative and agile suply chain, as summarised in table 5.4. This parallels the criteria mentioned by Fisher (1997) and Lee (2002), that functional products have a very stable demand pattern, low forecast errors and a high number of SKUs, while the opposite applies to innovative products. In addition, table 5.2 shows clearly that the inventory and lead time scores are less than cluster 1 (functional product). Table 5.3 also shows the mean scores for the lead time focus, inventory strategy and approach to choosing suppliers. Thus, lean and agile supply chains are labelled according to the details given in table 5.4.

Table 5.4: Cluster labelling

Classification	Cluster	UK
Product	1	Functional
	2	Innovative
Supply Chain	1	Lean
	2	Agile

Table 5.5 shows each category of functional and innovative product with a classification of lean and agile for each product respectively. From the results, 59 products have been classified as functional and 20 as innovative. A lean supply chain is classified as working for 50 products, with 29 products working under an agile SC.

In order to validate the cluster solution, the procedure for profiling each cluster is performed via an independent *t-test* to examine the differences across each group. Table 5.6 shows that all variables for product attributes have *p*-values of less than 0.05 (95% confidence level), except for the "pattern of demand", for which the *p*-values are 0.143 (90% confidence level). These results indicate that "pattern of demand", "forecast accuracy" and "number of SKUs" are significant in differentiating between functional and innovative products.

Table 5.5: K-means cluster analysis for the UK by 2x2 matrix

	KmeansUKProFinal2			
	Functional		Innovative	
Product chosen	KmeansUKSCFinal2		KmeansUKSCFinal2	
	Lean	Agile	Lean	Agile
fish and fish products	5	3	0	0
meat and poultry meat	3	3	1	0
fruit and vegetables	1	2	2	1
fruit and vegetable juice	0	0	0	0
potatoes	1	1	0	1
crude oils and fats	0	0	0	0
margarine and edible fats	1	0	0	0
refined oils and fats	0	0	0	0
butter or cheese	2	1	1	1
Milk	1	0	0	0
ice cream	0	3	0	0
Grain	0	1	0	0
starches and starch products	0	1	0	0
Malt	0	1	0	0
cereals	4	0	0	0
Bread	6	2	1	1
rusk or biscuits	0	1	1	0
cocoa, chocolate or candy	1	0	1	0
Sugar	1	1	0	0
macaroni, noodles, couscous or similar farinaceous products	0	0	1	0
condiments and seasonings	1	1	1	0
tea or coffee	0	1	2	0
alcoholic beverages	5	1	3	1
mineral waters or soft drinks	4	0	0	1
Egg	0	0	0	0
snacks	0	0	0	0
Cakes	0	0	0	0
others	0	0	0	0
TOTAL	36	23	14	6
Product classification	59		20	
Supply chain classification	50		29	

Table 5.6 t-test results: product type

	UK (n= 79)					
	Functional (n=59)		Innovative (n=20)			
	Mean	SD	Mean	SD	*t*	Sig.
Pattern of demand	1.72	.585	1.95	.686	-1.479	.143
Forecast accuracy	1.15	.360	2.90	.308	-19.472	.000
Number of SKUs	2.22	.804	1.65	.813	2.721	.008

As in the previous procedure for profiling each cluster for product attributes, a *t-test* is performed to examine the differences across each group, showing that the attributes used for clusters are significantly different. Table 5.7 shows that all variables for supply chain attributes have p-values of less than 0.05 for the UK.

Table 5.7 t-test results: supply chain type

	UK (n= 79)					
	Lean (n=50)		Agile (n=29)			
	Mean	SD	Mean	SD	*t*	Sig.
Approach to choosing suppliers	1.44	.501	2.41	.568	-7.922	.000
Inventory strategy	1.46	.503	2.14	.639	-5.217	.000
Lead time focus	1.24	.431	1.83	.468	-5.655	.000

5.2.2 Alignment of Supply Chain Strategy

Next, a cross-tabulation summary of each product-supply chain strategy combination is summarised, as represented by Fisher's matrix, for samples from the UK, as shown in Figure 5.1.

	Functional Product	Innovative Product
Physical Efficient/Lean Supply Chain	Total - 36 Manufacturer - 21 Distributor - 5 Wholesaler - 7 Retailer - 3	Total - 14 Manufacturer - 10 Distributor - 1 Wholesaler - 2 Retailer - 1
Responsive/Agile Supply Chain	Total - 23 Manufacturer - 14 Distributor - 2 Wholesaler - 4 Retailer - 3	Total - 6 Manufacturer - 2 Distributor - 2 Wholesaler – N/A Retailer - 2

Figure 5.1: Summary of companies that have aligned supply chain strategy and product classification in the UK

The results in Figure 5.2 show that functional-lean is the preferred product-supply chain strategy, at 46% of the total population. Functional-lean is the preferred product-supply chain strategy combination for all levels of the food supply chain in the UK except at the retailer level. That includes 21 (44.7%) manufacturers, 5 (50%) distributors, 7 (53.8%) wholesalers and 3 (33.3%) retailers, as the highest sample of the population compared with other categories. There is also high incidence of functional-agile combinations with 40% of the functional products' population. This finding supports Lee (2002) who noted instances where functional products work better with agile supply strategies due to the high uncertainty of food supplies, which can be dependent on weather conditions. Inherent uncertainty in demand, process and supply were highlighted to contribute to food supply chain uncertainty (Vorst et al., 1998), thus implying that agility is more practical for responding to changing demands. This includes fluctuation in process outcomes and production times due to the unstable process yield, perishable end-products, machine breakdowns, etc. To conclude, hypotheses H_1 is supported for manufacturers, distributors and wholesalers, but it is not supported for retailers, as the number of functional-agile product-supply chain strategy and functional-lean product-supply chain strategy in the UK is the same.

Innovative-agile is the expected matching product-supply chain strategy alignment, however, the number of companies in this category is the lowest compared with other types of product-supply chain strategy alignment. The result also shows manufacturers, distributors, wholesalers and retailers with 40%, 29%, 36% and 50% of the functional products' population respectively. Manufacturers for innovative products tend to opt for a lean supply chain, with 83%, rather than an agile supply chain. The results concluded that hypothesis H_2 is weakly supported due to the high number of innovative-lean product-supply chain strategy combinations in the UK. The results also show only 6 out of 20 innovative products were supported with agile supply chains. In other words, 70% of companies with innovative products preferred to opt for a lean supply chain rather than an agile supply chain. However, from the result, it can be seen that distributors and retailers have opted for an agile supply chain strategy to supply innovative products, with 50% higher than lean supply chain strategy.

In terms of multi-tier supply chain strategy alignment, the results indicate that the functional-lean product-supply chain strategy combination is aligned for all tiers in the UK except for the retailer level. This provides strong evidence for hypothesis H_{5a}. Alignment results for the innovative-agile combination (H_{5b}) are not supported at the manufacturer tier but have some evidence of support further downstream at the distributor and retailer tiers. Wholesaler data is not available due to limited responses.

5.2.3 Alignment of Competitive Priorities

The next step sought to assess the alignment between product classification and competitive priorities. A summary of the competitive priorities alignment results for the UK is shown in Table 5.6. The results are derived from the mean score value of the competitive priorities, where the alignment between each supply chain tier was banded as follows:

1- Very weak alignment
2- Weak alignment
3- Fair alignment
4- Strong alignment
5- Very strong alignment

Competitive priorities alignment can be divided into four combinations of product-supply chain strategy; namely, functional-lean, functional-agile, innovative-lean and innovative-agile. According to Roh et al. (2008), each combination of product-supply chain strategy has its own competitive priorities that help companies to compete successfully in the market. It is expected that functional products with lean supply should utilise price as a competitive priority and, therefore, be cost-driven, as proposed by several scholars (Fisher, 1997, Christopher and Towill, 2000, Lamming et al., 2000, Mason-Jones et al., 2000(a)). Based on the results shown in table 5.8, manufacturers and wholesalers are moderately aligned to price. The distributors' results show they are strongly aligned with price, which contrasts with retailers, where the alignment was found to be weak. Generally, hypothesis H_{1a} is strongly supported for distributors and moderately supported for manufacturers and wholesalers. Hypothesis H_{1a} does not apply to retailers.

Table 5.8: Alignment of competitive priorities in the UK

Product	Supply chain	Competitive priority	Manufacturer	Distributor	Wholesaler	Retailer
Functional	Lean	Cost	Moderate alignment	Strong alignment	Moderate alignment	Weak alignment
		Quality	Strong alignment	Moderate Alignment	Moderate alignment	Moderate alignment
	Agile	Cost	Moderate alignment	Moderate alignment	Moderate alignment	Moderate alignment
		Delivery reliability	Strong alignment	Strong alignment	Very Strong alignment	Strong alignment
		Flexibility	Moderate alignment	Moderate Alignment	Moderate alignment	Moderate alignment
		Quality	Strong alignment	Strong Alignment	Moderate alignment	Very strong alignment
Innovative	Lean	Speed Delivery	Moderate alignment	Strong alignment	Weak alignment	N/A
		Flexibility	Weak alignment	Moderate alignment	Moderate alignment	N/A
		Quality	Strong alignment	Very strong alignment	Moderate alignment	N/A
	Agile	Speed Delivery	Strong alignment	Strong Alignment	N/A	Very strong alignment
		Delivery reliability	Strong alignment	Very strong Alignment	N/A	Very strong alignment
		Product variety	Moderate alignment	Strong Alignment	N/A	Strong alignment
		Flexibility	Weak alignment	Moderate Alignment	N/A	Strong alignment
		Product Design	Strong alignment	Strong Alignment	N/A	Moderate alignment
		Quality	Moderate alignment	Strong Alignment	N/A	Strong alignment

There are indications that quality is moderately aligned with retailers, distributors and wholesalers adopting a functional-lean approach; manufacturers were found to have a strong alignment with this competitive priority; thus supporting theoretical research by Christopher and Towill (2000), Lamming et al. (2000) and Mason-Jones et al. (2000(b)). Therefore, hypothesis H_{1b} is supported. This implies that the quality of food is still a major focus for manufacturers competing in the market, especially with today's concerns about health issues.

The innovative-agile product-supply chain strategy combination revealed that product variety is strongly aligned with distributors and retailers, and moderately aligned with manufacturers. This contrasts with Fisher's (1997) theory. From the results, products that work with agile supply chains focus more on product variety in the downstream supply chain than in the upstream supply chain. Thus, hypothesis H_{2a} is supported. For innovative products, large order flexibility is not regarded as being as important to manufacturers as it is to retailers. The management of product variety and the need to flex order sizes appears to increase in importance, moving from upstream to downstream in innovative-agile supply chains. Thus, hypothesis H_{2b} is fully supported by retailers. Quality shows strong alignment in the downstream supply chain, while manufacturers are moderately aligned with this attribute, adopting an innovative-agile approach. Hypothesis H_{2c} is supported and the importance of quality for innovative products cannot be denied.

All supply chain tiers adopting an innovative-agile approach have a strong alignment in terms of delivery speed and delivery reliability. This supported hypotheses H_{2d} and H_{2e} that the primary goal of agile supply chains is fast delivery (Fisher, 1997, Naylor et al., 1999, Lamming et al., 2000, Narasimhan et al., 2006). Innovative-agile was also found to have adopted product design as their main competitive priority. The results supported hypothesis H_{2f}, thus supporting the evidence of Lamming et al. (2000) and Roh et al. (2008).

5.2.4 Competence Index

In order to investigate the performance of each product-supply chain strategy combination, the competence index introduced by Cleveland et al. (1989) was used, as shown in table 5.9.

Table 5.9: Competence index for the UK

	Functional with lean supply chain	Functional with agile supply chain	Innovative with lean supply chain	Innovative with agile supply chain
Number of companies	36	23	14	6
Competence Index for cost, quality:				
a) Manufacturer	0.78	0.00	0.78	0.48
b) Distributor	-0.60	0.95	0.95	0.48
c) Wholesaler	0.48	1.08	0.18	N/A
d) Retailer	0.48	0.48	N/A	0.78
Competence Index for cost, flexibility and quality:				
a) Manufacturer	1.08	1.08	1.38	0.78
b) Distributor	0.60	0.78	1.38	0.78
c) Wholesaler	0.78	1.38	0.60	N/A
d) Retailer	1.08	1.08	N/A	1.38
Competence Index for speed, flexibility:				
a) Manufacturer	0.52	1.48	2.08	0.52
b) Distributor	0.52	1.48	2.08	1.48
c) Wholesaler	0.52	2.08	1.48	N/A
d) Retailer	0.52	1.48	N/A	2.08
Competence Index for speed, flexibility, innovation:				
a) Manufacturer	0.30	1.38	1.38	1.38
b) Distributor	0.78	0.78	1.38	1.38
c) Wholesaler	0.30	1.38	1.38	N/A
d) Retailer	0.30	1.38	N/A	1.38

In the UK, the highest performance for cost and quality competence index was for manufacturers working under functional-lean and innovative-lean supply arrangements, with 0.78 index each. This result is supported by Naylor et al. (1999), Mason-Jones et al. (2000(a), 2000(b)), Narasimhan et al. (2006) and Roh et al. (2008), where functional products or lean supply chain prioritised cost and quality. However, distributors and wholesalers have a low competence index for cost and quality when they are working in a functional-lean combination, thus supporting the theory of Lee (2002), where distributors and wholesalers commonly do well in functional-agile product-supply chain combinations. These results also failed to support previous work that showed that retailers were more competent with an innovative-agile arrangement, with an index of 0.78. This result differs from the previous researchers (Fisher, 1997, Naylor et al., 1999, Mason-Jones et al., 2000 (a), Mason-Jones et al., 2000 (b), Lee, 2002, Narasimhan et al., 2006), who suggested cost and quality should be conspicuous in a functional-lean product-supply chain. Thus, hypothesis H_{4a} is supported for manufacturers but not supported for distributors, wholesalers and retailers.

A functional-agile product-supply chain strategy combination was expected to be more competent in terms of cost, flexibility and quality (Roh et al., 2008). However, the results showed that only wholesalers supported this theory (H_{4b}), while manufacturers and distributors performed better in cost, flexibility and quality priorities when they worked in innovative-lean product-supply chain strategies. However, retailers have high competence in cost, flexibility and quality when working with an innovative-agile product-supply chain strategy. Therefore, hypothesis H_{4b} is supported for wholesalers but not supported for other tiers, i.e. manufacturers, distributors and retailers.

An innovative-lean product-supply chain combination is expected to perform in speed of delivery and order flexibility. The results show that manufacturers and distributors appear to have the highest competency in speed of delivery and flexibility, with 2.08 index for each level. This finding confirms Roh et al. (2008) and supports hypothesis H_{4c}. In contrast, the result is not supported by wholesalers, but shows that they are the second highest in the competency index in speed of delivery and large order flexibility when working in an innovative-lean product-supply chain strategy combination. Although, retailers' data is not available in the innovative-lean category, they perform better in speed of delivery and flexibility when they are working in an innovative-agile product-supply chain strategy combination.

An innovative-agile product-supply chain strategy is expected to have the highest competence levels in speed, flexibility and innovation. The results suggest that all supply chain tiers align with the theory and support hypothesis H_{4d} except for the wholesalers. Due to the limited data, wholesalers' responses are not available.

5.3 2x2 matrix analysis in Malaysia

5.3.1 Cluster analysis

As in section 5.2, cluster analysis was performed on group products and supply chains using the significant attributes analysed in Sections 4.5.1 (correlation between product attributes) and 4.5.2 (correlation between supply chain design criteria); this was done for Malaysia in tables 4.4 and 4.6 respectively. The cluster methods have two stages, as suggested by Narasimhan et al. (2006), which are hierarchical and non-hierarchical procedures. The results of the percentages of response difference classifications between hierarchical and non-hierarchical clustering are shown in table 5.10.

Table 5.10: Percentages of difference classifications between hierarchical and non-hierarchical (K-means) cluster analysis

Percentage of differences	Malaysia
Product classification	= 15/73 x 100% = **20.55%**
Supply chain classification	= 3/73 x 100% = **4.11%**

The different results obtained for hierarchical and non-hierarchical methods of product classification and supply chain classification are 20.55% and 4.11% respectively. The results are sufficient to produce the final solution for this analysis. In order to classify products and supply chains, tables 5.11 and 5.12 demonstrate the means of each product and the supply chain attributes in order to classify either functional or innovative products, and either lean or agile supply chains. The different clusters have been tested using a t-test that can significantly define group interpretability.

Table 5.11: Means profile for each cluster of product type in Malaysia

KmeansMsiaPro2		Pattern of demand	Forecast Accuracy	Number of SKUs	Stage of product life cycle	Total lead time	Length of product life cycle
Cluster 1	Mean	1.64	1.05	1.50	1.95	2.36	1.76
	Std. Deviation	.485	.223	.707	.633	.765	.612
Cluster 2	Mean	1.87	2.53	2.13	1.73	2.36	1.71
	Std. Deviation	.743	.516	.743	.704	.745	.611

Table 5.12: Means profile for each cluster of supply chain type in Malaysia

KmeansMsiaSC2		Key aim of supply chain	Manufacturing focus	Inventory strategy	Lead time focus	Approach to choosing suppliers
Cluster 1	Mean	1.71	1.73	1.43	1.66	1.71
	Std. Deviation	.622	.751	.500	.548	.530
Cluster 2	Mean	2.33	2.62	2.80	2.00	2.33
	Std. Deviation	.724	.870	.414	.655	.724

Based on table 5.11 and the average scores for demand patterns, forecast errors, SKU numbers and stages of product life cycles, it was clearly shown that Cluster 1 and Cluster 2 could be classified as functional and innovative products respectively. Also, table 5.12 shows that from the average scores for inventory strategy, lead time focus and approach to choosing suppliers, Cluster 1 could be classified as a lean supply chain and Cluster 2 as an agile supply chain. Table 5.13 summarises the labelling cluster.

Table 5.13: Cluster labelling

Classification	Cluster	Malaysia
Product	1	Functional
	2	Innovative
Supply Chain	1	Lean
	2	Agile

The results agree with the criteria identified by previous researchers (Fisher, 1997, Lee, 2002), i.e. that functional products have a very stable demand pattern, low forecast errors and high numbers of SKUs, while the opposite applies to innovative products. However, the stage of product life cycle and lead time of products are not significant in distinguishing product types. The differences between cluster 1 and cluster 2, in terms of total lead time of product, are zero, while stage of product life cycle is 0.22. According to Aitken et al. (2003) and Wang et al. (2004), the stage of product life cycle for functional products is usually at the mature and decline level, however, table 5.11 show clearly that both Cluster 1 and Cluster 2 are between mature/decline (score=1) and growth (score=2) level of stage of product life cycle. Table 5.12 shows that all Cluster 1 supply chain attributes are less than Cluster 2. Thus, lean and agile supply chains are labelled according to the details given.

Table 5.14 shows the classification for type of product and supply chain for each product chosen. From the results, 58 products have been classified as functional and 15 products as innovative. The lean supply chain is classified as working with 58 products, with 15 products working with an agile supply chain.

Product chosen	KmeansMsiaPro2			
	Functional		Innovative	
	KmeansMsiaSC2		KmeansMsiaSC2	
	Lean	Agile	Lean	Agile
fish and fish products	5	0	2	0
meat and poultry meat	2	2	0	1
fruit and vegetables	1	0	0	1
fruit and vegetable juice	0	1	1	1
Potatoes	1	0	0	0
crude oils and fats	0	0	0	0
margarine and edible fats	0	1	0	0
refined oils and fats	0	0	0	0
butter or cheese	0	0	0	0
Milk	0	0	0	0
ice cream	1	0	0	0
Grain	1	0	0	0
starches and starch products	1	0	0	0
Malt	0	0	0	0
Cereals	1	0	0	0
Bread	5	1	1	0
rusk or biscuits	2	2	0	0
cocoa, chocolate or candy	2	0	0	1
Sugar	0	0	0	0
macaroni, noodles, couscous or similar farinaceous products	3	1	1	0
condiments and seasonings	8	0	1	1
tea or coffee	7	0	0	0
alcoholic beverages	0	0	0	0
mineral waters or soft drinks	3	1	2	0
Egg	0	0	0	0
Snacks	3	0	0	0
Cakes	0	0	1	0
Others	3	0	0	1
TOTAL	49	9	9	6
Product classification	58		15	
Supply chain classification	58		15	

Table 5.14: K-means cluster analysis in Malaysia (2x2 matrix)

A t-test was used to validate the cluster solution by examining the differences across each group. Table 5.15 shows the *p*-values for "forecast accuracy" and "number of SKUs" as less than 0.05, except for the "pattern of demand", which has a 0.152 p-value. 'Pattern of demand' indicated that when the data for the UK and Malaysia is combined, the *p*-value is significant at a 95% confidence level. Therefore, the pattern of demand, forecast accuracy and number of SKUs significantly differentiate the product classification into either functional or innovative products.

Table 5.15 t-test results: product classification

	Malaysia (n=73)					
	Functional (n=58)		Innovative (n=15)			
	Mean	SD	Mean	SD	*t*	Sig.
Pattern of demand	1.64	.485	1.87	.743	-1.447	.152
Forecast accuracy	1.05	.223	2.53	.516	-16.804	.000
Number of SKUs	1.50	.707	2.13	.743	-3.061	.003

A t-test was also performed to profile each cluster for supply chain classification. The lean and agile supply chains are significantly different, with a *p*-value of less than 0.05 using the three attributes: "approach to choosing suppliers", "inventory strategy" and "lead time focus".

Table 5.16: T-test results: supply chain classification

	Malaysia (n=73)					
	Lean (n=58)		Agile (n=15)			
	Mean	SD	Mean	SD	*t*	Sig.
Approach to choosing suppliers	1.71	.530	2.33	.724	-3.771	.000
Inventory strategy	1.43	.500	2.80	.414	-9.767	.000
Lead time focus	1.66	.548	2.00	.655	-2.087	.040

5.3.2 Alignment of supply chain strategy

In Malaysia the results demonstrated that 84.5% of the total population of functional products work significantly well with lean strategies. It can also be seen that each tier of the supply chain includes manufacturers, distributors, wholesalers and retailers, with a significant number working in functional-lean compared with other product-strategy combinations. Thus hypothesis H_1, food companies with functional products adopt lean supply chains as opposed to agile supply chains, is supported. The results empirically support the conceptual work of Fisher (1997), Huang et al. (2002), Lee (2002) and Selldin and Olhager (2007).

The results also revealed that slightly more innovative products were aligned with lean supply chains than with agile supply chains. Because of the very limited responses from distributors, wholesalers and retailers, H_2 cannot be confirmed in the case of Malaysia for the innovative-agile combination.

	Functional Product	Innovative Product
Physical Efficient/Lean Supply Chain	Total - 49 Manufacturer - 24 Distributor - 12 Wholesaler - 8 Retailer - 5	Total - 9 Manufacturer - 7 Distributor – N/A Wholesaler – N/A Retailer - 2
Responsive/Agile Supply Chain	Total - 9 Manufacturer - 6 Distributor - 2 Wholesaler – N/A Retailer - 1	Total - 6 Manufacturer - 5 Distributor - 1 Wholesaler – N/A Retailer – N/A

Figure 5.2: Summary of companies aligned between supply chain strategy and product classification in Malaysia

In terms of multi-tier supply chain strategy alignment, the results indicate that the functional-lean product-supply chain strategy combination is aligned for all tiers in Malaysia. This provides strong evidence for hypothesis H_{5a}. Alignment results for the innovative-agile combination (H_{5b}) are not supported at the manufacturer tier but have some evidence of support further downstream at the distributor and retailer tiers.

5.3.3 Alignment of competitive priorities

In Malaysia, price is strongly aligned with manufacturers, wholesalers and retailers of functional products supported by lean supply chains; distributors were found to be moderately aligned. Thus, hypothesis H_{1a} is supported. Quality for the functional-lean product-supply chain strategy combination is strongly aligned with manufacturers, distributors and wholesalers, and moderately aligned with retailers. Hence, hypothesis H_{1b} is supported for Malaysia.

For the innovative-agile product-supply chain strategy combination, product variety is moderately aligned throughout all tiers. Large order size flexibility has a very strong alignment for distributors and is moderately aligned for manufacturers. Quality, speed of delivery and delivery reliability are aligned for manufacturer and distributors. The results support previous findings (Fisher, 1997, Lee, 2002, Huang et al., 2002). For product design (innovation), the result supports Roh et al. (2008) in that it is a high priority for manufacturers, while for distributors it is only moderately aligned. In summary, hypotheses H_{2a}, H_{2b}, H_{2c}, H_{2d}, H_{2e} and H_{2f} are supported. However, the result cannot be confirmed for wholesalers due to a limited response.

For the functional-agile product-supply chain strategy, price is not a priority for distributors and retailers. This contrasts with Roh et al. (2008), who suggested that a functional-agile product-supply chain strategy prioritises cost to compete in the market, improve performance and satisfy customers. However, for flexibility and quality the scores support Roh et al. (2008) in that they have been prioritised and aligned for a functional-agile product-supply chain strategy. Conclusions cannot be drawn for wholesalers due to the non-availability of data for analysis.

The innovative-lean product-supply chain strategy is expected to prioritise speed of delivery and order flexibility as its objective. From the results, speed of delivery and order flexibility have been found to be fairly well aligned with the aims, with the addition of a focus on quality as a strong alignment of competitive priorities along the supply chain tiers. Table 5.17 shows the summary of the hypothesis testing.

Table 5.17: Alignment of competitive priorities in Malaysia

Product	Supply chain	Competitive priority	Manufacturer	Distributor	Wholesaler	Retailer
Functional	Lean	Cost	Strong alignment	Moderate alignment	Strong alignment	Strong Alignment
		Quality	Strong alignment	Strong alignment	Strong alignment	Moderate Alignment
	Agile	Cost	Moderate alignment	Very weak alignment	N/A	Weak alignment
		Delivery reliability	Fair alignment	Strong alignment	N/A	Moderate Alignment
		Flexibility	Moderate alignment	Moderate alignment	N/A	Moderate alignment
		Quality	Strong alignment	Very strong alignment	N/A	Strong Alignment
Innovative	Lean	Speed delivery	Moderate alignment	N/A	N/A	Moderate alignment
		Flexibility	Moderate alignment	N/A	N/A	Moderate Alignment
		Quality	Strong alignment	N/A	N/A	Strong Alignment
	Agile	Product variety	Moderate alignment	Moderate alignment	N/A	N/A
		Flexibility	Moderate alignment	Very strong alignment	N/A	N/A
		Quality	Strong alignment	Moderate alignment	N/A	N/A
		Speed Delivery	Strong alignment	Moderate alignment	N/A	N/A
		Delivery reliability	Strong alignment	Moderate alignment	N/A	N/A
		Design	Strong alignment	Moderate alignment	N/A	N/A

5.3.4 Competence Index

In the Malaysian food industry, the cost and quality competence index for manufacturers and retailers working with products with a functional-lean product-supply chain strategy, was found to be higher, as expected (H_{4a}). Distributors are more competent in cost and quality when they work with a functional-agile product-supply chain combination. Therefore, hypothesis H_{4a} is rejected for distributors. Wholesalers were not included due to the limited number of responses.

For the cost, flexibility and quality competence index, the highest competency level is expected when working with a functional-agile product-supply chain strategy. The result appears to support this theory for manufacturers and retailers (H_{4b}), while it was found more competent for the distributors to choose an innovative-agile product-supply chain strategy.

Retailers were found to have high competence levels for speed and delivery when working under innovative-lean (H_{4c}), as suggested by Roh et al (2008). On the other hand, manufacturers were found to perform better while working in a functional-lean product-supply chain strategy.

Manufacturers appear to achieve high levels of competency in speed of delivery, flexibility and innovation when working with an innovative-agile product-supply chain strategy. This result supports hypothesis H_{4d}. The result also shows that distributors did not conform to speed of delivery, flexibility and innovation under innovative-agile as suggested by Roh et al (2008). Distributors worked better when they adopted functional-lean and functional-agile product-supply chain strategies. Table 5.18 shows the results for competence index in Malaysia.

Table 5.18: Competence index for Malaysia

	Functional with lean supply chain	Functional with agile supply chain	Innovative with lean supply chain	Innovative with agile supply chain
Match or mismatch	Match	Mismatch	Mismatch	Match
Number of companies	49	9	9	6
Competence Index for cost and quality:				
a) Manufacturer	0.78	0.78	0.18	0.78
b) Distributor	0.48	0.95	N/A	0.95
c) Wholesaler	0.48	N/A	N/A	N/A
d) Retailer	0.78	0.78	0.48	N/A
Competence Index for cost, flexibility and quality				
a) Manufacturer	1.38	1.38	-0.18	0.78
b) Distributor	1.08	0.78	N/A	1.38
c) Wholesaler	1.08	N/A	N/A	N/A
d) Retailer	1.08	1.08	1.08	N/A
Competence Index for speed and flexibility:				
a) Manufacturer	2.08	0.52	1.48	1.48
b) Distributor	2.08	1.78	N/A	-0.08
c) Wholesaler	1.48	N/A	N/A	N/A
d) Retailer	1.48	1.48	1.48	N/A
Competence Index for speed, flexibility and innovation:				
a) Manufacturer	1.38	0.00	0.78	1.38
b) Distributor	1.38	1.38	N/A	-0.18
c) Wholesaler	1.08	N/A	N/A	N/A
d) Retailer	1.08	1.08	1.08	N/A

5.4 Summary

This chapter has investigated the alignment of supply chain strategies, alignment of competitive priorities and the competence index performance of manufacturers, distributors, wholesalers and retailers.

In general, food products in the UK and Malaysia can be classified into two groups: functional and innovative products. There are two choices of supply chain strategy for supplying functional products to customers, namely lean and agile. From the findings, functional products tend to work in lean supply chains rather than agile supply chains (H_1) except for retailers in the UK. The findings in the UK are consistent with a previous study (Lee, 2002). Lee (2002) highlighted that functional-agile is a common strategy adopted by retailers. The innovative product results for both countries conflict with Fisher (1997), Lee (2002) and Huang et al. (2002), who suggested that they would use an agile supply chain. However, a lean supply chain tends to be adopted for innovative products, with 70% and 60% of the innovative product population in the UK and Malaysia respectively. Therefore, the results conclude that hypothesis H_2 is not supported for manufacturers in the UK or any tiers in Malaysia. However, hypothesis H_2 is supported for distributors and retailers in the UK.

The empirical results and analysis of supply chain strategies adopted by either functional or innovative products are summarised in Table 5.19.

Table 5.19: Summary of results of supply chain strategy alignment in the UK and Malaysia

Hypotheses	UK	Malaysia
H_1: Food companies with a functional product adopt lean supply chain characteristics as opposed to agile supply chain characteristics.		
a) Manufacturer	Supported	Supported
b) Distributor	Supported	Supported
c) Wholesaler	Supported	Supported
d) Retailer	Not supported	Supported
H_2: Food companies with an innovative product adopt agile supply chain characteristics as opposed to lean supply chain characteristics.		
a) Manufacturer	Not supported	Not supported
b) Distributor	Supported	Not supported
c) Wholesaler	Not confirmed	Not supported
d) Retailer	Supported	Not supported
H_{5a}: Food supply chains for functional products adopt lean characteristics throughout the tiers of the chain.	Supported except for the retailer	Supported for all tiers
H_{5b}: Food supply chains for innovative products adopt agile characteristics throughout the tiers of the chain.	Not supported for manufacturer, but supported for downstream supply chain members	Not confirmed due to limited data

In terms of multi-tier supply chain strategy alignment, the results indicate that the functional-lean combination is aligned for all tiers for both countries except for the retailer level in the UK. This provides strong evidence for H_{5a}. Alignment results for the innovative-agile combination (H_{5b}) are not supported at the manufacturer tier but have some evidence of support further downstream at the distributor and retailer tiers in the UK. As there is limited data on the Malaysian industry, hypotheses H_{5b} cannot be confirmed across the tiers. The findings on the alignment of competitive priorities adopted by each product-SC strategy combination have been summarised in Table 5.20.

Table 5.20: Summary of results concerning the alignment of competitive priorities

Hypotheses	UK	Malaysia
H_{1a}: Food companies with functional-lean combination adopt a low selling price as a key competitive priority	Supported for manufacturer, distributor and wholesaler, rejected for retailer	Supported for all tiers
H_{1b}: Food companies with functional-lean combination adopt quality as a key competitive priority.	Supported for all tiers	Supported for all tiers
H_{2a}: Food companies with innovative-agile combination adopt product variety as a key competitive priority.	Supported for all tiers, no data for wholesaler	Supported for manufacturer and distributor, no data for wholesaler and retailer
H_{2b}: Food companies with innovative-agile combination adopt large order size flexibility as a key competitive priority.	Supported for distributor, and retailer, not supported for manufacturer, no data for wholesaler	Supported for manufacturer and distributor, no data for wholesaler and retailer
H_{2c}: Food companies with innovative-agile combination adopt quality as a key competitive priority.	Supported for all tiers, no data for wholesaler	Supported for manufacturer and distributor, no data for wholesaler and retailer
H_{2d}: Food companies with innovative-agile combination adopt delivery speed as a key competitive priority.	Supported for all tiers, no data for wholesaler	Supported for manufacturer and distributor, no data for wholesaler and retailer
H_{2e}: Food companies with innovative-agile combination adopt delivery reliability as a key competitive priority.	Supported for all tiers, no data for wholesaler	Supported for manufacturer and distributor, no data for wholesaler and retailer
H_{2f}: Food companies with innovative-agile combination adopt product design as a key competitive priority.	Supported for all tiers, no data for wholesaler	Supported for manufacturer and distributor, no data for wholesaler and retailer

The results indicate that use of a functional-lean product-supply chain strategy is not supported (H_1) for retailers in the UK and does not prioritise cost (H_{1a}) for competing in the market. However, manufacturers, distributors and wholesalers have adopted lean supply chains for functional products, thus choosing cost as one of their main competitive priorities. In Malaysia, the alignment of competitive priorities shows a functional-lean combination focus on cost for all tiers (H_{1a}). The results are aligned with Fisher (1997), Naylor et al. (1999), Mason-Jones et al. (2000(a), 2000(b), Lee (2002) and Narasimhan et al. (2006), in that functional products that work under a lean supply chain focus on cost rather than other types of competitive priorities, with the exception of retailers in the UK.

Quality was found to be a priority (H_{1b}, H_{2c}) for any type of product or supply chain strategy for both countries in the UK and Malaysia. This supported Selldin and Olhager (2007), who also found that quality was no different with different types of products or supply chain strategies. The findings are aligned with Fisher (1997), Lee (2002) and Huang et al. (2002), who noted that quality is important for both functional and innovative products.

The innovative-agile combination in the UK prioritises product variety (H_{2a}), speed of delivery (H_{2d}), delivery reliability (H_{2e}) and product design (H_{2f}) as suggested by Mason-Jones et al. (2000). However, order size flexibility (H_{2b}) was focused on the downstream supply chain, including distributors and retailers. Data for wholesalers is not available in the innovative-agile combination. Whilst in Malaysia, the innovative-agile combination is important for product variety (H_{2a}), large size of order flexibility (H_{2b}), speed of delivery (H_{2d}), delivery reliability (H_{2e}) and product design (H_{2f}) in the manufacturer and distributor tiers (upstream supply chain). Downstream supply chain (wholesaler and retailer) cannot be confirmed due to the limited response in the innovative-agile combination. Table 5.21 presents a summary of the competence index for each product-supply chain strategy.

Table 5.21: Summary of results of competence index among supply chain tiers

Hypotheses	UK	Malaysia
H_{4a}: Food companies with functional-lean product-supply chain strategy perform better in terms of cost and quality to:		
a) Manufacturer	Supported	Supported
b) Distributor	Not supported	Not supported
c) Wholesaler	Not supported	Not confirmed
d) Retailer	Not supported	Supported
H_{4b}: Food companies with functional-agile product-supply chain strategy perform better in terms of cost, order flexibility and quality to:		
a) Manufacturer	Not supported	Supported
b) Distributor	Not supported	Not supported
c) Wholesaler	Supported	Not confirmed
d) Retailer	Not supported	Supported
H_{4c}: Food companies with innovative-lean product-supply chain combinations perform better in terms of speed and order flexibility to:		
a) Manufacturer	Supported	Not supported
b) Distributor	Supported	Not confirmed
c) Wholesaler	Not supported	Not confirmed
d) Retailer	Not confirmed	Supported
H_{4d}: Food companies with innovative-agile product-supply chain combinations perform better in terms of speed, order flexibility and product design (innovation) to:		
a) Manufacturer	Supported	Supported
b) Distributor	Supported	Not supported
c) Wholesaler	Not confirmed	Not confirmed
d) Retailer	Supported	Not confirmed

The findings are divided into four categories: functional-lean, functional-agile, innovative-lean and innovative-agile product-supply chain strategies. The findings support hypothesis H_{4a} for both manufacturers in the UK and both ends of the supply chain tiers (manufacturer and retailer) in Malaysia for performing better in terms of cost and quality. Distributors and wholesalers for both countries have low competence indices of cost and quality for the combination of a functional-lean product-supply chain strategy.

The cost, flexibility and quality (H_{4b}) competence indices for wholesalers is high and aligned with Roh et al.'s (2008) theory on work in functional-agile product-supply chain strategy combination in the UK. In Malaysia only, both ends of the supply chain tiers (manufacturers and retailers) support hypothesis H_{3b}.

The innovative-lean product-supply chain strategy is expected to perform at the highest competence index in speed and flexibility (H_{3c}). However, results in the UK show only upstream supply chain tiers (manufacturers and distributors) are performing well in speed and order size flexibility when working under the innovative-lean product-supply chain strategy. In contrast, retailers (downstream supply chain) in Malaysia support hypothesis H_{4c}.

The findings for the innovative-agile product-supply chain strategy support Roh et al.'s (2008) suggestion that manufacturers, distributors and retailers work better in terms of speed of delivery, order flexibility and innovation competence (H_{4d}) in the UK. The results are as expected, with the exception of the wholesalers for whom no data is available in the UK. In Malaysia, only the manufacturers support hypothesis H_{3d} and align with Roh et al. (2008). Wholesaler and retailer levels cannot be confirmed due to limited response.

This chapter has discussed and shown the evidence of the empirical findings of statistical analysis, the relationship between product type and supply chain strategy adoption, and the competence index in order to test the hypotheses. The next chapter presents the results for the 3x3 analyses in the UK and Malaysia. All the processes and discussions are similar to those in this chapter with the addition of a 'hybrid' product.

Chapter 6 3X3 MATRIX ANALYSIS FOR THE UK AND MALAYSIA

6.1 Introduction

This chapter presents the empirical analysis and results for the alignment of supply chain strategies and competitive priorities. It is similar in approach to Chapter 5 but concerns a 3x3 matrix analysis in which products are clustered into three types (functional, hybrid and innovative) instead of two (functional and innovative). This chapter contains five sections: cluster analysis, alignment of supply chain strategy, alignment of competitive priorities, competence index and a summary of the results for both the UK and Malaysia. The first section details the cluster analysis used to classify products as functional, hybrid or innovative. The second section presents the cross-tabulation for the product-supply chain strategy combination for both countries, as suggested by Huang et al. (2002). The alignment of competitive priorities for each product-supply chain strategy combination then follows. The fourth section presents an analysis of the competence index, comparing the combinations of strengths and weaknesses, in accordance with Mason-Jones et al. (2000(a), 2000(b)) and Roh et al.'s (2008) suggestions. A summary and comparison of the results is shown in the final section.

6.2 3x3 matrix analysis in the UK

6.2.1 Cluster analysis

Following the results of the significant correlation between product attributes and supply chain design criteria in Chapter 4 (Sections 4.5.1 and 4.5.2 respectively), cluster analysis was performed to divide products and supply chain classification respectively into three groups. The three product types consist of functional, hybrid and innovative, while the supply chain types are lean, leagile and agile. The procedure used for clustering was the two-stage approach, as suggested by Narasimhan et al. (2006), which includes both hierarchical and non-hierarchical methods. The percentage differences between hierarchical and non-hierarchical methods are shown in Table 6.1. The result shows that the difference between hierarchical and non-hierarchical methods for product and supply chain classification is approximately 19.23% and 2.56% respectively. The difference, approximately 15% to 20%, between hierarchical and non-hierarchical cluster solutions is acceptable (Narasimhan et al., 2006).

Table 6.1: Difference in percentage between hierarchical and non-hierarchical (K-means) cluster analysis

Classification	UK difference (%)
Product	(15/78) x 100% = 19.23%
Supply chain	(2/78) x 100% = 2.56%

In order to classify products and supply chain categories, tables 6.2 and 6.3 present the means for each cluster, based on product and supply chain attributes, and classifies them as functional, hybrid or innovative products, and lean, leagile or agile supply chains respectively.

Table 6.2: Means profile for each cluster for product attributes in the UK for 3x3 matrix

KMeansUKPro		Pattern of demand	Forecast accuracy	Number of SKUs	Stage of product life cycle	Total lead time	Length of product life cycle
Cluster 1	Mean	1.89	1.42	1.39	1.58	2.55	2.12
	Std. Deviation	.676	.708	.502	.561	.754	.740
Cluster 2	Mean	1.39	1.51	1.50	1.61	2.61	1.74
	Std. Deviation	.576	.000	.509	.497	.608	.813
Cluster 3	Mean	2.06	2.78	2.94	1.41	2.33	1.69
	Std. Deviation	.429	.428	.242	.618	.832	.793

Table 6.3: Means profile for each cluster for supply chain attributes in the UK for 3x3 matrix

KMeansUKSC		Key aim of supply chain	Manufacturing focus	Inventory strategy	Lead time focus	Approach to choosing suppliers
Cluster 1	Mean	2.15	2.50	1.50	1.17	1.39
	Std. Deviation	.515	1.133	.506	.383	.493
Cluster 2	Mean	2.25	2.40	1.38	1.88	2.32
	Std. Deviation	.463	1.140	.000	.354	.557
Cluster 3	Mean	2.40	2.53	2.32	1.84	2.50
	Std. Deviation	.500	.943	.476	.473	.535

Based on tables 6.2 and 6.3, those with the lowest score of average means are categorised as functional products and lean supply chains respectively, while those with the highest score are categorised as innovative products and agile supply chains. Medium scores of means profile in tables 6.2 and 6.3 indicate hybrid products and leagile supply chains. Functional products are generally simple, standard and commodity products, for which demand can be accurately forecast; there is a low number of SKUs, a long lead time, and a long product life cycle. The innovative product criteria is the opposite of that of functional products, in that they are classified as having a volatile market demand, reducing the accuracy of forecasting and having a high number of SKUs. The results support Fisher (1997) and Lee (2002) to some degree. The lead time for innovative products appears similar to functional products in the UK. The product life cycle is also found to be longer than functional products, which contrasts with Fisher (1997).

Similarly, the lean supply chain, based on the same criteria, includes low inventory levels, low investment for reducing lead time, and the approach to choice of supplier is based on cost. An agile supply chain contrasts with the criteria of a lean supply chain. This result also supports Huang et al. (2002) and Christopher et al. (2006) in that a hybrid product and a leagile supply chain can be categorised as having a volatile demand, similar to that of an innovative product. A hybrid and leagile supply chain is expected to have a long lead time due to the adoption of postponement activity. The result also indicates that the length of the product life cycle for innovative products is longer, not shorter, than functional and hybrid. This result contrasts with the theory (Fisher, 1997, Lee, 2002). Thus, product and supply chains are labelled according to the details summarised in table 6.4.

Table 6.4: Cluster labelling

Classification	Cluster	UK
Product	1	Functional
	2	Hybrid
	3	Innovative
Supply Chain	1	Lean
	2	Le-agile
	3	Agile

Table 6.5 presents each product classification associated with different supply chain strategies. The results found that functional, hybrid and innovative products had 32, 28 and 18 responses respectively. The total returned questionnaires indicated that a lean supply chain was classified as working for 45 products, with 8 and 25 products working under leagile and agile supply chains respectively.

Product chosen	KMeansUKPro								
	Functional			Hybrid			Innovative		
	KMeansUKSC			KMeansUKSC			KMeansUKSC		
	Lean	Leagile	Agile	Lean	Leagile	Agile	Lean	Leagile	Agile
Fish and fish products	1	1	1	3	1	0	0	0	1
Meat and poultry meat	1	0	2	0	0	1	1	1	0
Fruit and vegetables	0	1	2	1	0	0	2	0	0
Fruit and vegetable juice	0	0	0	0	0	0	0	0	0
Potatoes	0	0	1	1	0	0	0	0	1
Crude oils and fats	0	0	0	0	0	0	0	0	0
Margarine and edible fats	1	0	0	0	0	0	0	0	0
Refined oils and fats	0	0	0	0	0	0	0	0	0
Butter or cheese	1	1	0	0	1	0	0	1	1
Milk	0	0	0	1	0	0	0	0	0
Ice cream	0	0	3	0	0	0	0	0	0
Grain	0	0	0	0	1	0	0	0	0
Starches and starch products	0	0	1	0	0	0	0	0	0
Malt	0	0	1	0	0	0	0	0	0
Cereals	1	0	0	3	0	0	0	0	0
Bread	1	0	1	5	0	1	1	0	1
Rusk or biscuits	1	0	0	0	0	1	0	0	0
Cocoa, chocolate or candy	1	0	0	0	0	0	1	0	0
Sugar	0	0	0	1	0	1	0	0	0
Macaroni, noodles, couscous or similar farinaceous products	0	0	0	0	0	0	1	0	0
Condiments and seasonings	1	0	0	0	0	1	1	0	0
Tea or coffee	0	0	1	0	0	0	2	0	0
Alcoholic beverages	3	0	2	3	0	0	2	0	0
Mineral waters or soft drinks	2	0	0	2	0	0	0	0	1
Egg	0	0	0	0	0	0	0	0	0
Snacks	0	0	0	0	0	0	0	0	0
Cakes	0	0	0	0	0	0	0	0	0
TOTAL	14	3	15	20	3	5	11	2	5
Product classification		32			28			18	
Supply chain classification		45			8			25	

Table 6.5: K-means cluster analysis for the UK by 3x3 matrix

In order to validate the cluster solution, one-way ANOVA was performed to examine the differences across each group of clusters. One-way ANOVA has a similar objective to t-test analysis. T-test analysis is commonly used to test whether two groups are significantly different, while ANOVA is useful for testing whether three or more categories are significantly different (Saunders et al., 2009). Tables 6.6 and 6.7 show the results of differentiation between product and supply chain clusters respectively.

Table 6.6: ANOVA results: product classification

		Sum of Squares	df	Mean Square	F	Sig.
	Between Groups	7.007	2	3.503	11.921	.000
Pattern of demand	Within Groups	22.335	76	.294		
	Total	29.342	78			
	Between Groups	36.043	2	18.022	71.441	.000
Forecast accuracy	Within Groups	19.172	76	.252		
	Total	55.215	78			
	Between Groups	42.388	2	21.194	122.428	.000
Number of SKUs	Within Groups	13.157	76	.173		
	Total	55.544	78			

Table 6.6 indicates that the product attributes, "pattern of demand", "forecast accuracy" and "number of SKUs", were found to be significant in distinguishing the product cluster results. All variables for product attributes have *p*-values of less than 0.05. This means that functional (cluster 1), hybrid (cluster 2) and innovative (cluster 3) are significantly grouped and unique as different groups.

The results in table 6.7 also show that the ANOVA analysis was performed to validate the cluster analysis in grouping the supply chain categories. The results indicated that approaches to choosing suppliers, lead time focus and inventory strategy are significantly different. The p-value of ANOVA results for supply chain attributes are less than 0.05. This means supply chain attributes show disparity across the cluster group with 95% confidence level.

Table 6.7: ANOVA results: supply chain classification

		Sum of Squares	df	Mean Square	F	Sig.
Approach to choosing suppliers	Between Groups	18.363	2	9.181	34.211	.000
	Within Groups	20.397	76	.268		
	Total	38.759	78			
Lead time focus	Between Groups	8.751	2	4.376	25.892	.000
	Within Groups	12.844	76	.169		
	Total	21.595	78			
Inventory strategy	Between Groups	15.364	2	7.682	34.464	.000
	Within Groups	16.940	76	.223		
	Total	32.304	78			

6.2.2 Alignment of Supply Chain Strategy

A cross tabulation in figure 6.2 summarises Huang et al.'s (2002) matrix and demonstrates the number of samples in each category. The results show a 3x3 matrix with product type in column and supply chain type in row.

	Functional Product	Hybrid Product	Innovative Product
Physical Efficient/Lean Supply Chain	Total - 14 Manufacturer - 8 Distributor-0 Wholesaler - 4 Retailer - 2	Total - 20 Manufacturer-13 Distributor – 4 Wholesaler - 3 Retailer - 0	Total - 11 Manufacturer - 8 Distributor - 1 Wholesaler – 0 Retailer - 2
Le-agile Supply Chain	Total - 3 Manufacturer - 1 Distributor - 0 Wholesaler – 2 Retailer - 0	Total - 3 Manufacturer - 3 Distributor - 0 Wholesaler – 0 Retailer - 0	Total - 2 Manufacturer - 0 Distributor - 0 Wholesaler – 2 Retailer - 0
Agile Supply Chain	Total - 15 Manufacturer - 11 Distributor - 2 Wholesaler – 1 Retailer - 1	Total - 5 Manufacturer -2 Distributor - 1 Wholesaler – 1 Retailer - 1	Total - 4 Manufacturer - 1 Distributor - 1 Wholesaler – 0 Retailer - 3

Figure 6.1: Summary of companies aligned between supply chain strategy and product classification in the UK

The results appear to show that functional products work well with a lean supply chain strategy (43.7% of the functional product population), which includes 8 (40.0%) manufacturers, 0 (0%) distributors, 4 (57.1%) wholesalers and 2 (66.7%) retailers as opposed to agile supply chain as proposed by Fisher (1997). Functional products were also found to work well with an agile supply chain strategy (46.9% of the functional product population), which includes 11 (55.0%) manufacturers, 2 (100.0%) distributors, 1 (14.29%) wholesaler and 1 (33.3%) retailer. Thus, hypothesis H_1 is weakly supported for manufacturers and not supported for distributors; however, it is strongly supported for wholesalers and retailers. Hybrid-leagile is the expected matching product-supply chain strategy alignment, however, hybrid products were preferred for working through a lean supply chain, with 20 (71.4% of the hybrid product population). The results indicate that hybrid product in upstream level (manufacturers and distributors) are dominant working in lean supply chain. Thus, hypothesis H_3 is strongly supported. The results show that hybrid products are not chosen for leagile supply chains, as suggested by Huang et al. (2002) due to a single assessment of supply chain level. It was found that in all tiers of the supply chain of hybrid products, a lean rather than a leagile and agile supply chain was adopted, except for the retailers, who preferred to work with an agile supply chain. This supported the view that hybrid products in downstream supply chain adopt agile rather than lean (Huang et al., 2002). The results for those working with a lean supply chain include 72.2% of manufacturers, 80.0% of distributors, 75.0% of wholesalers and none of the retailers. For innovative products, 64.7%, are found to be well aligned and to work dominantly in lean, rather than leagile and agile supply chains. This result opposes that of Fisher (1997) but supports Lee (2002). Approximately 23.5% of the total innovative products work in agile supply chains, whereas only retailers support the hypothesis H_2. Manufacturers, distributors and wholesalers do not support hypothesis H_2.

In terms of *multi-tier supply chain strategy alignment*, the results show that, with the exception of the wholesaler level, the functional-lean product-supply chain strategy combination is not aligned in the UK. As a result, hypothesis H_{5a} is not supported. Alignment results for the innovative-agile combination (H_{5b}) are not supported at the upstream supply chain, but have some evidence of support further downstream at the retailer level. At the distributor level, innovative products work well in both lean and agile supply chain strategies. Hypothesis H_{5c} is not supported as the number of companies working under a leagile supply chain strategy is very limited. The reason for this may be due to the splitting of a strategy between a lean and agile supply chain, resulting in companies being required to choose either lean or agile, rather than a combination of supply chain strategy named leagile. It makes more sense, therefore, to have three types of products with two types of supply chain strategy for a multi-tier investigation. From the results, manufacturers, distributors and wholesalers prefer to work in lean supply rather than agile supply chain and retailers work in agile supply chain. Hypothesis H_{5c} (hybrid-leagile supply chain) is weakly supported across supply chain tiers.

6.2.3 Alignment of competitive priorities

A summary of the competitive priorities alignment results for product-supply chain strategy combinations is shown in Table 6.8. The results are derived from the mean score value of the competitive priorities, where the alignment between each supply chain tier was banded as follows:

1- Very weak alignment

2- Weak alignment

3- Moderate alignment

4- Strong alignment

5- Very strong alignment

Competitive priorities alignment can be divided into nine combinations of product-supply chain strategy; namely, functional-lean, functional-leagile, functional-agile, hybrid-lean, hybrid-leagile, hybrid-agile, innovative-lean, innovative-leagile and innovative-agile. Chapter 5 (2x2 matrix analysis) has explained that each combination of product-supply chain strategy has its own competitive priorities in order to compete in the market. However, Roh et al. (2008)

suggested only 2x2 matrix competitive priorities-supply chain strategy alignment, therefore, competitive priorities for functional-leagile, hybrid-lean, hybrid-leagile, hybrid-agile and innovative-leagile are still limited in the literature. This section provides the empirical evidence and suggests the competitive priorities-supply chain strategy alignment for the 3x3 matrix. Competitive priorities alignment between each supply chain tier is shown in table 6.8.

Table 6.8(a): Alignment of competitive priorities in the UK

Product	Supply chain	Competitive priority	Manufacturer	Distributor	Wholesaler	Retailer
Functional	Lean	Cost	Strong alignment	N/A	Moderate alignment	Weak alignment
		Quality	Strong alignment	N/A	Moderate alignment	Strong alignment
	Leagile	Cost	Moderate Alignment	N/A	Moderate alignment	N/A
		Delivery reliability	Very strong alignment	N/A	Very strong alignment	N/A
		Flexibility	Strong Alignment	N/A	Moderate alignment	N/A
		Quality	Very strong alignment	N/A	Strong alignment	N/A
		Speed of delivery	Very Strong alignment	N/A	Strong alignment	N/A
	Agile	Cost	Moderate Alignment	Moderate Alignment	Moderate alignment	Strong alignment
		Delivery reliability	Strong alignment	Strong alignment	Very strong alignment	Very strong alignment
		Flexibility	Moderate alignment	Moderate alignment	Moderate alignment	Strong alignment
		Quality	Strong alignment	Strong alignment	Very strong alignment	Very strong alignment
		Speed of delivery	Moderate alignment	Strong alignment	Strong alignment	Very strong alignment

Table 6.8(b): Alignment of competitive priorities in the UK

Product	Supply chain	Competitive priority	Manufacturer	Distributor	Wholesaler	Retailer
Hybrid	Lean	Cost	Weak alignment	Strong alignment	Strong alignment	N/A
		Delivery reliability	Strong alignment	Strong alignment	Strong alignment	N/A
		Quality	Strong alignment	Moderate alignment	Strong alignment	N/A
		Flexibility	Strong alignment	Moderate alignment	Weak alignment	N/A
		Speed of delivery	Moderate alignment	Moderate alignment	Strong alignment	N/A
	Leagile	Cost	Weak Alignment	N/A	N/A	N/A
		Delivery reliability	Very strong alignment	N/A	N/A	N/A
		Quality	Moderate alignment	N/A	N/A	N/A
		Flexibility	Weak alignment	N/A	N/A	N/A
		Speed of delivery	Strong alignment	N/A	N/A	N/A
	Agile	Cost	Strong alignment	Moderate alignment	Very strong alignment	Moderate Alignment
		Delivery reliability	Very strong alignment	Strong alignment	Very strong alignment	Strong alignment
		Quality	Strong alignment	Very strong alignment	Very weak alignment	Very strong alignment
		Flexibility	Weak alignment	Moderate alignment	Moderate alignment	Weak alignment
		Speed of delivery	Strong alignment	Moderate alignment	Very strong alignment	Moderate alignment

Table 6.8(c): Alignment of competitive priorities in the UK

Product	Supply chain	Competitive priority	Manufacturer	Distributor	Wholesaler	Retailer
	Lean	Cost	Moderate alignment	Strong alignment	N/A	Weak alignment
		Delivery reliability	Strong alignment	Very strong alignment	N/A	Strong alignment
		Quality	Strong alignment	Strong alignment	N/A	Moderate Alignment
		Flexibility	Weak alignment	Weak alignment	N/A	Strong alignment
		Speed of delivery	Strong alignment	Strong alignment	N/A	Moderate alignment
Innovative	Leagile	Cost	N/A	N/A	Strong alignment	N/A
		Delivery reliability	N/A	N/A	Strong alignment	N/A
		Quality	N/A	N/A	Moderate alignment	N/A
		Flexibility	N/A	N/A	Moderate alignment	N/A
		Speed of delivery	N/A	N/A	Weak alignment	N/A
	Agile	Product variety	Moderate alignment	Very strong alignment	N/A	Strong alignment
		Flexibility	Moderate alignment	Moderate alignment	N/A	Moderate alignment
		Quality	Moderate alignment	Strong alignment	N/A	Strong alignment
		Speed of delivery	Moderate alignment	Strong alignment	N/A	Very strong alignment
		Delivery reliability	Strong alignment	Very Strong alignment	N/A	Very strong alignment
		Product design	Moderate alignment	Strong alignment	N/A	Moderate alignment

The functional-lean supply chain is expected to be cost driven due to price being a competitive priority. In the UK, the results show that cost appears to be strongly aligned with manufacturer's strategy and moderately aligned to wholesalers using functional-lean product-supply chain strategies. This contrasts with retailers, for whom cost is not a priority, thus the alignment was found to be weak. Hypothesis H_{1a} is, therefore, supported for manufacturers and wholesalers, but H_{1a} is not supported for retailers. Functional-lean product-supply chain strategy alignments prioritise quality to win orders at every level of the supply chain. Hence, hypothesis H_{1b} is supported across all tiers of the supply chain. The results are aligned with Fisher (1997), Huang et al. (2002), Mason-Jones et al. (2000(a), and Roh et al. (2008). However, there is no data available for distributors in this sample.

The functional-leagile and functional-agile product-supply chain strategy results show that cost, delivery reliability, flexibility, quality and speed of delivery are aligned at all levels of the supply chain tiers. Functional-leagile shows a stronger alignment to the listed competitive priorities in the upstream supply chain compared with the downstream supply chain. In contrast, the functional-agile product-supply chain strategy indicates a stronger alignment at the downstream level of the supply chain with the identified competitive priorities (cost, delivery reliability, flexibility, quality and speed of delivery).

The results demonstrate that there are very limited responses in hybrid-leagile product-supply chain strategies. The results show alignment to competitive priorities only from manufacturers and are unable to show comparisons with other levels of supply chain tiers. Cost and flexibility of orders are not shown to be crucial for hybrid-leagile product-supply chain strategies. The results indicate that all hypotheses, delivery reliability (H_{3e}), and speed of delivery (H_{3d}), were supported, with a strong alignment to the manufacturer level, while quality (H_{3c}) showed a moderate alignment. Other supply chain tiers (distributor, wholesaler and retailer) cannot be confirmed due to the limited response. The result also indicates that hybrid-lean product-supply chain strategies have strong alignment with delivery reliability, quality and speed of delivery at all levels of supply chain tiers, excluding retailers, due to non-availability of data. Cost has a weak alignment with the supply chain upstream (manufacturer). Therefore, hypothesis H_{3a} is supported. Cost has a strong alignment at the downstream level (wholesaler) and order flexibility has a weak alignment in the downstream supply chain. Hybrid-lean also supported quality (H_{3b}) at the upstream level supply chain. The hybrid-agile product-supply chain strategy has good alignment with quality (H_{3c}), speed of delivery (H_{3d}), and delivery reliability (H_{3e}) at all levels of the supply chain tiers. However, retailers do not prioritise order flexibility (H_{3f}) as market winners at the downstream level.

The innovative-agile product-supply chain strategy is expected to have a very good alignment with delivery reliability and speed of delivery. The results prove that delivery reliability (H_{2e}), and speed of delivery (H_{2d}) are well aligned at all levels of supply chain tiers. The results also indicate that product variety, order size flexibility, quality, and product design are well aligned across supply chain tiers. Thus, hypothesis H_{2a}, H_{2b}, H_{2c}, H_{2f} are supported. Wholesalers have provided a limited response in this category; therefore, the hypothesis testing cannot be confirmed.

6.2.4 Competence index

As in Chapter 5, performance of each product-supply chain strategy combination was investigated by calculating the competence index introduced by

Cleveland et al. (1989). The results of the competence index are summarised in table 6.9. Respondent product-supply chain strategies were categorised into nine groups based on the three dimensions of types of products (functional, hybrid and innovative) and supply chain strategies (lean, leagile and agile). Competitive priority combinations were categorised into four groups (cost and quality, cost, flexibility and quality, speed and flexibility, and speed, flexibility and innovation).

Table 6.9: Competence index for the UK (3x3 matrix)

	Functional with lean supply chain	Funtional with leagile supply chain	Functional with agile supply chain	Hybrid with lean supply chain	Hybrid with leagile supply chain	Hybrid with agile supply chain	Innovative with lean supply chain	Innovative with leagile supply chain	Innovative with agile supply chain
Number of companies									
Competence Index for cost, quality:									
e) Manufacturer	0.78	0.18	0.48	0.78	-	0.78	0.78	-	0.18
f) Distributor	-	-	0.18	0.00	-	0.78	0.48	-	0.48
g) Wholesaler	0.18	0.78	0.18	0.78	-	0.18	-	-	-
h) Retailer	0.48	-	0.78	-	-	0.18	0.00	-	0.48
Competence Index for cost, flexibility and quality:									
e) Manufacturer	1.08	1.08	1.38	0.78	-	1.08	1.38	-	0.60
f) Distributor	-	-	0.60	1.38	-	0.78	1.38	-	0.78
g) Wholesaler	1.38	1.38	-0.18	1.38	-	-0.18	-	-	-
h) Retailer	0.30	-	1.38	-	-	-0.18	0.60	-	1.08
Competence Index for speed, flexibility:									
e) Manufacturer	-0.68	2.08	2.08	2.08	-	2.08	1.48	-	-0.68
f) Distributor	-	-	1.78	1.00	-	0.52	2.08	-	0.78
g) Wholesaler	-1.38	2.08	0.70	1.00	-	1.30	-	-	-
h) Retailer	0.52	-	2.08	-	-	0.52	0.52	-	1.08
Competence Index for speed, flexibility, innovation:									
e) Manufacturer	0.10	2.26	2.86	2.86	-	2.86	1.78	-	-0.68
f) Distributor	-	-	2.08	1.18	-	1.30	2.86	-	1.48
g) Wholesaler	-1.30	2.86	2.26	1.30	-	2.86	-	-	-
h) Retailer	0.10	-	2.86	-	-	1.30	0.10	-	2.08

The results are expected to yield a high competence index for cost and quality when functional-lean product-supply chain strategy combination is executed. The results indicate that manufacturers are aligned with Roh et al. (2008) achieving 0.78 on the competence index. At the same time, manufacturers in hybrid-lean, hybrid-agile and innovative-lean also performed well with the same index, 0.78. Wholesalers and retailers did not perform well in the cost and quality competence index when associated with the functional-lean product-supply chain strategy. Because no data was available for distributors in a functional-lean combination, hypothesis H_{4a} cannot be confirmed. Hypothesis H_{4a} is supported for manufacturers, but not for wholesalers and retailers.

Functional-agile product-supply chain strategy is expected to score highly on the competence index in combination of cost, flexibility and quality. The results indicate that only manufacturers and retailers reached the highest competence level in this category, attaining 1.38 each on the index. The result supported Roh et al. (2008). Thus, hypothesis H_{4b} is supported for manufacturer and retailer levels. On the other hand, H_{4b} is rejected for other tiers, including distributor and wholesaler.

Good results were expected for speed and flexibility when working with a combination of innovative-lean. The result showed that only distributors have high competence levels on the index in this category. Manufacturers and retailers have not performed well in speed and delivery when working under an innovative-lean combination. Therefore, hypothesis H_{4c} is not supported for manufacturers and retailers, but is supported for distributors.

Roh et al. (2008), suggests an innovative-agile product-supply chain strategy combination for good performances in the competitive priorities of speed, flexibility and innovation. From the calculation of competence index, none of the supply chain tiers is working well under this category. Thus, hypothesis H_{4d} is rejected for all supply chain tiers.

The survey results also indicate that retailers in a functional-agile product-supply chain strategy combination performed very well in every combination of competitive priorities. The results are consistent with Lee (2002), who mentioned that the functional-agile supply chain strategy is a common strategy among food retailers. Wholesalers were found to have a high competence index when adopting a functional-leagile product-supply chain strategy combination for all competitive priority combinations. For distributors, the results appear to show that the competence index is the highest for all combinations of competitive priorities when the distributor adopts an innovative-lean product-supply chain strategy, except for the cost and quality competence index. Distributors show the highest competence index in cost and quality when working under the hybrid-agile product-supply chain strategy.

6.3 3x3 matrix analysis in Malaysia

6.3.1 Cluster analysis in Malaysia

The procedure for analysing the 3x3 matrix in Malaysia is similar to the procedure explained in Section 6.2 (analysing 3x3 matrix in the UK). The differences in percentages between hierarchical and non-hierarchical clustering methods are summarised in Table 6.10. The result shows that the differences between hierarchical and non-hierarchical methods for product and supply chain classification are approximately 20.55% and 4.11% respectively. The results are similar to the UK samples. According to Narasimhan et al. (2006), differences of around 20% or less between hierarchical and non-hierarchical methods are acceptable.

Table 6.10: Percentage difference in classifications between hierarchical and non-hierarchical (K-means) cluster analysis

Classification	UK difference (%)
Product	(15/73) x 100% = 20.55%
Supply chain	(3/73) x 100% = 4.11%

Tables 6.11 and 6.12 present the means of each attribute for product and supply chain type in Malaysia. The attributes are clustered as functional, hybrid or innovative for product types, and lean, leagile or agile for supply chain types. Cluster 1 (the lowest line) is categorised as functional products and lean supply chains. Cluster 2 (medium line) indicates hybrid products and leagile supply chains. The last and the highest line represents innovative products and agile supply chains.

KMeansMsiaPro		Pattern of demand	Forecast accuracy	Number of SKUs	Stage of product life	Total lead time	Length of product time
Cluster 1	Mean	1.43	1.14	1.25	1.94	2.21	1.79
	Std. Deviation	.535	.448	.440	.614	.802	.623
Cluster 2	Mean	1.65	1.53	2.80	1.73	2.25	1.57
	Std. Deviation	.483	.743	.414	.704	.770	.646
Cluster 3	Mean	1.93	2.57	1.86	2.00	2.71	1.86
	Std. Deviation	.704	.535	.378	.816	.488	.378

Table 6.11: Means profile for product for each cluster in Malaysia (3x3 matrix)

KMeansMsiaSC		Key aim of supply chain	Manufacturing focus	Inventory strategy	Lead time focus	Approach to choosing suppliers
Cluster1	Mean	1.73	1.72	1.44	1.68	1.71
	Std. Deviation	.639	.750	.501	.571	.527
Cluster 2	Mean	2.50	2.50	2.83	2.50	1.00
	Std. Deviation	.707	.707	.000	.707	.000
Cluster 3	Mean	2.25	2.80	3.00	1.83	2.58
	Std. Deviation	.754	.789	.389	.577	.515

Table 6.12: Means profile for supply chain for each cluster in Malaysia (3x3 matrix)

The labels for each cluster are summarised in table 6.13.

Table 6.13: Cluster labelling

Classification	Cluster	Malaysia
Product	1	Functional
	2	Hybrid
	3	Innovative
Supply Chain	1	Lean
	2	Le-agile
	3	Agile

From the results, total lead time for all three types of made-to-order products contrasted with previous suggestions (Fisher, 1997, Lee, 2002). According to Fisher (1997), innovative products have a very short lead time compared with functional products, however, in food industries, total lead time for functional, hybrid or innovative are almost same. The number of SKUs for innovative products also differs from Fisher's theory. Innovative products are expected to have millions of component parts and millions of varieties of SKUs. However, in the food industry, the category and meaning of this product classification differs from other products in other sectors. The difference between types of product in terms of product life cycle is not significant in the food industry. Therefore, this profiling result also supports the idea that length of product life cycle is insignificant for the purpose of differentiating functional, hybrid or innovative products, which conflicts with the views of Aiken et al., (2003).

Table 6.14 presents the classification for type of product and supply chain for each product chosen. The cluster analysis reveals 52 functional products, 15 and 7 products for hybrid and innovative respectively. The results also indicate that of the 73 respondents, supply chain type classified 59, 2 and 12 as adopting lean, leagile and agile supply chains respectively.

	KmeansMsiaPro						
	Functional		Hybrid			Innovative	
	KmeansMsiaSC		KmeansMsiaSC			KmeansMsiaSC	
	Lean	Agile	Lean	Leagile	Agile	Lean	Agile
Fish and fish products	4	0	2	0	0	1	0
Meat and poultry meat	2	1	0	1	1	0	0
Fruit and vegetables	1	0	0	1	0	0	0
Fruit and vegetable juice	0	0	0	0	1	1	1
Potatoes	0	0	1	0	0	0	0
Crude oils and fats	0	0	0	0	0	0	0
Margarine and edible fats	0	1	0	0	0	0	0
Refined oils and fats	0	0	0	0	0	0	0
Butter or cheese	0	0	0	0	0	0	0
Milk	0	0	0	0	0	0	0
Ice cream	1	0	0	0	0	0	0
Grain	1	0	0	0	0	0	0
Starches and starch products	1	0	0	0	0	0	0
Malt	0	0	0	0	0	0	0
Cereals	1	0	0	0	0	0	0
Bread	5	1	0	0	0	1	0
Rusk or biscuits	2	2	0	0	0	0	0
Cocoa, chocolate or candy	1	0	1	0	1	0	0
Sugar	0	0	0	0	0	0	0
Macaroni, noodles, couscous or similar farinaceous products	2	1	1	0	0	1	0
Condiments and seasonings	8	0	1	0	0	1	0
Tea or coffee	6	0	1	0	0	0	0
Alcoholic beverages	0	0	0	0	0	0	0
Mineral waters or soft drinks	3	0	2	0	1	0	0
Egg	0	0	0	0	0	0	0
Snacks	3	0	0	0	0	0	0
Cakes	1	0	0	0	0	0	0
Others	3	0	0	0	0	0	1
TOTAL	45	6	9	2	4	5	2
Product classification	52			15		7	
Supply chain classification	59			2		12	

Table 6.14: K-means cluster analysis for Malaysia by 3x3 matrix

The ANOVA was performed to examine the significant differences between the cluster solution for both product and supply chain type. The explanation for using ANOVA can be obtained from previous chapters (refer to Chapter 3). Tables 6.15 and 6.16 illustrates the differentiation between product and supply chain clusters respectively.

Table 6.15: ANOVA result: product type

		Sum of Squares	df	Mean Square	F	Sig.
Pattern of demand	Between Groups	1.459	2	.729	2.516	.088
	Within Groups	20.295	70	.290		
	Total	21.753	72			
Forecast accuracy	Between Groups	13.253	2	6.626	23.803	.000
	Within Groups	19.487	70	.278		
	Total	32.740	72			
Number of SKUs	Between Groups	28.070	2	14.035	75.904	.000
	Within Groups	12.943	70	.185		
	Total	41.014	72			

Table 6.15 indicates the pattern of demand, forecast accuracy and number of SKUs found to be significant in clustering the product classifications. Forecast accuracy and number of SKUs are significantly different at p=0.05, with a 95% confidence level, while pattern of demand is significantly different at p=0.088, with a more than 90% confidence level.

Table 6.16: ANOVA result: supply chain type

		Sum of Squares	df	Mean Square	F	Sig.
Approach to choosing suppliers	Between Groups	9.009	2	4.505	16.580	.000
	Within Groups	19.018	70	.272		
	Total	28.027	72			
Lead time focus	Between Groups	1.473	2	.736	2.236	.114
	Within Groups	23.048	70	.329		
	Total	24.521	72			
Inventory strategy	Between Groups	22.750	2	11.375	49.124	.000
	Within Groups	16.209	70	.232		
	Total	38.959	72			

Table 6.16 shows the ANOVA result, indicating that the cluster analysis is significantly different for each cluster group. The result shows that the approach to choosing suppliers and inventory strategy is significantly different. The p value for lead time focus is 0.114 and only significant at a low confidence level of more than 85%.

6.3.2 Alignment of Supply Chain Strategy

Figure 6.2 illustrates Huang et al.'s (2002) matrix, and articulates the results of the alignment of product-supply chain strategies in Malaysia. The results indicate that more than two thirds of the surveyed companies (49 out of 51, 88.23%) are adopting a lean supply chain as their supply chain strategy. Innovative and hybrid products are the least common products working in the matching matrix, as proposed by Huang et al. (2002). It can also be seen that each tier of the supply chain includes manufacturers, distributors, wholesalers and retailers, with a significant number working in functional-lean compared with other product-supply chain strategy combinations. Thus, hypothesis H_1 is supported for all supply chain tiers.

	Functional Product	Hybrid Product	Innovative Product
Physical Efficient/Lean Supply Chain	Total - 45 Manufacturer - 23 Distributor – 12 Wholesaler - 7 Retailer - 3	Total - 9 Manufacturer – 5 Distributor – 0 Wholesaler - 1 Retailer - 3	Total - 5 Manufacturer - 4 Distributor - 0 Wholesaler – 0 Retailer - 1
Le-agile Supply Chain	Total - 0 Manufacturer - 0 Distributor - 0 Wholesaler – 0 Retailer - 0	Total - 2 Manufacturer - 2 Distributor - 0 Wholesaler – 0 Retailer - 0	Total - 0 Manufacturer - 0 Distributor - 0 Wholesaler – 0 Retailer - 0
Agile Supply Chain	Total - 6 Manufacturer - 6 Distributor - 0 Wholesaler – 0 Retailer - 0	Total - 4 Manufacturer -1 Distributor - 2 Wholesaler – 0 Retailer - 1	Total - 2 Manufacturer - 1 Distributor - 1 Wholesaler – 0 Retailer - 0

Figure 6.2: Summary of companies that aligned between supply chain strategy and product classification in Malaysia

The results empirically aligned with Selldin and Olhager (2007) and, thus, supported the theory of Fisher (1997), Huang et al. (2002), Lee (2002) and findings of Selldin and Olhager (2007). Both hybrid and innovative products were found to be more likely to adopt a lean supply chain as opposed to leagile and agile supply chains respectively. The results for hybrid products show that the majority of manufacturers (62.5% of the hybrid population) and retailers (75% of the hybrid population) aligned with lean rather than leagile or agile supply chain. This indicates that the results oppose the findings of Huang et al. (2002). Manufacturers, wholesalers and retailers adopted lean supply chain for hybrid products, with the exception of the distributors. However, the distributors adopted agile supply chain strategy rather than leagile and lean supply chain. Therefore, hypothesis H_3 is supported for manufacturers work at lean supply chain at the upstream level. H_3 is not supported for downstream supply chain except for the distributors. Similarly, innovative products produced the same results as hybrid products, with the exception of wholesalers. Manufacturers and retailers were found to adopt a lean supply chain as opposed to leagile and agile supply chain. Thus, hypothesis H_2 is supported for manufacturers and retailers. However, the result contrasted with Fisher (1997) and Huang et al. (2002), aligning, instead, with the findings of Selldin and Olhager (2007), in that innovative products did not significantly adopt agile supply chains. As in hybrid products, distributors for innovative products tended to choose agile supply chains, therefore hypothesis H_2 is supported for distributors.

The least preferred supply chain strategy in the Malaysian food industry is the leagile supply chain. The result from the survey sample shows that none of the selected respondents chose functional-leagile and innovative-leagile product-supply chain strategies. This may be due to the splitting of each supply chain tier, resulting in the respondents only being able to choose either lean or agile rather than leagile supply chain. This makes more sense than choosing leagile supply chain as their supply chain strategy. The combination of lean and agile, with the decoupling point, is named leagile supply chain (Naylor et al., 1999). No conclusion can be reached regarding the decoupling point because of the limited response from downstream supply chain tiers in innovative products, including distributors, wholesalers and retailers.

In terms of multi-tier supply chain strategy alignment, the results show that all supply chain tiers for functional-lean product-supply chain strategy combination are aligned in Malaysia. As a result, hypothesis H_{4a} is strongly supported. Alignment results for the innovative-agile combination (H_{4b}) are not supported at any supply chain tiers with the exception of distributors. Manufacturers, wholesalers and retailers work under lean supply chain and are assessed as aligned between hybrid-lean supply chain, except for the distributor. Therefore, hypothesis H_{4c} is not supported.

6.3.3 Alignment of Competitive Priorities

A summary of the competitive priority alignment results for product-supply chain strategy combinations is shown in Table 6.17. The results are derived from mean score values, as explained in Section 3.8.7 (Chapter 3).

Table 6.17(a): Alignment of competitive priorities in Malaysia

Product	Supply chain	Competitive priority	Manufacturer	Distributor	Wholesaler	Retailer
Functional	Lean	Cost	Strong alignment	Moderate alignment	Strong alignment	Strong alignment
		Quality	Strong alignment	Strong alignment	Strong alignment	Moderate alignment
	Agile	Cost	Moderate alignment	N/A	N/A	N/A
		Delivery reliability	Moderate alignment	N/A	N/A	N/A
		Flexibility	Moderate alignment	N/A	N/A	N/A
		Quality	Strong alignment	N/A	N/A	N/A
		Speed of delivery	Moderate alignment	N/A	N/A	N/A

Functional products with a lean supply chain strategy are expected to have high competence for price aligned across the tiers. The results show that functional-lean product-supply chain strategy is strongly aligned across tiers for manufacturers, wholesalers and retailers, while distributors were found to be moderately aligned. The results also show that quality has a strong alignment across tiers and is moderately aligned at the retailer level. Thus, H_{1a} and H_{1b} are strongly supported.

From the literature review, it could be seen that Roh et al. (2008) proposed the competitive priorities for functional and innovative products. Hitherto, there are no resources or suggestions for the hybrid product. Therefore, in this research, hypothesis testing is designed where the upstream supply chain is expected to focus on cost and quality, and the downstream supply chain is expected to focus on delivery reliability, quality, order flexibility and speed of delivery. According to Huang et al. (2002), hybrid products are expected to align and work well in a leagile supply chain strategy. The result indicates that there are insufficient responses for a conclusion to be drawn, as only manufacturers are available in the leagile supply chain. Thus, hypotheses H_{3a} and H_{3b} are supported for manufacturers, but the hypotheses are not confirmed for distributors, wholesalers and retailers. Hypotheses H_{3c} (quality for downstream), H_{3d} (speed of delivery) H_{3e} (delivery reliability) and H_{3f} (flexibility) are not confirmed for the downstream supply chain, including distributors, wholesalers and retailers.

Innovative products are supposed to be aligned in an agile supply chain strategy prioritising cost, delivery reliability, quality, order flexibility and speed of delivery (Fisher, 1997, Mason-Jones et al., 2000(a), Roh et al., 2008). The results show that the innovative-agile product-supply chain strategy is aligned with all competitive priorities as suggested for manufacturers and distributors. There is no data available for wholesalers and retailers as a result of the limited response in this study. Therefore, hypotheses H_{2a}, H_{2b}, H_{2c}, H_{2d}, H_{2e} and H_{2f} are supported.

Table 6.17(b): Alignment of competitive priorities in Malaysia

Product	Supply chain	Competitive priority	Manufacturer	Distributor	Wholesaler	Retailer
Hybrid	Lean	Cost	Moderate alignment	Very strong alignment	N/A	Moderate alignment
		Delivery reliability	Strong alignment	Strong alignment	N/A	Moderate alignment
		Quality	Strong alignment	Strong alignment	N/A	Strong alignment
		Flexibility	Moderate alignment	Moderate alignment	N/A	Moderate alignment
		Speed of delivery	Strong alignment	Strong alignment	N/A	Moderate alignment
	Leagile	Cost	Moderate alignment	N/A	N/A	N/A
		Delivery reliability	Strong alignment	N/A	N/A	N/A
		Quality	Strong alignment	N/A	N/A	N/A
		Flexibility	Strong alignment	N/A	N/A	N/A
		Speed of delivery	Strong alignment	N/A	N/A	N/A
	Agile	Cost	Very weak alignment	Very weak alignment	N/A	Weak Alignment
		Delivery reliability	Very strong alignment	Strong alignment	N/A	Moderate alignment
		Quality	Very strong alignment	Very strong alignment	N/A	Strong alignment
		Flexibility	Very weak alignment	Moderate alignment	N/A	Moderate alignment
		Speed of delivery	Very strong alignment	Strong alignment	N/A	Strong alignment

Table 6.17(c): Alignment of competitive priorities in Malaysia

Product	Supply chain	Competitive priority	Manufacturer	Distributor	Wholesaler	Retailer
Innovative	Lean	Cost	Very weak alignment	N/A	N/A	Moderate alignment
		Delivery reliability	Very strong alignment	N/A	N/A	Weak alignment
		Quality	Very weak alignment	N/A	N/A	Weak alignment
		Flexibility	Very strong alignment	N/A	N/A	Strong alignment
		Speed of delivery	Very strong alignment	N/A	N/A	Moderate alignment
	Agile	Product variety	Strong alignment	Moderate alignment	N/A	N/A
		Flexibility	Very strong alignment	Moderate alignment	N/A	N/A
		Quality	Moderate alignment	Very strong alignment	N/A	N/A
		Speed of delivery	Moderate alignment	Moderate alignment	N/A	N/A
		Delivery reliability	Moderate alignment	Moderate alignment	N/A	N/A
		Product design	Moderate alignment	Moderate alignment	N/A	N/A

6.3.4 Competitive Index

Performance for product-supply chain strategy combinations in Malaysia are shown in table 6.18.

Table 6.18: Competence index for Malaysia

	Functional with lean supply chain	Functional with leagile supply chain	Functional with agile supply chain	Hybrid with lean supply chain	Hybrid with leagile supply chain	Hybrid with agile supply chain	Innovative with lean supply chain	Innovative with leagile supply chain	Innovative with agile supply chain
Number of companies									
Competence Index for cost, quality:									
a) Manufacturer	0.78	-	-	0.48	-	0.18	0.78	-	0.48
b) Distributor	0.48	-	-	-	-	0.78	-	-	0.78
c) Wholesaler	0.48	-	-	0.48	-	-	-	-	-
d) Retailer	0.78	-	-	0.48	-	0.78	0.78	-	-
Competence Index for cost, flexibility and quality:									
a) Manufacturer	1.38	-	-	1.38	-	-0.18	0.78	-	0.78
b) Distributor	1.08	-	-	-	-	0.78	-	-	1.38
c) Wholesaler	1.08	-	-	1.08	-	-	-	-	-
d) Retailer	1.38	-	-	1.08	-	1.08	1.08	-	-
Competence Index for speed, flexibility:									
a) Manufacturer	1.12	-	-	2.08	-	1.48	1.48	-	0.52
b) Distributor	2.08	-	-	-	-	1.30	-	-	-0.08
c) Wholesaler	1.48	-	-	1.48	-	-	-	-	-
d) Retailer	2.08	-	-	2.08	-	1.30	-0.78	-	-
Competence Index for speed, flexibility, innovation:									
a) Manufacturer	2.08	-	-	2.26	-	2.26	1.30	-	1.30
b) Distributor	2.26	-	-	-	-	2.08	-	-	-0.60
c) Wholesaler	1.78	-	-	2.26	-	-	-	-	-
d) Retailer	2.56	-	-	2.86	-	2.08	-0.78	-	-

Based on the previous work (Roh et al., 2008), it was expected that the functional-lean product-supply chain strategy combination would perform better in cost and price competence than other product-supply chain strategy combinations. The results shown in table 6.18 indicate that manufacturers, wholesalers and retailers reach the highest competence level, with 0.78, 0.48 and 0.78 indices respectively. However, for distributors, the results are not aligned with the expectations of Roh et al's theory, thus hypothesis H_{4a} is not supported. However, hypothesis H_{4a} is supported for manufacturers, wholesalers and retailers. The functional-agile product-supply chain strategy combination was expected to have high competence in cost, flexibility and quality, however, none of the responses obtained for this research were in this category, therefore, hypothesis H_{5b} is not confirmed for all supply chain tiers.

Roh et al. (2008) also suggested that innovative-lean product-supply chain strategy is focused on speed and flexibility in order to compete in the market. The result shows that innovative-lean for manufacturers and retailers is not competent in speed and flexibility. The result indicates that they are competent when they are working in hybrid-lean for both manufacturers (with 2.08 index) and retailers (with 2.08 index), and functional-lean for the retailers (with 2.08 index). Thus, hypothesis H_{4c} is not supported for manufacturers and retailers.

Speed, flexibility and innovation were expected to be more appropriate concerns for innovative-agile product-supply chain strategy (Roh et al., 2008) in order to maintain competence in the market. The result shows that manufacturers and distributors are not performing well, while wholesaler and retailer data is not available due to the limited response. Manufacturers and distributors perform well when they are working in hybrid-lean and hybrid-agile, while distributors perform well when they are in functional-lean product-supply chain strategy. Thus, hypothesis H_{4d} is not supported for manufacturers and distributors. The hypothesis H_{4d} cannot be confirmed for wholesalers and retailers.

6.4 Summary

This chapter has presented three main results that cover the alignment of supply chain strategies, alignment of competitive priorities and performance of competence index for four supply chain tiers consisting of manufacturers, distributors, wholesalers and retailers. The results have demonstrated three types of product: functional, hybrid and innovative, which are aligned with three supply chain strategy choices: lean, leagile or agile.

From the results, three types of products can be significantly classified within the food industry: functional, hybrid and innovative products - 32, 28 and 17 respectively. In general, the findings indicate that the lean supply chain is the most common strategy for all three types of product. In addition, the agile supply chain was also found with many functional products. The least common supply chain in the food industry was the leagile, which was evenly distributed among functional, hybrid and innovative products.

The findings of the analysis of supply chain strategy adopted by functional, innovative and hybrid products are summarised in table 6.19.

Table 6.19: Summary of results of supply chain strategy alignment in the UK and Malaysia

Hypotheses	UK	Malaysia
H_1: Food companies with a functional product adopt lean supply chain characteristics as opposed to leagile and agile supply chain characteristics.		
a) Manufacturer	Weakly supported	Supported
b) Distributor	N/A	Supported
c) Wholesaler	Supported	Supported
d) Retailer	Supported	Supported
H_2: Food companies with an innovative product adopt agile supply chain characteristics as opposed to lean and leagile supply chain characteristics.		
a) Manufacturer	Not supported	Not supported
b) Distributor	Not supported	Not confirmed
c) Wholesaler	Not supported	Not available
d) Retailer	Supported	Not confirmed
H_3: Food companies with a hybrid product adopt leagile supply chain characteristics as opposed to lean and agile supply chain characteristics, where lean supply on upstream supply chain and agile supply in downstream supply chain..		
a) Manufacturer	Not supported	Not supported
b) Distributor	Not supported	Not available
c) Wholesaler	Not supported	Not supported
d) Retailer	Not supported	Not supported
H_{5a}: Food supply chains for functional products adopt lean characteristics throughout the tiers of the chain.	Not supported	Supported
H_{5b}: Food supply chains for innovative products adopt agile characteristics throughout the tiers of the chain.	Not supported for upstream but supported for downstream supply chain	Not supported
H_{5c}: Food supply chains for hybrid products adopt leagile characteristics throughout the tiers of the chain.	Not supported	Not supported

The findings on the alignment of competitive priorities adopted by each product-supply chain strategy is summarised in table 6.19. The results indicate that the functional-lean product-supply chain strategy is supported (H_1) for wholesalers and retailers, and weakly supported for manufacturers. The functional-lean product-supply chain strategy also prioritises cost (H_{1a}) as expected, except for retailers. However, the percentage of functional products indicates that they are also working well in agile supply chains, with approximately 47% of the functional products. The innovative-agile product-supply chain strategy (H_2) was only supported for retailers, while the hybrid-leagile product-supply chain strategy (H_3) was supported for manufacturers rather than other supply chain tiers.

Table 6.20: Summary of results on alignment of competitive priorities in the UK and Malaysia

Hypotheses	UK	Malaysia
H_{1a}: Food companies with functional-lean product-supply chain strategy adopt a low selling price as one of their main competitive priorities.	Supported except for the retailer (functional-lean)	Supported for all tiers
H_{1b}: Food companies with functional-lean product-supply chain strategy adopt quality as one of their main competitive priorities.	Supported for all tiers	Supported for all tiers
H_{2a}: Food companies with innovative-agile product-supply chain strategy adopt product variety as one of their main competitive priorities.	Supported for all tiers	Supported for manufacturer and distributor
H_{2b}: Food companies with innovative-agile product-supply chain strategy adopt large order size flexibility as one of their main competitive priorities.	Supported for all tiers	Supported for manufacturer and distributor
H_{2c}: Food companies with innovative-agile product-supply chain strategy adopt quality as one of their main competitive priorities.	Supported for all tiers	Supported for manufacturer and distributor
H_{2d}: Food companies with innovative-agile product-supply chain strategy adopt delivery speedy as one of their main competitive priorities.	Supported for all tiers	Supported for manufacturer and distributor
H_{2e}: Food companies with innovative-agile product-supply chain combinations adopt delivery reliability as a key competitive priority.	Supported for all tiers	Supported for manufacturer and distributor
H_{2f}: Food companies with innovative-agile product-supply chain combinations adopt product design as a key competitive priority.	Supported for all tiers	Supported for manufacturer and distributor

It is expected that the functional-lean product-supply chain combination prioritises cost and quality. From the results, hypotheses H_{1a} and H_{1b} are both supported and aligned with other supply chain tiers except for retailers in the UK. This result is aligned with the 2x2 matrix analysis. The results are also consistent with Fisher (1997), Naylor et al. (1999), Mason-Jones et al. (2000(a)), (2000(b)), Lee (2002) and Narasimhan et al. (2006). The 3x3 analysis in this chapter shows the same result as the 2x2 analysis, in which quality (H_{1b}, H_{2c}) is a competitive priority for both countries and both types of product and SC strategy. Selldin and Olhager also found the same result, thus supporting Fisher (1997), Lee (2002) and Huang et al. (2002).

Hypotheses H_{2a} (product variety), H_{2b} (large order size flexibility), H_{2c} (quality), H_{2d} (speed of delivery), and H_{2e} (delivery reliability) are supported for both the UK and Malaysia. Data for wholesalers in the UK, and wholesalers and retailers in Malaysia, are not available. Therefore, downstream supply chain alignment cannot be confirmed due to the limited response in innovative-agile combination, similar to the 2x2 analysis (Chapter 5 refers).

Table 6.21 provides a summary of the competence index for each product-supply chain strategy.

Table 6.21: Summary of results of competence index among supply chain tiers

Hypotheses	UK	Malaysia
H_{4a}: Food companies with functional-lean product-supply chain strategy perform better in terms of cost and quality to:		
a) Manufacturer	Supported	Supported
b) Distributor	Not available	Not supported
c) Wholesaler	Not supported	Supported
d) Retailer	Not supported	Supported
H_{4b}: Food companies with functional-agile product-supply chain strategy perform better in terms of cost, flexibility and quality to:		
a) Manufacturer	Supported	Not confirmed
b) Distributor	Not supported	Not confirmed
c) Wholesaler	Not supported	Not confirmed
d) Retailer	Supported	Not confirmed
H_{4c}: Food companies with innovative-lean product-supply chain combinations perform better in terms of service level include speed and flexibility to:		
a) Manufacturer	Not supported	Not supported
b) Distributor	Supported	Not available
c) Wholesaler	Not available	Not available
d) Retailer	Not supported	Not supported
H_{4d}: Food companies with innovative-agile product-supply chain combinations perform better in terms of service level include speed, flexibility and product design to:		
a) Manufacturer	Not supported	Not supported
b) Distributor	Not available	Not supported
c) Wholesaler	Not supported	Not available
d) Retailer	Not supported	Not available

The findings are divided into nine categories: functional-lean, functional-agile, functional-leagile, innovative-lean, innovative agile, innovative-leagile, hybrid-lean, hybrid-leagile and hybrid-agile product-supply chain strategies. However, a hypothesis for the hybrid combination is not available in the literature, therefore, this study concentrates only on testing the four combinations of the 2x2 analysis. The combinations include functional-lean, functional-agile, innovative-lean and innovative-agile product-supply chain strategies.

The findings supported hypothesis H_{4a} for manufacturers in both the UK and Malaysia. However, hypothesis H_{4a} is reversed for the wholesalers and retailers in these two countries; it is not supported for the UK but supported for Malaysia. The functional-agile product-supply chain strategy was expected to have a high competence index for competitive priorities in cost, flexibility and quality. The results show that hypothesis H_{5b} is not supported for all supply chain tiers in Malaysia, but is supported for manufacturers and retailers in the UK.

The product-supply chain strategy combination of innovative-lean is expected to have a high competence level in speed and flexibility; however the results show that only distributors in the UK support hypothesis H_{4c}. The rest of the supply chain tiers in both countries are not consistent with Roh et al. (2008). Similar results are found for the combination of competence index in terms of speed, flexibility and product design in both countries. The results indicate that hypothesis H_{4d} is not supported for all supply chain tiers in both countries. The results oppose the proposed framework for matching competitive priorities and supply chain strategies.

This chapter has presented the evidence of empirical findings of statistical analysis, the relationship between product type and supply chain strategy adoption, and competence index in order to test hypotheses, as in Chapter 5. The main findings of the research are discussed in the next chapter.

Chapter 7 DISCUSSION

7.1 Introduction

This chapter presents the key findings and discussions on the results revealed in Chapters 4, 5 and 6. The key findings are summarised under six headings as follows:

a) Association between product and supply chain strategy
b) Demand attributes to classify product type
c) Product-supply chain strategy alignment in the UK and Malaysia
d) Product-competitive priorities alignment in the UK and Malaysia
e) Differences between product and supply chain strategy alignment and product and competitive priorities alignment in the UK and Malaysia
f) Product-supply chain strategy-competence index between the UK and Malaysia

The discussions focus on the results of the 2x2 matrix and the 3x3 matrix analysis for both the UK and Malaysia and include arguments and evidence from previous research, some agreeing and some disagreeing with the current findings. In conclusion, the chapter highlights a summary of key findings.

7.2 Research findings and discussions

7.2.1 Association between product and supply chain strategy

For more than a decade, the association between product type and supply chain strategy, proposed by Fisher (1997), has been widely cited, generally accepted and enthusiastically extended by many researchers (Mason-Jones et al., 2000(a), Mason-Jones et al., 2000(b), Ramdas and Spekman, 2000, Huang et al., 2002, Lee, 2002, Wang et al., 2004, Christopher et al., 2006, Wong et al., 2006). However, empirical support of Fisher's work is limited. One recently published empirical research study was undertaken by Lo and Power (2010), who conclude that the association between product nature and supply chain strategy is not significant. The findings reported in this research indicate that the relationship between functional products and lean supply chains is significant, a view shared by Selldin and Olhager (2007) in their research. Selldin and Olhager (2007) also found that there is no clear match between product and supply chain strategy, but companies have a tendency to match the appropriate supply chain with the product type. Selldin and Olhager (2007) highlight the two possible reasons for this:

'A move along the product life cycle from the introductory phase to the mature phase may imply a move from a basically innovative character of the product to a more functional type of product, while the company maintains a market-responsive supply chain and does not acknowledge the need to shift the focus to physical efficiency'.

'Companies with functional products may implement new manufacturing concepts such as quick response and agile manufacturing, improving responsiveness and

flexibility to levels that are higher than what the products and markets require, and at the expense of efficiency'.

The results shows that in the UK, the alignment of supply chain strategy for each supply chain member in the Fisher's matrix resulted a mismatched between product type and supply chain strategy especially in downstream, supply chain (wholesaler and retailer). From the cluster analysis, 41% of product that categorised as functional products that adopted lean strategy are perishable foods such as fruit and vegetables, fish, meat and bread. The need to sell food in responsive way is important to fulfil customer requirements (Vorst et al., 2000). Perhaps, this is one of the reason behind a relative mismatch strategy for the functional food especially in downstream supply chain.

However, Lo and Power (2010) argue that product classification into two groups (functional and innovative) appears to be problematic. The evidence of 'hybrid' products existing between functional and innovative products in the results of this research supports Huang et al. (2002), and, thus, supports Lo and Power's (2010) opinion. The results oppose Selldin and Olhager's (2007) view that product life cycle influences the mismatched product and supply chain strategy in the food industry. Aitken et al. (2003) highlighted that the supply chain strategy adoption is influenced by the product life cycle. Food product life cycles differ from those of commercial products. Food product demand is influenced by season and weather. Also, product life cycle changes (Selldin and Olhager, 2007) influence the adoption of the supply chain strategy, as the nature of lead time for food is shorter than that of commercial products (Lee, 2002), which also contributes to the mismatch between product and supply chain strategy. The mismatch in the alignment between product and supply chain strategy is discussed in a later section and related to company performance, as proposed by Fisher (1997).

7.2.2 Demand attributes to classify product type

Fisher (1997) initially generated a list of product attributes in order to distinguish functional from innovative. Huang et al. (2002) extended Fisher's idea with the addition of hybrid products. From our empirical findings, both functional and innovative products exist in the food industry and can be clearly distinguished by three product demand attributes: 'pattern of demand', 'forecast accuracy' and 'number of SKUs'. However, there is no agreement amongst researchers in the literature regarding the classification of demand attributes. The validity of the guidelines suggested by the previous researchers (Fisher, 1997, Lee, 2002, Huang et al., 2002, Aitken et al., 2003, Wong et al., 2006) is still questionable, due to the limited availability of empirical evidence. The results presented in this research provide the important demand attributes and the significant attributes consistent with Selldin and Olhager (2007). The findings show that pattern of demand has a strong correlation with forecast accuracy for both the UK and Malaysia. These results align with Fisher's (1997) and Huang et al.'s (2002) theories that pattern of demand has a strong influence on forecast accuracy; however, the number of SKUs correlate largely with the pattern of demand in the UK, but correlate with forecast accuracy in Malaysia. In other words, pattern of demand, forecast accuracy and number of SKUs are inter-related, and as such, are important for indicating product classification. The results are aligned with Selldin and Olhager's (2007) findings, which show that the number of SKUs and forecast accuracy are important for characterising product type. Other attributes, such as stage of product life cycle, total lead time and length of product life cycle, are found to be unrelated to demand. The means profile results show that lead time and length of functional and innovative products life cycles conflict with the results of Fisher (1997) and Huang et al. (2002). The lead time and length of innovative products life cycles were found to be longer than those of functional products. According to Wang et al. (2004), different product types might require different supply chain strategies at different stages of their life cycles. The correlation result of stage of product life cycle is not significant to the demand pattern but may have an impact on the supply chain strategy. However, Polli and Cook (1969) claim that the life cycle model is irrelevant to the food industry due to the seasonal sales fluctuations. Seasonally fluctuating demand makes it difficult to predict and trace the life cycle of products. Therefore, the results provide some support for Polli and Cook (1969).

However, in Malaysia, in addition to the three product attributes, 'total lead time', 'length of product life cycle' and 'stage of product life cycle' are also significant for differentiating the products. This is possibly due to the stable business environment in Malaysia (Jusoh and Parnell, 2008) as compared with the more volatile and challenging business environment of the UK, which has to cope with four different seasonal requirements. Therefore, 'total lead time', 'length of product life cycle' and 'stage of product life cycle' are possibly shorter (Stewart, 1997, Jagdev and Browne, 1998, Childerhouse and Towill, 2000, Waller et al., 2000, Christopher et al., 2004) in the UK, contributing to less significant attributes in order to differentiate products as functional, hybrid or innovative. The findings show that length of product life cycle and lead time for functional products are shorter than those of innovative products.

Fisher (1997) claims that demand would be the critical criterion for distinguishing between products. It is argued that the demand pattern is highly correlated with the position of a firm in its supply chain tiers. According to Lee et al. (1997), demand for products is influenced by the bullwhip effect across supply chain tiers, as the accuracy of the demand forecast decreases from customers to the manufacturers. The bullwhip effect is more obvious for the innovative products or seasonal products, where the demand accuracy is low because companies are further away from the customers (Lee et al., 1997). Nowadays, it is considered essential to shorten lead time in order to provide a responsive service and assessment of business performance. Mason-Jones et al (1999) presented the ELA survey of replenishment lead times, where food and beverage industries had the shortest lead time among other industries within a 5 day period in 1987, and a 3 day period in 1997 respectively. It was expected that replenishment lead time for the year 2008 would be reduced to 1 day, therefore, the difference between products, in terms of lead time, is difficult to distinguish. Demand attributes are not sufficient to distinguish type of product and it is suggested that other aspects should be included, such as level of coordination of information (Lee et al., 1997), network tiers (Harland, 1996), network structure (Lo and Power, 2010) and operations strategy (Li and O'Brien, 2001).

7.2.3 Product-supply chain strategy alignment in the UK and Malaysia

Fisher (1997) recommended a match between functional products and lean supply chains, and innovative products and agile supply chains. When a functional product is supported by an agile supply chain, or an innovative product is supported by a lean supply chain, Fisher's theory suggests a mismatch occurs and the consequence is a sub-optimal arrangement. The results produced by this research provide only limited support for a matching theory between product type and supply chain strategy. Findings from both the UK and Malaysian studies show that functional products are supported by lean supply chains. However, in the UK study, the research findings also show that functional products are also supported by agile supply chains. From an holistic, multi-tier perspective, the alignment between product and supply chain strategy across supply chain tiers indicates good alignment for functional products in the food supply chains of both countries. The results provide evidence that functional products are supported by lean supply chains across supply chain tiers, as suggested by Fisher (1997). The only exception is at the retailer level in the UK. The results are consistent with findings by Selldin and Olhager (2007) that functional products are supported by lean supply chains and are found to be more common for both countries. However, in the UK, the findings also show that functional products work well with the agile supply chain. This is probably due to the adoption of cumulative capabilities rather than a capabilities trade off (Kwasi and Meredith, 2007) as in the UK. More than a decade ago, the notion of trade off capabilities, either low cost or high service level, was proposed (Mason-Jones et al, 2000(a), Mason-Jones et al., 2000(b)); however, the pressure from customers today has resulted in the adoption of cumulative capabilities in order to meet changing customer preferences (Vorst et al., 1998). In developing countries, such as Malaysia, the adoption of trade off capabilities appears to be a common objective that may be due to the more stable environment (Jusoh and Parnell, 2008). This result provides further support for Lee (2002) who argues that it is possible that mismatched strategies might take place in different industries and it is expected that functional-lean and functional-agile alignments are common product-supply chain strategies for the food industry.

In addition, the results show that functional products in the UK work well in both agile and lean supply chain strategy when the product at the downstream level. The results showed functional products equally use lean and agile strategy at retailer level. 50% of the functional products that work in agile supply chain were perishable products. Perhaps, it contributes to the need of agile supply chain strategy to speedy market demand due to its short shelf life. Besides, fresh produce has become what retailers describe as a 'destination' category that customers will switch stores. In the UK, the power struggles between buyers and sellers that have characterised the UK fresh food is being replaced with great competition between chains (Fearne and Hughes, 1999).

The results for innovative products do not completely fit Fisher's (1997) model in either country. Manufacturers of innovative food products in the UK are likely to be supported by lean, rather than agile supply chains. Distributors and retailers of innovative food products are more likely to adopt agile supply chains. The implication here is that the supply chain cannot be wholly categorised as either lean or agile. An explanation for this is that a hybrid product is produced containing both functional and innovative characteristics. Lo and Power (2010) have made a similar claim in their research. Such a concept has been explored by Huang et al. (2002) who, taking inspiration from Naylor et al. (1999) and their exposition of "leagility", articulated the notion of the hybrid product and hybrid supply chain. The hybrid supply chain is supported by lean and agile approaches. Upstream, the focus of the supply chain is on being lean but downstream, in order to respond to changing customer requirements, the emphasis is on being agile. The term "leagile" embodies this hybridisation of the chain: downstream demand is market-driven, but in upstream tiers demand is less volatile. Trade-off between efficiency and responsiveness exists for a single product within a single supply chain.

From the findings (Chapter 6), hybrid products also work most in a lean supply chain strategy rather than leagile or agile supply chain. Leagility does not appear to be significant across the chain. According to Mason-Jones et al. (2000(a)) the definition of leagile is: *"Combination of the lean and agile paradigm within a total supply chain strategy by positioning the decoupling point".*

Naylor et al. (1999) described the decoupling point:

> *"Lean paradigm can be applied to the supply chain upstream of the decoupling point as the demand is smooth and standard products flow through a number of value streams, whereas agile paradigm must be applied downstream from the decoupling point as demand is variable and the product variety per value stream has increased".*

From the definition, upstream supply chain adopted lean; while downstream supply chain adopted agile, therefore, the results indicate that products can be divided into three types (functional, hybrid and innovative), while supply chain strategy can be classified into two types: lean and agile when evaluated in each single tier.

Lee (2002) pointed out that some functional food products are supported by agile supply chains. Lee (2002) called the functional-agile combination risk-hedging supply chains that aim to apply inventory pools and share with other companies to reduce risk of supply disruption. The results also found no such significance in the relationship between innovative products and agile supply chains, but rather worked more in an innovative-lean combination. The results contrasted with Fisher (1997). This may due to the strategy change that bargaining power of retailers that many of retailers have offered more innovative, qualitative and segmented product ranges that nearly close to manufacturer's brand (Bininger, 2008). Therefore, the length of life cycle of innovative products resulted against Fisher's guidelines. The food product is now views as commercial products compared to commodity requirements with fulfil the standard requirement to keep the market moving (Fearne and Hughes, 1999).

In Malaysia, multi-tier results for innovative products cannot be confirmed due to a limited response from distributors, wholesalers and retailers, yet it should be noted that the supply chains supporting innovative products are likely to be shorter and have fewer tiers, so the lack of data for some downstream tiers, and in particular wholesalers, is not unexpected. However, the findings do suggest that manufacturers do not adopt agile supply chains. This does not rule out the possibility of a similar hybrid/ leagile supply chain operation in the UK.

7.2.4 Product-competitive priorities alignment in the UK and Malaysia

With regard to the analysis of competitive priorities in Malaysia, for functional-lean combinations price and quality were strongly aligned and conspicuous across all tiers. Such alignment was less apparent in the UK, particularly at the level of the retailer, where alignment was weak. This can be partially explained by the recognition that the UK retailers surveyed were typically those for whom brand has become an important source of advantage and, although appreciative of price competition, they do not necessarily recognise it as the prime source of competitive advantage. Binninger (2008) has provided some support for this view. This was not the case in Malaysia's developing economy where price is a dominant factor. According to Lee (2002), functional-agile supply chain strategy is a common strategy for retailers. The demand in downstream is more market driven and determined by the end user (Naylor et al., 1999). From a competitive priority perspective, the result also found that retailers in the UK, who have functional products supported by lean supply strategies, did not prioritise cost in order to win market orders. This contrasts with that in Malaysia, where functional-lean product-supply chain strategy focuses on cost along the tiers, as suggested by Fisher (1997), Lamming et al. (2000), Mason Jones et al. (2000(a), (b)) and Roh et al. (2008). This is probably due to the shifted strategies adopted by retailers in the UK (Laaksonen and Reynolds, 1994, Burt, 2000, Grunert et al., 2006) where retail brand (5th generation) becomes a competitive strategy to gain customer loyalty (Binninger, 2008) rather than cost (1st generation). A possible reason for Malaysian companies focusing more on cost is that the level of per capita income for developing countries is lower than that of developed countries, which contributes to the power of low price purchasing. Thus, the conservative attitude in buying products at more affordable prices is understandable for developing countries (Jusoh and Parnell, 2008).

In addition, in the UK, strong alignment was evident across tiers for the innovative-agile combination for delivery speed and delivery reliability. Evidence of the hybridisation of the chains was also present for this product-supply chain strategy combination, as competitive priorities generally increased when moving from the manufacturer to the distributor. For example, delivery reliability shifted from "strong" to "very strong", product variety from "moderate" to "strong" and flexibility from "weak" to "moderate". Quality and reliability of products are found to be significantly important in any combination of products and supply chains, thus supporting the claim that quality is important for all types of product and supply chains (Fisher, 1997, Huang et al., 2002, Selldin and Olhager, 2007).

7.2.5 Differences between product and supply chain strategy alignment and product and competitive priorities alignment in the UK and Malaysia

This research has evaluated two types of alignment with the same principles that introduced by Fisher (1997) in recognising type of products in order to differentiate types of demand. The alignment covered in the research are between product types and supply chain strategy (Fisher, 1997, Huang et al., 2002, Lee, 2002) and product types and competitive priorities (Mason-Jones et al., 2000(a),(b)). From the findings, the alignment between product types and supply strategy for the UK, not aligned as expected as discussed in section 7.2.3. The product-supply strategy alignment in Malaysia is as expected by the theory and suggestion. However, both product-supply chain strategy and product-competitive priorities alignment results were aligned with theory suggested by the previous researchers (Fisher, 1997, Huang et al., 2002, Lee, 2002, Mason-Jones et al., 2000 (a), (b)). Cousin (2005) pointed that competitive position and competitive priorities are the main factors that must be examined before aligning the supply to match with the strategic goals and objectives. Company who is being cost-focused will generally consider supply as playing merely a cost reduction (Cousin, 2005). For example from the results, retailer in the UK not choosing cost as their main competitive priorities, therefore the alignment of retailer in lean supply chain is not aligned. Meanwhile, for innovative products for both the UK and Malaysia, seems supported the theory (Fisher, 1997, Huang et al., 2002, Lee, 2002) that aligned with supply strategy and competitive priorities. All three types of products (functional, hybrid and innovative) which work with agile supply chain, are all aligned with competitive priorities for both the UK and Malaysia. Therefore, there is clear relationship between supply strategy and competitive priorities, thus can be as a core capability of supply chain to increase performance and match with strategic goals and objectives. The measurement of competitive performance that measures the supply chain competence are discussed in next section.

7.2.6 Product-supply chain strategy-competence index between the UK and Malaysia

The competitive index has been adopted from Cleveland et al. (1989) who introduced the notion of production competence. Production competence/incompetence is a measurement of the combined effects of strengths and weaknesses in a manufacturer's key performance areas. This research adopted the methodology to combine competitive priorities and market winners, as suggested by Roh et al. (2008), Mason-Jones et al (2000(a)) and Mason-Jones et al. (2000(b)). Roh et al. (2008) proposed the alignment between competitive priorities and supply chain types with the addition of organisational culture into the alignment framework. From the findings, the results show that the alignment of functional-lean product combination with cost and quality competitive priorities for both the UK and Malaysia food industries are significantly supported at the manufacturer's level. The results indicate that 2x2 matrix and 3x3 matrix analyses, based on Fisher's and Huang et al.'s theories respectively, are both significant in terms of the cost and quality competence index. In Malaysia, all supply chain tiers are competent in cost and quality for functional-lean combination except for the distributor. In other words, the alignment of competitive priorities and supply chain strategy supports Lamming et al. (2000) and Roh et al. (2008) where the functional-lean combination works in a stable market demand with competitive advantage focusing on low cost and high productivity. Companies are concerned about quality and provision of reliable services. The results in Malaysia provide empirical support that the criteria of organisations focusing on cost and quality, as summarised by Roh et al. (2008), includes standardisation, knowledge work/sharing, skill acquisition and development, continuous improvement and teamwork. Malaysian companies have been classified as a mixture of group and hierarchical culture due to the high levels of teamwork (Abdullah, 1992) and high power distance adoption (Hofstede, 1980), which respects the hierarchical status (Abdullah, 1992); while the UK has been classified as having adopted an individualistic culture (Hofstede, 1980). The results in Malaysia and the UK partially support the suggestion of Roh et al. (2008) that organisational culture influences the choice of SC strategy and method of doing business (Sheu et al.,2004). The findings further serve to support the theory that the patterns of organisational culture are not mutually exclusive and no organisation exists solely in one specific cultural pattern (Pheysey, 1993, Al-Khalifa and Aspinwall, 2001). Quinn and Cameron (1983, 2006) argue that organisational life cycle culture could change over time and influence the shift of organisational culture. In addition, factors such as language, management style (Sheu et al., 2004), economic development, political dominance, age of managers, technological breakthrough (Hofstede, 1980, Hofstede, 2001) and age of company (Cameron and Quinn, 2006) might also affect the shift of culture.

The 2x2 matrix analysis results for both the UK and Malaysia show that manufacturers who associate with functional-lean and innovative-agile combinations supported Roh et al. (2008). However, the results of the 3x3 matrix opposed Roh et al's theory. This provides an opportunity for future researchers to explore and add hybrid products to form a complete framework. Sun et al. (2009) found that an appropriate supply chain strategy has an impact on the performance of a company. Cagliano et al. (2004) investigated the impact of supply chain strategy on manufacturing performance. Delivery speed and reliability do not indicate an improvement in performance, but conformance (quality), volume, mix flexibility, lead time and cost do make a difference. Therefore, the findings provide further support for Cagliano et al. (2004), as in terms of cost and quality, supply chain performance does make a difference. However, conclusions cannot be drawn regarding the value of the competence index in cost and quality, as an innovative-lean combination scores the same competence value as a functional-lean combination.

Chapter 8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

This chapter presents the conclusions of the research, specifically addressing the following:

a) Conclusion
b) Contribution to knowledge
c) Limitations and recommendations for future research

The summary of results presents the major conclusions that can be drawn to answer the primary objective of the research. Contribution to knowledge explains the findings and generalises them into a broader context, thus increasing understanding of the research topic. Recommendations for future research are suggested in the final section.

8.2 Conclusion

This research began with an explanation of the motivation for undertaking research on the importance of supply chain alignment across supply chain tiers. The objective of this research is to focus on an empirical investigation of the alignment between product attributes and supply chain strategy, and to examine the linkage with customer satisfaction in the marketplace. In recent years, research has highlighted the benefits of adopting an holistic and integrated supply chain approach, including the concepts of downstream-to-upstream supply chain strategy development and performance measurement. However, despite the widespread attention and ubiquity of the supply chain alignment notion, there has been no empirical study of strategy alignment across multi-tier supply chains. Previous empirical studies have tended to focus either on a single general manufacturing company, or have regarded a supply chain as a single, homogeneous entity and have, therefore, provided a simplistic and partial view of the alignment of product nature and supply chain types. This study, however, has adopted a more holistic supply chain perspective and attempted to deduce supply chain product alignment implications for different supply chain tiers for companies operating in the food sectors in the UK and Malaysia.

A literature review is included to discuss the knowledge gap and potential improvements in the research area. The literature review traces the evolution of the supply chain definition that began with a narrow perspective focusing on purchasing departments. The importance of an holistic view of supply chains becomes clear when pressure from customers makes competition in the marketplace more challenging. One of the arguments in the literature relates to the importance of aligning supply chain strategy with market requirements to influence business performance. Fisher's (1997) theory proposed that in order to devise an effective supply chain strategy, it is important to understand the nature of demand for products. This theory was extensively explored with the addition of the hybrid concept proposed by Huang et al. (2002). A comprehensive review on product and supply chain attributes was undertaken to design a questionnaire and to identify the alignment of product-supply chain combinations as well as competitive priorities.

The chapter on methodology explains the measurement tools used to test the validity, reliability of the analysis, and analysis steps in order to answer the research questions. The results and findings are covered in three chapters that consist of general findings, alignments for the two-dimensional product-supply chain array and alignments for the three-dimensional product-supply chain array for both the UK and Malaysian food industries. Discussions then follow, comparing the major findings of this research with those of previous studies.

The results indicate that supply chains that possess lean characteristics uniformly across their tiers and emphasise price and quality generally support functional food products. This conforms with Fisher's (1997) theory. The findings also support Lamming et al. (2000), Mason-Jones et al. (2000(a)) and Mason-Jones et al. (2000(b)). However, agile supply chains do not uniformly support innovative food products. In general, innovative products were found to be supported by short, hybrid supply chains, where manufacturers have an efficient (analogous to functional) focus, while downstream partners have an agile focus. Delivery speed and delivery reliability were conspicuous competitive priorities for these products. In addition, the functional-lean relationship was commonly found in Malaysia, with relatively few product-supply chain mismatches. A far greater proportion of product-supply chain mismatches were found in the UK. The mismatched strategies of functional-agile, innovative-agile and hybrid-lean are found in the results, opposing the findings of Fisher (1997) and Huang et al. (2002).

This phenomenon could be due to several issues. First, the nature of market requirements in the food industry differs from other industries. Food products turned to be a commercial product rather than commodity products as power of retailer take place in the markets by producing their own brand to capture customer's demand.

Laaksonen and Reynolds (1994) and Binninger (2008) reported the same view. Second, attributes to classify market demands are still questionable and there may be other influential aspects to be taken into consideration. Third, the adoption of a postponement strategy in innovative products across the tiers results in a misalignment of product-supply chain strategy, especially in the upstream supply chain tiers. Fourth, the adoption of a hybrid strategy, rather than a single trade-off, nowadays influences industrial practices and changes over time.

8.3 Contribution to knowledge

The findings are relevant to both the theory and practice of supply chain management. The study contributes to knowledge in the following ways:

a) The study provides empirical evidence for Fisher's theory of the multi-tier supply chains that has not previously been covered by previous researchers; thus viewing the alignment from an holistic approach.

b) The study reveals that food supply chain common work in lean supply strategy and focusing cost and quality as suggested by Fisher (1997), Huang et al. (2002), Lee (2002), Mason-Jones et al. (2000 (a), (b)). Food supply chain also found work in mismatch strategy at agile supply chain with speed of delivery, delivery reliability, quality and product variety as their competitive priorities to win market demands.

c)

d) The study also reveals the adoption of a supply chain strategy and competitive priorities for the food industry have inter-relationship to each other. The competitive priorities focused are aligned with supply chain strategy adopted.

Therefore the strategic goals and objectives of company are inter-related with supply chain strategy and competitive priorities.

e) This study advocates the significant attributes that correlate with demand; pattern of demand, number of SKUs and forecast accuracy for product attributes while approach to choosing suppliers, inventory strategy and lead time for supply chain attributes. The study provides evidence that alignment between product type and supply chain strategy is not significant. The results suggest that aligning competitive priorities with a supply chain strategy is more appropriate than aligning competitive priorities with a product type.

f) The study also provides an empirical analysis of Huang et al.'s (2002) study of multi-tier supply chains and proves that hybrid products (as shown in Table 6.5 and 6.14 in page no 169 and 186 respectively) exist in the food industry. Innovative products adopt the postponement activity, which results in misalignment across the chain in the food industry (as shown in Figure 6.1 and 6.2 in page 172 and 189 respectively). The leagile supply chain cannot be assessed across the chain, as the supply chain is divided into only two types; either lean or agile, but products can be categorised into three types: functional, hybrid and innovative.

8.4 Limitations and future research

This research succeeds in achieving the aims and objectives; however, there are some limitations and areas for future research. Firstly, the research is limited to the food industry in the UK and Malaysia. The findings are not relevant to other industries as the nature of food demand is unlike other industries. Secondly, restriction of data resulting from a low response rate (8-11% response rate), especially from the distributors, wholesalers and retailers, has also contributed to the limitation of results. This research successfully investigated the adoption of a supply chain strategy in multi-tier supply chains. The number of responses for each product-supply chain combination, however, is limited due to the product types and also as a result of the supply chain strategy being divided into two and three types, in accordance with the theory of Fisher (1997) and Huang et al. (2002) respectively. Thirdly, the postal questionnaire is the cheapest way to obtain data; however, the truthful level of respondents' answers is limited (Saunders et al., 2003). Fourthly, the selection of product and supply chain attributes is limited and the results are valid to the sample of research. Finally, supply chain strategy adoption may be valid at one point in time, however, this may change in the future as competitive priorities and demand requirements are expected to be cyclic and change from time to time (Christopher and Towill, 2000).

In spite of its limitations, however, this research does attempt to both acquire empirical evidence and to investigate Fisher's, Lee's and Huang et al.'s studies of the food industry. The conclusion reached has been generalised for the food industries in the UK and Malaysia. There are, however, some areas for future research. Firstly, as different companies may have different strategies for winning orders, it is suggested that case studies are conducted in the future. Case studies are proposed to investigate in detail, and take into consideration, supply chain networks and different types of processes (Lambert and Cooper, 2000) for food companies. This methodology would facilitate deeper understanding of food companies, which cannot be acquired from the survey research. Secondly, supply chain strategy alignment could be explored, to include supply chain structure, operation strategy adopted, size of company, local or international based company, level of supply chain collaboration for each tier, information technology, perishability factor, end of season markdown; and a larger sample size for each product-supply chain strategy combination could be beneficial. Thirdly, product attributes for functional and innovative are well known in the literature; however, attributes for hybrid or intermediate products are limited. Fourthly, strategy alignment could be investigated in other industries and in other countries for comparative studies between group, rational, hierarchical, or developmental-oriented organisational culture, in order to understand fully the link between supply chain strategy and organisational culture, as suggested by Roh et al (2008). Fifthly, Mason-Jones et al. (2000(a), 2000(b)) and Roh et al. (2008) proposed competitive priorities for 2x2 matrix for supply chain strategy, however, there is no research covering competitive priorities for the hybrid strategy. Finally, as the supply chain strategy has a high potential for cyclical change, longitudinal research is recommended in the future, as the demand requirements are likely to change from time to time.

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Feb 2009

Dear Operations Manager/Supply Chain Manager,

I am undertaking some important research on behalf of the University of Liverpool and would very much appreciate 10 minutes of your valuable time to complete and return the attached questionnaire as soon as possible.

I am hoping the results of the research will provide UK food businesses with a view of their end-to-end supply chain challenges and levels of performance. All respondents will receive a summary of the results. All company identity is 'KEEP PRIVATE AND CONFIDENTIAL' in which no individual's response can be identified.

Once again, the questionnaire should only take a few minutes to complete. Please omit any questions you are unsure of.
Thank you very much for your assistance.

Yours sincerely

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p/s If possible, please forward this questionnaire to the Operations Department. Many thanks!

UNIVERSITY OF LIVERPOOL

SURVEY FOR FOOD MANUFACTURER

SECTION ONE: RESPONDENT DETAILS

Name	
Position	
Kindly attach business card Or Fill in details of business address in the blank space provided.	

SECTION TWO: BACKGROUND OF COMPANY

*Please **TICK** [√] your answer for each question.*

1. Type of goods produced

Meat	☐	Fruit and vegetables	☐	Dairy products	☐
Fish	☐	Vegetable, animal oils and fat	☐	Grain and starch products	☐
Beverages	☐	Others (please specify): [...]			☐

2. Number of employees at your location

0-4	☐	10-19	☐	50-99	☐	250-499	☐
5-9	☐	20-49	☐	100-249	☐	> 500	☐

3. Approximate annual turnover (£) in year 2007 at your location

<100 thousand (th)	☐	100 th-500 th	☐	500 th-1 Million (M)	☐
1M-5M	☐	5M-10M	☐	10M-20M	☐
20M-50M	☐	50M-100M	☐	100M-500M	☐
> 500M					☐

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SECTION THREE: CLASSIFICATION OF PRODUCT

*Please **TICK [√] ONE** only for the best explanation.*

1. Choose ONE PRODUCT in your company as a reference to answer the questions below.

Fish and fish products	☐	Meat/Poultry meat	☐	Fruit and vegetables	☐
Fruit and vegetable juice	☐	Potatoes	☐	Crude oils and fats	☐
Margarine and edible fats	☐	Refined oils and fats	☐	Butter or cheese	☐
Milk	☐	Ice cream	☐	Grain	☐
Starches and starch products	☐	Malt	☐	Cereals	☐
Bread	☐	Rusk or biscuits	☐	Cocoa, chocolate or candy sugar	☐
Sugar	☐	Macaroni, noodles, couscous or similar farinaceous products	☐	Condiments and seasonings	☐
Tea or coffee	☐	Alcoholic beverages	☐	Mineral waters or soft drinks	☐

2. How accurate is a typical forecast for this product?

Less than 10 %	☐	10-20%	☐	20-30 %	☐	30-40%	☐	40-50%	☐
50-60%	☐	60-70%	☐	70-80%	☐	80-90%	☐	90-100%	☐

3. What is the pattern of demand volatility for the product on a monthly basis?

Stable with minimal change	☐	Volatile but still predictable	☐	Erratic, highly changing, turbulent	☐

4. Number of Stock Keeping Units (SKUs) including pack variations for this product

< 10	☐	10-20	☐	20-40	☐	40-60	☐
60-80	☐	80-100	☐	>100			☐

5. Stage of product life cycle

Introduction	☐	Growth	☐	Mature	☐	Decline	☐

6. Total lead time (order receipt to delivery) at your location for this product

< 5 days	☐	1 week-2 weeks	☐	2 weeks-6 months	☐

7. Shelf life of this product

< 1 week	☐	1 - 4 weeks	☐	1 – 6 months	☐	> 6 months	☐

8. Product life cycle between 'new products'

3 - 6 months	☐	6 - 12 months	☐	1-2 years	☐	2 - 4 years	☐	> 4 years	☐

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SECTION FOUR: CATEGORISATION OF SUPPLY CHAIN

*Please **TICK [√]** the answer which **BEST** describes the supply chain characteristics in your company by referring to the product chosen in **SECTION THREE.***

1. Key aim to your supply chain

Focus on low cost	☐	Balanced focus between low cost and high service level, tries to achieve mass customisation by postponing product differentiation	☐	Focus on high service level and respond quickly to unpredictable demand in order to minimise stock outs	☐

2. Manufacturing focus

Maintain high average plant utilisation rate	☐	Balance asset utilisation and inventory quantity to deal with demand changes	☐	Ensure the constant raw materials availability to manufacture and utilise inventory to compensate for demand fluctuation	☐

3. Inventory strategy

High turns and minimises inventory as low as possible to avoid wastage and cost	☐	Keep intermediate stock to cover the demand fluctuation and minimise inventory of raw material	☐	Ensure the stock level of all types of inventory is significant to deal with erratic demand and tide over unpredictable market requirements	☐

4. Lead time focus

Shorten lead time without investment	☐	Invest moderately to reduce lead time	☐	Invest aggressively in ways to reduce lead times	☐

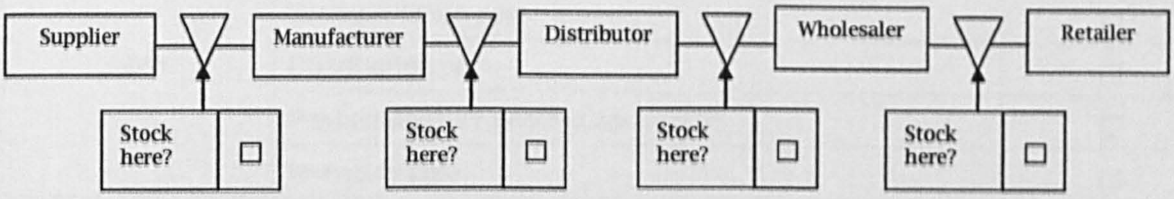
5. Approach to choosing suppliers

Primarily low cost and high quality	☐	Primarily low cost and high quality, but capability for speed and flexibility as and when required	☐	Primarily speed, flexibility and quality	☐

6. Which schematic diagram best describes your supply chain structure?

Supplier — Manufacturer — Distributor — Retailer	☐
Supplier — Manufacturer — Distributor — Wholesaler — Retailer	☐
Supplier — Manufacturer — Wholesaler — Retailer	☐
Supplier — Manufacturer — Retailer	☐

7. Where is the point at which strategic stock is held to reduce the risk of being out of stock for long periods? [where; ▽ = storage and warehouse]



8. What is the operation strategy used in your company? (TICK [√] only ONE)

Ship-to-Stock	☐	Make-to-Stock	☐	Assemble-to-Order	☐	Make-to-order	☐	Buy-to-Order	☐

SECTION FIVE: SUPPLY STRATEGY

1. What is your MAIN competitive priority to win orders from customers compared to your competitors?

*Rate the competitive priorities below by **CIRCLING** the level of their importance.*

WIN ORDERS		Level of Importance				
		Highly In-significant	In-significant	Fairly Significant	Significant	Highly Significant
		1	2	3	4	5
a	Offer low selling price	1	2	3	4	5
b	Offer quick delivery	1	2	3	4	5
c	Offer reliable delivery	1	2	3	4	5
d	Offer variety of product	1	2	3	4	5
e	Offer large order size flexibility	1	2	3	4	5
f	Offer superior volume flexibility	1	2	3	4	5
g	Offer superior product design	1	2	3	4	5
h	Offer superior manufacturing quality	1	2	3	4	5
i	Offer superior after sales support	1	2	3	4	5
j	Offer specific customer's requirements	1	2	3	4	5
k	Offer new product frequently	1	2	3	4	5
l	Offer superior brand image	1	2	3	4	5
m	Others (....................................)	1	2	3	4	5

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SECTION SIX: PERFORMANCE MEASURES

*Please **TICK [√]** your answer.*

1. Which of the following KPIs do you use?

Supply strategy	Key Performance Indicators (KPIs)	TICK [√]
COST	Total supply chain cost	☐
	Transportation cost	☐
	Distribution cost	☐
	Product delivery process costs (PDP)	☐
	Inventory cost	☐
CUSTOMER SERVICE (RESPONSIVENESS)	Stock out	☐
	Backorder	☐
	Inventory level	☐
	Throughput time	☐
	Delivery on-time	☐
	Late delivery	☐
	Lead time (Total order cycle time)	☐
	Volume flexibility (Demand variability)	☐
	Delivery flexibility	☐
	Forecast accuracy	☐
	Customer response time	☐
	Fill rate	☐
QUALITY	Customer complaint	☐

2. Which enabler/initiative is implemented in your company to improve the performance of your supply chain?

No	Enablers/Initiatives	TICK [√]
a	Electronic Data Interchange (EDI)	☐
b	Electronic Point-of-Sale (EPOS)	☐
c	Collaborative Planning, Forecasting and Replenishment (CPFR)	☐
d	Efficient Consumer Response (ECR)	☐
e	Quick Response (QR)	☐
f	Radio Frequency Identification Components (RFID)	☐
g	Barcode and Scanning System	☐

h	Enterprise Resources Planning (ERP)	Vendor Managed Inventory (VMI)		☐
		Purchasing Vendor Management		☐
		Purchase Order Management		☐
		Material Requirement Planning (MRP)		☐
		Manufacturing Resource Planning (MRPII)		☐
		Manufacturing Execution Systems (MES)		☐
		Capacity Requirement Planning		☐
		Advanced Planning and Scheduling (APS)		☐
		Product Data Management (PDM)		☐
		Product Lifecycle Management (PLM)		☐
		Inventory Management Systems		☐
		Transportation Management System	Transportation Planning Systems	☐
			Transportation Scheduling Systems	☐
		Warehouse Management Systems (WMS)		☐
		Shop-floor Execution Systems		☐
		Sales Order Management		☐
		Sales Force Automation (SFA)		☐
		Price Optimisation Software		☐
		Price Management Software		☐
		Category Management Software		☐
		Store Management Software		☐
		Multi-Channel Retailing		☐
		Customer Relationship Management (CRM)		☐
		Quality Management (QM)		☐
		Enterprise Asset Management (EAM)		☐
		Others (...)		☐
		Others (...)		☐
		Others (...)		☐
i	Others (please specify): (...)			☐

3. Number of direct suppliers to your company									
0 - 1	☐	2 - 5	☐	5 - 10	☐	10 - 20	☐	>20	☐

4. Organisational strategy for supplier system			
One supplier for one single part or component	☐	Multiple suppliers for a single part or component	☐

SECTION SEVEN: RESULT OF QUESTIONNAIRE			
*Please **TICK** [√] your answer.*			
1. Do you wish to receive the questionnaire results?			
Yes	☐	No	☐

~Thank you for your time

Section	Manufacture of food products and beverages	
15.1	Production, processing and preserving of meat and meat products	
	15.11	Production and preserving of meat
	15.12	Production and preserving of poultry meat
	15.13	Production of meat and poultry meat products
15.2	Processing and preserving of fish and fish products	
	15.20	Processing and preserving of fish and fish products
	15.20/1	Freezing of fish
	15.20/9	Other fish processing and preserving
15.3	Processing and preserving of fruit and vegetables	
	15.31	Processing and preserving of potatoes
	15.32	Manufacture of fruit and vegetable juice
	15.33	Processing and preserving of fruit and vegetables not elsewhere classified
15.4	Manufacture of vegetable and animal oils and fats	
	15.41	Manufacture of crude oils and fats
	15.42	Manufacture of refined oils and fats
	15.43	Manufacture of margarine and similar edible fats
15.5	Manufacture of dairy products	
	15.51	Operations of dairies and cheese making
	15.51/1	Liquid milk and cream production
	15.51/2	Butter and cheese production
	15.51/9	Manufacture of other milk products
	15.52	Manufacture of ice cream
15.6	Manufacture of grain mill products, starches and starch products	
	15.61	Manufacture of grain mill products
	15.61/1	Grain milling
	15.61/2	Manufacture of breakfast cereals-based foods
	15.62	Manufacture of starches and starch products
15.7	Manufacture of prepared animal feeds	
	15.71	Manufacture of prepared feeds for farm animals
	15.72	Manufacture of prepared pet foods

15.8	Manufacture of other foods	
	15.81	Manufacture of bread; manufacture of fresh pastry goods and cakes
	15.82	Manufacture of rusks and biscuits; manufacture of preserved pasty goods and cakes
	15.83	Manufacture of sugar
	15.84	Manufacture of cocoa, chocolate and sugar confectionery
	15.84/1	Manufacture of cocoa and chocolate confectionery
	15.84/2	Manufacture of sugar confectionery
	15.85	Manufacture of macaroni, noodles, couscous and similar farinaceous products
	15.86	Processing of tea and coffee
	15.86/1	Tea processing
	15.86/2	Production of coffee and coffee substitutes
	15.87	Manufacture of condiments and seasonings
	15.88	Manufacture of homogenised food preparations and dietetic food
	15.89	Manufacture of other food products not elsewhere classified
	15.89/1	Manufacture of soups
	15.89/9	Manufacture of other food products not elsewhere classified
15.9	Manufacture of beverages	
	15.91	Manufacture of distilled potable alcoholic beverages
	15.92	Production ethyl alcohol from fermented materials
	15.93	Manufacture of wines
	15.93/1	Manufacture of wine of fresh grapes and grape juice
	15.93/2	Manufacture of wine based on concentrated grape must
	15.94	Manufacture of cider and other fruit wines
	15.94/1	Manufacture of cider and perry
	15.94/9	Manufacture of other fermented fruit beverages
	15.95	Manufacture of other non-distilled fermented beverages
	15.96	Manufacture of beer
	15.97	Manufacture of malt
	15.98	Production of mineral waters and soft drinks
Section	Wholesale	
51.3	Wholesale of food, beverages and tobacco	
	51.31	Wholesale of fruit and vegetables
	51.32	Wholesale of meat and meat products
	51.33	Wholesale of dairy produce, eggs and edible oils and fats
	51.33/1	Wholesale of dairy produce
	51.33/2	Wholesale of edible oils and fats
	51.34	Wholesale of alcohol and other beverages
	51.34/1	Wholesale of fruit and vegetable juices, mineral waters and soft drinks
	51.34/2	Wholesale of wine, beer, spirits and other alcohol beverages
	51.35	Wholesale of tobacco products
	51.36	Wholesale of sugar and chocolate and sugar confectionery
	51.37	Wholesale of coffee, tea, cocoa and spices
	51.38	Wholesale of other food including fish, crustaceans and molluscs
	51.39	Non-specialised wholesale of food, beverages and tobacco
52.2	Retail sale of food, beverages and tobacco in specialised stores	
	52.21	Retail sale of fruit and vegetables
	52.22	Retail sale of meat and meat products
	52.23	Retail sale of fish, crustaceans and molluscs
	52.24	Retail sale of bread, cakes, flour confectionery and sugar confectionery
	52.25	Retail sale of alcohol and other beverages
	52.26	Retail sale of tobacco products
	52.27	Other retail sale of food, beverages and tobacco in specialised stores