Examining Supply Chain Quality Management in the Chinese Automobile Industry

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Abstract

The aim of this thesis is to understand what supply chain quality management (SCQM) is and to examine SCQM practices in the Chinese automobile industry by comparing the different SCQM implementation between Chinese Self-owned Brands (CSBs) and Joint Ventures (JVs). This thesis attempts to reveal and understand SCQM practices in order to provide new insights in dealing with quality issues along the supply chain. Hence, in this thesis three research questions (RQs) are explored and answered: RQ1) What are the main factors impacting on SCQM in the Chinese automobile industry? RQ2) What are the differences between CSBs and JVs in the field of SCQM? RQ3) Why do such differences occur?

A mixed research methodology was implemented to answer these three RQs. First, a case study in seven Chinese automobile companies was conducted. Resulting from this qualitative method, this research proposes a robust SCQM framework and generates SCQM measurements. SCQM is conceptualised as a multidimensional construct and the framework is composed of companywide quality management, supplier-side SCQM, customer-side SCQM, and performance. The measurement model evaluation, structural model evaluation, and multigroup analysis were conducted in sequence to investigate multi-dimensionality of SCQM, test the relationships among these dimensions, and clarify the different SCQM between CSBs and JVs. Variance-based structural equation modelling of Partial Least Square (PLS) on the platform of Smart-PLS 3.0 was used to analyse the 196 quantitative data that were collected from CSBs and JVs. Further, six follow-up interviews were then conducted to identify the root causes of the findings of the survey study.

This research finds that companywide quality management cannot directly influence operational performance due to the complexity of China's automobile supply chain. It illustrates that customer-side SCQM practices have the most significant influence on operational performance. This study also clarifies that ownership bears a critical impact on the relationship between customer-side SCQM practices and operational performance. It extends the SCQM literature by studying a large number of automobile companies in China and comparing the different supply chain level quality practices

between CSBs and JVs. It provides good breadth to the literature by answering the calls for ownership and emerging market research. This thesis also enhances the understanding of managers about the best SCQM practices to assist companies in moving from their current practices to their preferred one. It also illustrates significant directions for supply chain level quality system designs for automobile companies.

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List of Abbreviations

AFQ: All-For-Quality

AGV: Automated Guided Vehicle

ANPQP: Alliance New Product Quality Procedure

AT: Agency Theory

CAAM: Chinese Association of Automobile Manufacturer

CI: Customer Involvement

CRD: Customer Relationship Development

DMS: Dealership Management System

DSD: Dealer Support Department

DT: Defect Tracking

EM: Employee Management

ERP: Enterprise Resource Planning

FPQCS: Five Process Quality Control System

FTT: First Time Through

Inv: Inventory

IT: Information Technology

JIT: Just In Time

MIIS: Ministry of Industry and Information Technology

MIS: Management Information System

OM: Operations Management

P: Production

PD: Product Development

PM: Process Management

Prod: Productivity

QCC: Quality Control Circle

QCDDS: Quality Control Data Distribution System

QI: Quality Information

QIS: Quality Information System

QM: Quality Management

Qual: Quality

RBV: Resource-based View

R&D: Research and Development

RDT: Resource-dependency Theory

RO: Research Objective

RQ: Research Question

RV: Relational View

S: Sale

SC: Supply Chain

SCM: Supply Chain Management

SCQM: Supply Chain Quality Management

SD: Supplier Development

SQAS: Supplier Quality Assurance System

SQP: Strategic Quality Planning

SS: Supplier Selection

T: Training

TCE: Transaction Cost Economics

TCSD: Total Customer Service Department

TMC: Top Management Commitment

TPS: Toyota Production System

UF: Use of Feedback

Chapter One: Introduction

1.1. Chapter Introduction

This chapter aims to describe the background of the research, provide an overview of research gaps, propose the research questions, and clarify the research objectives. The theoretical focus and industrial focus are also identified. The chapter provides a clear picture of why the focus is on Supply Chain Quality Management (SCQM) and why the researcher is conducting the research in the Chinese automobile industry. This chapter also introduces the design of the research and describes the function of each phase of study. It then outlines the structure of the thesis by pointing out the content of each chapter. Finally, the chapter discusses the researcher's conference participation, paper submission, and dissemination of the research findings.

1.2. Research Background

The Supply Chain (SC) of the automobile industry is growing longer and more complicated because of the involvement of a vast number of components and the high degree of participation of suppliers and dealers in the business (Taylor and Taylor, 2008). The recently exposed quality scandal of FAW-VW, which recalled 563,605 Sagitar vehicles due to the broken trailing arm of the back-shaft, and the recall of 173,632 E-Class vehicles of Beijing Benz, in which the engine has a high risk of self-ignition (Sohu, 2015), have revealed that quality problems in the SC can create tremendous implications for customer confidence and brand identity in China. Moreover, the recall of 17,000 sports cars by Aston Martin caused by problematic accelerator pedals that were made in China (Cauchi, 2014), and practices such as those by JAC Motor, which used rusty steel plates to build car frame and chassis (Sina, 2013), exposed the poor quality control of Chinese automobile companies. Therefore, how to supervise the quality of components and automobile has become a significant topic in the automobile industry. However, because of the competitive SC environment at present, there is limited knowledge about how organisations design and apply their quality practices to reduce product recall.

Quality Management (QM) should be extended to the SC context because most products are designed, manufactured, and delivered through complex SC networks, with SC partners located in different geographical regions (Flynn and Flynn, 2005; Kaynak and Hartley, 2008). Therefore, instead of focusing only on their organisational quality management, organisations must extend their vision and efforts of quality improvement to the whole of the SC (Lin et al., 2005; Foster, 2008). As a result, QM has become more SC-oriented (Huo et al., 2014). Faced with this criticism, practitioners and scholars are paying much more attention to the importance of Supply Chain Quality Management (SCQM) in addressing issues that impact on automobile quality (Vanichchinchai and Igel, 2011). SCQM is "*a systems-based approach to performance improvement that leverages opportunities created by upstream and downstream linkages with suppliers and customers*" (Foster, 2008, p.461). Although scholars have recognised the importance of addressing quality issues and proposed SCQM concepts (Foster, 2008), limited empirical studies has been carried out from an SC viewpoint (Huo et al., 2014).

Since 2008, China has broken world records for automobile production and sales every year. According to data from the China Association of Automobile Manufacturers (CAAM, 2015), automobile production in China increased from 9.3 million in 2008 to 23.7 million in 2014. Besides the large amount of total production, China also has the most competitive automobile market in the world, which includes more than 100 brands and 300 models (twice and three times as many as the USA, respectively). These brands can be categorised into three groups: Chinese Self-Owned Brands (CSBs), Joint Venture Brands (JVs), and Imported Brands (IBs). CSBs are purely controlled by Chinese firms, which are either state owned enterprises (SOE) or private owned enterprises (POE). For instance, HongQi is a SOE brand and Haval is a POE brand. JVs are jointly established by Chinese firms and foreign companies, in which the foreign company cannot exceed 50% of the brand ownership. For instance, FAW-Volkswagen is a Chinese-German JV and Dongfeng-Citroën is a Chinese-French JV. IBs represent the cars that are assembled in foreign countries and which are then exported to China. Infinity and Jaguar are common examples on Chinese roads.

Moreover, the Initial Quality Study (IQS) of JD Power, which is determined by problems reported per 100 vehicles (with a lower number of problems representing

higher quality) based on customer feedback, indicates that there are 23 brands whose quality is above the mass market average level in China (JD Power, 2015). According to this study, the rating gap between CSBs and competitors has decreased from 145 problems reported per 100 vehicles in 2008 to 22 problems reported per 100 vehicles in 2015. Some of the CSBs models, such as the Chery 3, have also obtained five-star certification from the European New Car Assessment Programme. However, with the in-depth research of IQS, there are only four CSBs (i.e. Zoyte, Roewe, Haima, and Chery) exceeding the market average quality level compared to 15 JVs and four IBs. The number of four CSBs is an unsatisfactorily small number compared to the total brand quantity in the Chinese market. It shows that although CSBs are trying to reduce the number of defects and malfunctions, the extent of quality improvement is still lagging behind other competitors, especially the JVs.

1.3. Overview of the Research Gap and Research Questions

Although SCQM has gained attention in the academic arena, the research effort in theory construction of SCQM is nevertheless insufficient. In recent years, some related studies have discussed SCQM (Robinson and Malhotra, 2005; Foster, 2008; Kuei et al., 2011; Mellat-Parast, 2013; Zeng et al., 2013; Hu and Flynn; 2015). However, they aimed at identifying SCQM, citing the expected benefits in conducting SCQM, and proposing the implementation paths. Little empirical effort has been made to compare the different SCQM practices among organisations especially in emerging markets and to identify the causes of the differences. In summary, the research gaps are consolidated and presented as follows.

Firstly, *the studied SCQM practices and performance are incomplete* because the majority of previous research has focused on the company internally or upstream SC (Zeng et al., 2013). Secondly, compared to the SCQM study that focused on developed economies, there is a lack of SCQM studies that investigate emerging economies especially China, the role of which turn out to be extremely important in the global market (Foster, 2008). Moreover, for the studies that investigated the Chinese automobile industry, *no study has focused on SCQM from the perspective of CSBs*.

In order to fill these two gaps, this research aims to compare CSBs with JVs which have established manufacturing operations in China by analysing the SCQM practices and

performance that are generated from a specifically designed SCQM framework. Three Research Questions (RQs) are proposed and will be answered:

- RQ1: What are the main factors impacting on SCQM in the Chinese automobile industry?
- RQ2: What are the differences between CSBs and JVs in the field of SCQM?
- RQ3: Why do such differences occur?

The emergence of these RQs is discussed in detail in Section 2.6. This study strives to answer these three RQs in order to contribute to the knowledge in the area of SCQM. RQ1 aims to build a comprehensive SCQM framework and develop SCQM measurements that contain companywide QM, upstream and downstream SCQM. It also aims to investigate SCQM implementation in the Chinese automobile industry by testing the relationships between SCQM practices and performance; by doing so, RQ1 addresses the first literature gap. RQ2 aims to compare the SCQM implementation between different automobile companies' this addresses the second literature gap. RQ3 aims to identify the root causes of the findings of RQ2; it provides more information to address the second literature gap.

1.4. Research Objectives

In confronting the importance of the Chinese automobile market and gaps of the existing SCQM literature, this research aims to achieve three Research Objectives (ROs):

- RO1: To investigate the SCQM practices of the Chinese automobile market
- RO2: To clarify the different SCQM practices and performance between CSBs and JVs
- RO3: To identify the root causes of the differences

To achieve RO1, an SCQM framework and SCQM measurements should be developed. Then the characteristics of SCQM in the Chinese automobile industry can be identified by evaluating the importance of SCQM practices in influencing performance and testing the relationships among the SCQM practices. Hence, RO1 closely links to RQ1 and the first literature gap. To achieve RO2, a multigroup analysis should be conducted to identify the different relationships between SCQM practices and performance as well

as the different focuses on applying SCQM practices in CSBs and JVs. Thus, RO2 closely relates to RQ2 and the second literature gap. To achieve RO3, the findings generated from achieving RO2 (i.e. the different focus on SCQM) should be interpreted in detail by collecting more necessary data. RO3 closely links to RQ3 and the second literature gap.

1.5. Research Scope

Even though SCQM integrates several aspects of QM and Supply Chain Management (SCM), it doesn't focus on all the aspects of these two concepts. From the perspective of QM, SCQM specifically focuses on the everyday practised quality approaches that involve all employees but not on the technological innovation quality projects (Huo et al., 2014). Thus, Six Sigma and Quality Function Deployment of QM will not be considered in this study. From the perspective of SCM, Braziotis and Tannock (2011) categorized three groups of factors (i.e. contractual factors, enabling factors, and enhancing factors) for a highly collaborated supply chain. The automobile supply chain can also be regarded as highly collaborated due to the high participation degree of supplier and dealer (Womack et al., 2007). Therefore, based on Braziotis and Tannock (2011)'s categorization, the supplier side SCQM practices and customer side SCQM practices verify that SCQM focuses on contractual factors (i.e. who to cooperate) and enabling factors (i.e. how to cooperate). It doesn't focus on the enhancing factors that deal with the power issue in supply chains.

This research aims to investigate the focal manufactures (i.e. automobile companies) and their SC partners (i.e. component suppliers and customers) in the field of SCQM. Organisations operate and cooperate with its key suppliers and customers in supply chains which build a complex network of continuous relationships (Wang et al., 2011). Within the network, the whole system dynamics lead organisations to access and acquire partner's resources to develop shared knowledge and idiosyncratic capabilities (Wang et al., 2011). Instead of merely focusing on the product (i.e. automobile), this research also emphasises the relationship among automobile companies and SC partners. It aims to investigate how automobile companies coordinate the web of inter-firm relationships in this high complexity industry. Hence, the unit of analysis of this research is supply network (Braziotis et al., 2013). The dotted area in the following figure shows the unit of analysis of this research.

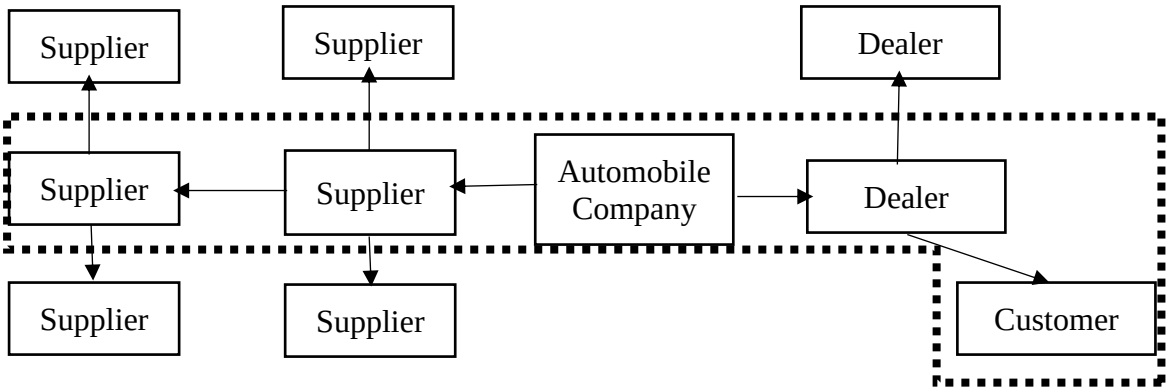


Figure 1.1: The Unit of Analysis

1.6. Theoretical Perspective

As a relatively new concept, the notion of SCQM can become clearer and richer if examined from a variety of important theoretical perspectives. In this research, the Resource-based View (RBV) and Relational View (RV) are adopted as the conceptual underpinning. RBV examines how certain assets and capabilities lay a foundation for competitive advantage and superior performance (Barney, 1991). The basic approach of the RBV is viewing the firm as a bundle of resources, and asserting that resource heterogeneity exists among firms (Ketchen and Hult, 2007). The resource includes materials, human, organisational resources, and skills that enable the creating of unique values. Also, resource must be difficult to imitate, and must be able to contribute to performance (Schroeder et al., 2002). In this research, each SCQM practice is treated as the resource that is simultaneously valuable, rare, imperfectly imitable and non-substitutable. RV indicated that a pair or networks of firms can develop relationships that result in sustained competitive advantages (Dyer and Singh, 1998). It assists the researcher to extend QM from a firm-level theory to the SC perspective. RV takes the inter-organisational level analysis and examines how cooperation among SC partners enables organisations to improve performance (Kanter, 1994; Paulraj et al., 2008). In this research, interactions between automobile companies and suppliers/customers are regarded as relational behaviours that drive performance.

Other theories, such as Agency Theory (AT), Transaction Cost Economics (TCE), and Resource-dependency Theory (RDT) are also frequently used in the field of Supply Chain Management (SCM) and Operations Management (OM) (Zu and Kaynak, 2012; Sarkis et al., 2011). However, compared to RBV and RV, they are not suitable to explain SCQM in this research. AT is concerned with agency relationships (Zu and

Kaynak, 2012). Two parties have an agency relationship when they cooperate and engage in an association wherein the principal delegates decisions and/or work to an agent to act on its behalf (Eisenhardt, 1989; Rungtusanatham et al., 2007). AT deals with the problems of different attitudes between the principal and the agent toward the same goal and risk-sharing (Eisenhardt, 1989; Zu and Kaynak, 2012). Thus, AT is not suitable to be adopted in this research. TCE focuses on the 'make or buy' decision - whether a firm should make a product within its organisational boundaries or purchase it - from an outside provider (Williamson, 1975). The primary goal is to maximise performance by minimising transaction costs intra/inter organisations (Ketchen and Hult, 2007). However, this research does not emphasise how to minimise the cost during SCQM implementation. Hence, TCE is not adopted to explain SCQM. RDT deals with formulation and management of power in inter-organisational relations (Ireland and Webb, 2007). Ulrich and Barney (1984) argued that organisational success from an RDT perspective is determined by organisations that maximise their power. This research does not investigate the power of SC members in SCQM implementation, but cooperation. Therefore, RDT is also not applied in this research.

1.7. Industrial Perspective

The automobile industry, which closely links diverse industry sectors to build the machine that changed the world, plays a significant role in economic development on earth (Womack et al., 2007). China is nursing the aspiration of building its own automobile brands and producing high quality cars. With the aid of the Soviet Union, the First Automobile Works (FAW) released the first Chinese automobile in 1956 (Lu et al., 2014). After this breakthrough, China spent 52 years to become the world's largest automobile market and maker in 2008 based on The Reform and Opening-up Policy and Foreign Direct Investment (Lu et al., 2014).

Even though the Chinese automobile industry has experienced rapid production and market growth, China is still not one of the world's foremost automobile powers (Lu et al., 2014). JVs, which are operated by foreign multi-national companies, are leading the Chinese automobile market. Due to the diverse choices in the market and the increasing income, Chinese customers can easily change from one CSB to a JV that has better quality and higher brand value. Thus, CSBs that break into the market through low prices and low quality are facing severe problems (Yang, 2014). According to CAAM

(2014), CSBs experienced the "10th consecutive decrease of monthly sales" from October 2013 to July 2014, which tremendously damaged the development of the brand identity. Currently, CSBs only occupy 31% of the Chinese automobile market (CAAM, 2015). However, the sales volume of JVs in China increased considerably from 2013. For instance, Nissan sold 1.27 million cars in China, an increase of 17.2% compared to 2012 (CAAM, 2014). Moreover, CSBs also suffered setbacks in upgrading their low-end models. Only 41% of Chinese customers expect CSBs to be ready with a premium car after 2020 and another 18% of Chinese customers even believe CSBs can only produce a premium car after 2030 (McKinsey, 2013). The low customer expectation directly causes unsatisfactory sales of existing CSBs' premium models. For example, BenTeng, one famous CSB, only sold 8,000 of its high-end B90 models in 2013 compared to Volkswagen, which sold 270,000 Sagitars (at the same price as the B90) in the same period (Sohu Auto, 2015). The same problem was also experienced by other CSBs, such as HongQi and LiFan. Furthermore, Chinese customers are becoming more sophisticated and assertive, and starting to rank quality, safety and brand (to show the owner's social status and business credibility) as the most important criteria when selecting a vehicle (McKinsey, 2013). However, the CSBs, which do not completely master the core technologies, cannot easily attract Chinese customers. Chinese customers regard quality as a given characteristic, and the brand that cannot meet their expectation (e.g. discover defects) will face sales decline. For instance, Great Wall Motor had only sold 4786 of its premium flagship model, the H8, 4 months after release (delayed for two years because of technical defects), which does not even match the monthly sales target (Sina, 2015).

1.8. Research Design

The research started with gaining a solid understanding and focus on the SCQM through systematic literature review and case study as shown in Figure 1.2. The aim of the literature review was to identify the important elements that contribute toward the key perspective, theories, and variables that may be important to be considered within the research domains. In the beginning of the second year of the PhD study, the "Phase One: Fact Finding Case Study" was carried out. Seven exploratory case studies were conducted to gain more practical understanding on the issues or elements that highly influenced the SCQM. The findings were consequently being used to develop an SCQM framework, generate SCQM measurements, and propose hypotheses. The second phase

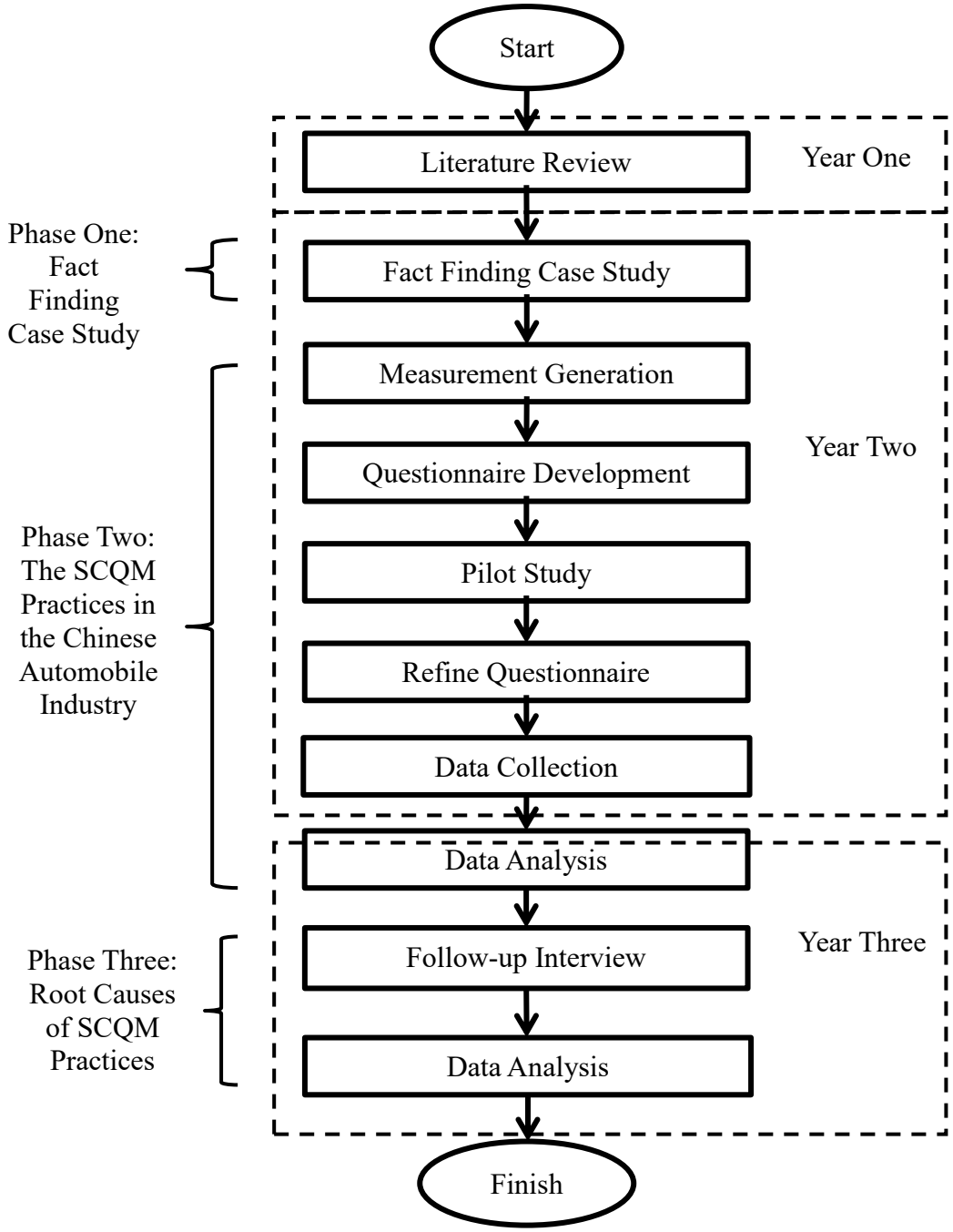


Figure 1.2: Research design

of study, namely "Phase Two: The SCQM Practices in the Chinese Automobile Industry", developed the SCQM structural model, generated the SCQM scales, and tested the generalisability of the study in the larger sample of the Chinese automobile industry. This phase applied survey research as the instrument. Structural Equation Modelling (SEM) was then used to analyse data with the aid of Smart-PLS 3.0 software to answer RQ1 and RQ2. The findings of RQ1 and RQ2 were treated as key input in developing tools in answering RQ3 in "Phase Three: Root Causes of SCQM Practices".

This phase collected data by conducting six follow-up interviews to clarify the root causes of the SCQM practices in the Chinese automobile industry. The research methodology is discussed in detail Chapter Three.

1.9. Thesis Structure

The remainder of this research is organised as follows. Chapter Two provides a systematic literature review of SCQM that leads to the justification for filling the research gaps. It discusses the formation, definition, and literature gaps in the SCQM domain. Chapter Three contains a description of various research methodologies and the corresponding epistemological and ontological assumption. A mixed research methodology is used to collect and analyse the primary data by conducting a three-phase-study. The chapter also discusses the design of case study, survey study, and follow-up interview. Chapter Four contains the "Phase One Study" that aims to gain a fundamental understanding of SCQM in the Chinese automobile industry by conducting a case study in seven major Chinese automobile companies. This chapter also assists in SCQM measurement generation and hypotheses building. Chapter Five contains the "Phase Two Study" that generates the SCQM measurements and builds the structural model. It then evaluates the measurement model and structural model by using the Partial Least Square (PLS) method. Chapter Six contains the "Phase Three Study" that interprets the findings of Chapter Five by conducting six follow-up interviews. Chapter Seven presents a summary of contributions, limitations, and conclusions. It also proposes future research directions based on the outcomes of this PhD research.

1.10. Conference Participation and Dissemination of Findings

Based on this PhD research, the researcher has generated five conference papers and presented the research at four prestigious international conferences. One of the conference papers obtained the "Best Paper Award" at the *10th International Conference on Operations and Supply Chain Management*. That award was granted to the researcher to commend the excellent research findings, outstanding theoretical and managerial contributions, and good presentation of the conference paper, which clarified the different SCQM implementation between CSBs and JVs and pointed out the development direction for CSBs. Moreover, based on the PhD research output, the researcher wrote two journal articles and submitted them to two leading journals. One

is an ABS 4* journal and the other is an ABS 3* journal. Both are under review at present.

1.11. Chapter Summary

This chapter started with recent quality problems in the Chinese automobile industry to introduce the necessity of investigating quality along the SC. It briefly identified that QM should be extended from the firm level to the whole SC in order to deal with the current challenges. This chapter also provided an overview of the two literature gaps in SCQM and linked them to the proposed three RQs. Moreover, these three RQs and the three ROs can be answered and achieved by carrying out the three-phase study that utilised a mixed research methodology. The theoretical perspective was also discussed in this chapter. The RBV and relational theory would underpin this research. Further, the industrial perspective - quality issues in the Chinese automobile industry - was discussed in detail. In addition, this chapter also designed the thesis structure by allocating the content of the following six chapters. Finally, the output of this research in terms of conference papers and journal articles was also described in Section 1.10.

Chapter Two: Literature Review

2.1. Chapter Introduction

This chapter aims to clarify the emerging process of SCQM, define SCQM, illuminate the content of SCQM, discuss the current SCQM research body, point out the research gaps, and propose research aims and questions by a systematic literature review. The method of selecting articles used in this chapter is documentary research using electronic databases and data reduction procedures to collect information about a specific phenomenon (Platt, 1981), in this case, SCQM. The researcher identified potentially relevant research through a structured search based on a combination of the keywords 'supply chain quality management', 'supply chain', 'quality', "supplier quality', 'upstream quality', 'upstream management', 'customer quality', 'downstream management', 'downstream quality', and 'internal quality' present in the document title and abstract of peer-reviewed scholarly journals in the ProQuest's ABI/INFORM global database. Moreover, the researcher reviewed SCQM related books to gain a more comprehensive understanding of this field.

An article had to fulfil three requirements to be included in the final sample. First, the article had to discuss SCQM explicitly. Second, the publication titles of articles were situated in the domain of operations management and management science. Third, the article was not based on a mathematical modelling or experiment research method. This study aimed to investigate the managerial practices of automobile companies in conducting SCQM, therefore, the articles mathematical modelling or experiment research that mainly focused on quality engineering, quality modelling, lot size, and game theory were not included in the literature review. For example, Das (2011) identified an approach to align with the suppliers to improve product quality and service. However, it focused on analysing the component price, the cost of monitoring quality per unit, inspection cost, and production capacity by conducting a mathematic modelling to find the optimised result. Even though this paper was chosen after the structured research, it was still be removed from the literature review. Hence, out of the 147 identified articles, 53 studies adopted an existing instrument. To ensure a high degree of comprehensiveness, the researcher performed a forward and backward search

of citations in articles, which were identified through the database searches. The researcher then analysed the selected studies by clarifying their methodologies, focus of research in terms of sample information, SCQM constructs, performance indicators, and research findings. Besides these 53 research papers, the researcher also reviewed books, such as Ross (1998), Lu et al. (2014), and Flynn and Zhao (2015), to assist in conducting the systematic literature review.

2.2. The Origin of SCQM

In order to continuously improve the position in the global market, nowadays companies must provide customers with products of high quality, competitive price, and maintain excellent safety standards (Hu and Flynn, 2015). Product recalls like the Takata airbag scandal that caused the biggest ever automobile recall in the world, covering up to 44 million vehicles, have revealed that component quality is becoming the most significant factor for ensuring the safety of automobiles that are produced by the global supply chain (Korosec, 2016). Product quality problems can have tremendous impacts on SC, and this risk is becoming more frequent in multi-layered and multi-location based SC. Providing superior quality products through the alignment and deployment of both QM and SCM could prevent this type of product recall (Kuei et al., 2011).

Quality performance and SC performance have been treated as trade-offs in the past, because companies could provide speedy delivery only through sacrificing quality (Chen and Yang, 2002; Flynn and Flynn, 2005). However, as the global market is continuously evolving, organisations are confronting more fluctuating and competitive environments (Mehra and Agrawal, 2003). Important changes in the business environment bring academics' and practitioners' focus to SCQM (Sila et al., 2006). According to one of the very first works that mentioned SCQM, Ross (1998) identified three factors causing the emphasis change. First, companies that have implemented TQM, which focuses on quality improvement within one company, have to expand their quality concerns to other SC partners to realise the full quality improvement potential. Second, companies start to serve a fluctuating market by offering value-added services. This requires better understanding of SCs and focus on service quality. Third, in order to take advantage of the market, companies start to expand their activities outside their organisations instead only focusing on internal logistic activities. Confronting these

business changes, dealing with traditional trade-offs is no longer an appropriate choice open to organisations; the threats from competitions and decline in markets have forced organisations to confront the changes in both SCM and QM, to enhance cumulative capabilities along business process, and to build a quality-driven SC (Madu and Kuei, 2004).

Dale et al. (2007, p.4) stated that "*quality originates from the Latin word quails which means such as the thing really is*". QM is a widely used and dynamic management philosophy (Kaynak and Hartley, 2008). It is an integrated approach at all levels and in all functions of an organisation, focusing on defect prevention, high quality output attainment and continuous improvements, in order to meet and exceed customer expectations (Flynn et al., 1994; Dale et al., 2007; Sadikoglu and Zehir, 2010; Calabrese and Corbò, 2015). QM develops from the inspection stage, bypassing the quality control stage and quality assurance stages, reaching the total quality management stage (Dale et al., 2007). From the perspective of QM, organisations need to focus on internal activities such as process control, product design improvement, and training to ensure product quality. It is a systematic approach that involves all the employees and works across all the departments (Dale et al., 2007).

However, due to the increasingly important roles of suppliers and customers, the QM concept should be expanded both backwards through suppliers and forwards through customers along with the whole SC (Deming, 1982; Zeng et al., 2014). QM focus should shift from an internal process orientation to externalisation that closely links to upstream and downstream partners (Foster et al., 2011). Many studies have also pointed out that supplier quality management and customer focus are essential components in QM (Kaynak and Hartley, 2008; Huo et al., 2014). These guide companies to treat their suppliers and customers as an extension of their business boundaries (Foster et al., 2011). Thus, traditional QM should extend to a SC perspective in order to utilise quality improvement and the SC partner relationship at the same time (Robinson and Malhotra, 2005). This updated QM can then produce competitive advantages for the SC through improving productivity, reducing process variance, shortening inventory, boosting profits, expanding market share, and enhancing customer satisfaction and profits (Tan et al., 1999; Flynn and Flynn, 2005; Sila et al., 2006).

The SC is "a set of three or more parties directly involved in the upstream and downstream flows of products, services, finances, and information from a source to a customer" (Mentzer et al., 2001, p.4). The close relationships among SC members are the foundations for efficient operation and value creation, thus gaining the benefits of cost reduction and competitive advantages for the whole SC (Holweg et al., 2005). SCM is implemented by organisations to handle cooperation among all the SC members (Christopher, 1992). In the past, it was only concerned with logistics (Gilmour, 1999); however, it has evolved to focus on the operational level functions as well as the strategic level decisions of internal and external partners (Cooper et al., 1997; Vanichchichai and Igel, 2011). Therefore, as clarified by Cooper et al. (1997), SCM is the coordination of key business processes, which provide products, services and information in order to add value for all the SC stakeholders. Moreover, Mentzer et al. (2001, p.18) regard SCM as "*the systemic and strategic integration of traditional business functions and the tactics across these business functions within a particular company and across businesses within the SC, for the purposes of improving the long-term performance of the individual companies and the SC as a whole*". The wide scope of SCM captures the synergy and cross-functional collaboration of intra/inter-management and integration in order to respond to customers at the right time and place, with the lowest cost (Potter et al., 2004).

From the perspective of SCM, the quality of a product depends on the quality of the raw material and component that build up the product (Batson and McGough, 2006). The product cannot satisfy the customer if it is composed of poor quality materials (Bowersox et al., 2002). SCM acts as an approach to improve competitive performance by integrating the internal departments of an organisation and linking them with the external suppliers and customers (Flynn and Flynn, 2005). SCM pays close attention to the relationship between the suppliers and customers and focuses on the performance of upstream and downstream members (Kanji and Wong, 1999; Sun and Ni, 2012). It results in better quality, faster product development, less cost, and shorter lead times (Forster et al., 2011). Nowadays SCs involve diverse departments and organisations, and each has its own priorities (Narayanan and Raman, 2004). Unifying the different goals of each SC partner causes an increased focus on cost reduction (Liker and Choi 2004). However, the fierce competition and the declining markets have required a change in SCM. SCM needs to move from the transaction perspective, which only

focuses on the cost of establishing and maintaining the relationships between the buyers and suppliers, to a broader perspective. For example, in nowadays suppliers should also provide input in the field of quality and design to their buyers (Wagner and Bode, 2014). Purchasing departments should move their emphasis from transactions to processes by joint quality planning (Batson and McGough, 2006).

Recognising and satisfying customer requirements are the drivers of SCM and QM (Flynn and Flynn, 2005). Both SCM and QM play important roles in achieving competitive advantages in order to enhance customer satisfaction and business performance (Sila et al., 2006; Vanichchichai and Igel, 2009). The integration of SC goals with quality goals helps the company to gain cumulative capabilities that further assist the company to confront the dynamics (Flynn and Flynn, 2005). Moreover, applying QM practices with all SC partners facilitates the synchronization across the whole SC (Ferdows et al., 2004). The competitive advantage that obtained from this integration is difficult to imitate (Flynn and Flynn, 2005). For example, maintaining and sustaining quality efforts in supplier selection and process management can significantly reduce cost (Forker et al., 1996), shorten the incoming inspection time (Heiko, 1990), eliminate reworks as well as transportation times (Flynn and Flynn, 2005), and proactively meet customer demands (Sila et al., 2006).

To gain synergies through integrating all the internal and external parties (i.e. implementing the same quality control standard in both focal company and its supplier), SCQM has emerged as a new management concept involving both QM and SCM (Sila et al., 2006). Foster (2008, p.461) regarded SCQM as a "systems-based approach" of continuous improvement through the cooperation of all SC members. It aims to add value for the whole SC through satisfying all the SC stakeholders (Robinson and Malhotra, 2005; Lin et al., 2005; Foster, 2008; Kuei et al., 2008). SCQM is a new management philosophy with a horizontal perspective, in which each party contributes to the others' improvement and result in better business performance (Flynn and Flynn, 2005). It designs a systematic blueprint of an SC-level quality plan (Kuei et al., 2011). It integrates upstream and downstream continuous improvement processes and expands QM from an internal focus to external integration of all SC members (Sun and Ni, 2012). Meanwhile, it is also an extension of SCM through its enhancement of SC competencies, by implementing QM practices for each party in the whole SC (Kuei et al., 2008). Thus,

it creates a culture of a supply chain quality (SCQ) community that differs from both QM and SCM (Kuei et al., 2011). Purchasing and logistics managers should adopt a quality-driven mind-set and operations managers should spend more time on emphasising suppliers and customers (Foster et al., 2011). However, more research is needed as this newly merged philosophy is still far from complete (Flynn and Flynn, 2005). For instance, quality practices need to be adopted even further from a traditional firm-centric perspective to an inter-organisational SC orientation involving suppliers as well as customers (Robinson and Malhotra, 2005).

2.3. Definition of SCQM

The body of research on SCQM has grown significantly over recent years. Authors have typically defined SCQM following a process, strategy, knowledge, and SC integration focus (Ross, 1998; Kuei and Madu, 2001; Robinson and Malhotra, 2005; Foster, 2008; Mellat-Parast, 2013; Hu et al., 2015). Table 2.1 summarises those proposed SCQM definitions and lists the papers that cited the corresponding definitions. Among these definitions, Robinson and Malhotra (2005) is the best recognised in this domain.

Ross (1998) was one of the first to provide a definition of SCQM, recognising it as the last stage of quality improvement. He emphasised the importance of quality improvement along the SC and defined SCQM as follows: "*the participation of all members of a supply channel network in the continuous and synchronised improvement of all processes, products, services, and work cultures focused on generating sources of productivity and competitive differentiation through the active promotion of market-winning product and service solutions that provide total customer value and satisfaction*" (Ross, 1988, p.237). Robinson and Malhotra (2005) then expanded this definition by emphasising the business process. They argued that based on all SC participants' efforts, SCQM is the integration of business processes to measure, analyse, and continually improve product, service, and process. Their explanation is perhaps one of the most well-known definitions of SCQM in the literature. They noted that the process of cooperating with external partners requires significant concerns in the fields of leadership, communication and partnership, quality and SC practices, and integration related strategy and management. The internal integration focuses developing structures and guidelines that generate environments for implementing quality strategy

and management (Robinson and Malhotra, 2005). Similarly, Kuei et al. (2008) also highlighted the process-centric nature of SCQM. They clarified that SCQM, which designs quality into SCs, optimises the materials flow, stabilises SC-level quality systems, and maximises the seamless data sharing, is an effective approach to the new business pressures (e.g. outsourcing, SC relationships).

Moreover, SCQM is also a strategic philosophy that aims to satisfy customers by utilising the close SC upstream and downstream relationships (Foster, 2008). As defined by Foster (2008), SCQM is a systems-based theory which aims to improve performance by utilising the opportunities created by cooperating with suppliers and customers. The strategic collaboration with all the SC partners is one of the critical success factors of SCQM implementation (Foster, 2008). Furthermore, Mellat-Parast (2013) treated SCQM as a cooperative learning process that aims to achieve continuous improvement. He emphasised the inter-organisational learning and defined SCQM as: "*the coordination and integration of inter-firm processes involving all partners (firms) in the supply chain through continuous improvement of inter-organisational processes to enhance performance and achieve customer satisfaction through emphasis on cooperative learning*" (Mellat-Parast, 2013, p.515). In addition, SCQM also emphasises SC integration to jointly manage intra and inter organisational quality-related issues. Similarly, Hu et al. (2015) defined SCQM as a comprehensive management system to improve quality in an SC by focusing on the strategic design of supply chain quality, internal quality integration, and upstream and downstream quality integration.

Table 2.1 summarises the characteristics of SCQM proposed by the literature. It shows that process, strategy, and SC integration are the most significant characteristics of SCQM. Knowledge focus is barely discussed in the SCQM literature. Therefore, based on these critical characteristics, SCQM is defined as follows in this study:

> *A SC-wide approach that systematically utilises cooperation to analyse, stabilise, and continually improve the quality of the processes and offerings (products and/or services) to satisfy internal and external customers.*

Table 2.1: Characteristics of SCQM

Authors	Definition	Characteristics				Definition cited by
		P	S	K	SCI	
Ross (1998)	As the participation of all members of a supply channel network in the continuous and synchronised improvement of all processes, products, services, and work cultures focused on generating sources of productivity and competitive differentiation through the active promotion of market- winning product and service solutions that provide total customer value and satisfaction.	√	×	×	×	Sila et al. (2006); Vanichchinchai and Igel (2009); Mellat-Parast (2013); Zeng et al. (2013)
Kuei and Madu (2001)	SC: a production-distribution network; Q: achieving customer satisfaction rapidly and profitably; M: enabling conditions and enhancing trust for supply chain quality	√	√	×	×	Kuei et al. (2008,2011); Quang (2016)
Robinson and Malhotra (2005)	The formal coordination and integration of business processes involving all partner organizations in the supply channel to measure, analyse and continually improve products, services, and processes in order to create value and achieve satisfaction of intermediate and final customers in the marketplace.	√	×	×	√	Kuei et al. (2008,2011); Soltani et al. (2011); Terziovski and Hermel (2011); Zu and Kaynak (2012); Lin et al. (2013); Mellat-Parast (2013); Zeng et al. (2013); Huo et al. (2014,2015); Quang (2016)
Foster (2008)	A systems-based approach to performance improvement that leverages opportunities created by upstream and downstream linkages with suppliers and customers.	√	√	×	√	Foster et al. (2011); Li et al. (2011); Soltani et al. (2011); Diaye et al. (2014)
Mellat-Parast (2013)	The coordination and integration of inter-firm processes involving all partners in the supply chain through continuous improvement of inter-organizational processes to enhance performance and achieve customer satisfaction through emphasis on cooperative learning.	√	×	√	√	-
Hu et al. (2015)	A holistic management system to improve quality in a supply chain, which includes supply chain leadership for quality, strategic supply chain design for quality, upstream quality management system, downstream quality management system, internal quality integration, and product recall strategy.	√	√	×	√	Hu and Flynn (2015)

(√: Include the characteristic; ×: Exclude the characteristic; P: Process; S: Strategy; K: Knowledge; SCI: supply chain integration

2.4.The Contents of SCQM

Based on the proposed SCQM definition, SCQM requires simultaneous integration of internal practices, upstream supplier quality performance and downstream customer requirements. To realise the full potential of SCQM, organisations need to emphasise on internal and external cooperation processes (Flynn and Flynn, 2005; Lin et al., 2005; Robinson and Malhotra, 2005; Foster, 2008; Kaynak and Hartley, 2008; Kuei et al., 2011; Huo et al., 2014; Hu et al., 2015). Hence, in this study SCQM is conceptualised into four elements: companywide QM, supplier-side SCQM, customer-side SCQM, and performance. By systematically reviewing the SCQM-related literature, Table 2.2 summarises the most frequently investigated SCQM practices in the literature.

2.4.1. Companywide QM

Companywide QM refers to quality-related activities within an organisation's boundaries. It is the effort of a company to facilitate improvement in quality through the cooperation among its own departments and staff (Kaynak and Hartley, 2008; Zeng et al., 2013; Hu et al., 2015). The organisation needs to manage its strategies, practices, and procedures across various internal departments and hierarchies into synchronised and collaborative processes, with the goal of satisfying the quality requirements of final customers (Flynn et al., 2010; Stank et al., 2001). Table 2.2 categorises the eight most frequently used companywide QM practices. They aim to improve quality through enhancing cooperation among every department within the company.

Top management commitment lays the foundation for quality commitment to the entire SC and impels SCQM by creating goals and systems that aim to improve performance and satisfy customers (Kaynak and Hartley, 2008; Zu et al., 2011; Hu and Flynn, 2015; Quang et al., 2016). Strategic quality planning highlights the extent to which the organisation has a comprehensive and structured plan regarding short-term and long-term quality goals (Zeng et al., 2013; Hu and Flynn, 2015; Zhao et al., 2015). Employee management practice indicates whether the company motivates and empowers all the staff to participate in quality-related activities (Kuei et al., 2008; Terziovski and Hermel, 2011; Zhao et al., 2015). Process management refers to the way that the company implements Statistical Process Control (SPC) software and other quality techniques to supervise and optimise the manufacturing process (Robinson and Malhotra, 2005; Han et al., 2011; Hietschold et al., 2014; Zhuang et al., 2015). It emphasises the standardised

Table 2.2: The most frequently investigated SCQM elements

SCQM element	SCQM Practice	Reference
Companywide QM	Top Management Commitment to Quality	Kuei et al. (2001,2002); Romano (2002); Bandyopadhyay and Sprague (2003); Fynes et al. (2005); Lin et al. (2005); Robinson and Malhotra (2005); Vanichchinchai, and Igel (2009); Han et al. (2011); Terziovski and Hermel (2011); Vanichchinchai and Igel (2011); Jraisat and Sawalha (2013); Zeng et al. (2013); Dellana and Kros (2014); Diaye et al. (2014); Ford (2015); Hu et al. (2015); Hu and Flynn (2015); Quang et al. (2016)
	Strategic quality planning	Kuei et al. (2001,2002); Romano (2002); Flynn and Flynn (2005); Lin et al. (2005); Robinson and Malhotra (2005); Batson and McGough (2006); Yeung (2008); Vanichchinchai, and Igel (2009); Han et al. (2011); Li et al. (2011); Terziovski and Hermel (2011); Vanichchinchai and Igel (2011); Zeng et al. (2013); Ford (2015); Hu et al. (2015); Hu and Flynn (2015); Zhao et al. (2015)
	Employee management	Kuei et al. (2001,2002); Romano (2002); Flynn and Flynn (2005); Lin et al. (2005); Lo et al. (2007); Vanichchinchai, and Igel (2009); Terziovski and Hermel (2011); Vanichchinchai and Igel (2011); Zeng et al. (2013); Diaye et al. (2014); Huo et al. (2014, 2015); Ford (2015); Hu et al. (2015); Hu and Flynn (2015); Quang et al. (2016)
	Process management	Kuei et al. (2001,2002); Romano (2002); Flynn and Flynn (2005); Bandyopadhyay and Sprague (2003); Lin et al. (2005); Robinson and Malhotra (2005); Lo et al. (2007); Vanichchinchai, and Igel (2009); Han et al. (2011); Li et al. (2011); Terziovski and Hermel (2011); Zeng et al. (2013); Dellana and Kros (2014); Diaye et al. (2014); Ford (2015); Hu et al. (2015); Hu and Flynn (2015); Zhuang et al. (2015); Quang et al. (2016)
	Quality training	Kuei et al. (2001,2002); Romano (2002); Lin et al. (2005); Yeung (2008); Vanichchinchai, and Igel (2009); Jraisat and Sawalha (2013); Diaye et al. (2014)
	Product development	Kuei et al. (2001,2002); Romano (2002);Bandyopadhyay and Sprague (2003); Lin et al. (2005); Batson and McGough (2006); Vanichchinchai, and Igel (2009); Zeng et al. (2013); Quang et al. (2016)
	Quality information	Kuei et al. (2001,2002); Romano (2002); Bandyopadhyay and Sprague (2003); Flynn and Flynn (2005); Lin et al. (2005); Fynes et al. (2005); Robinson and Malhotra (2005); Vanichchinchai, and Igel (2009); Vanichchinchai and Igel (2011); Xu (2011); Diaye et al. (2014); Ford (2015); Quang et al. (2016)
	Defect tracking	Li et al. (2011); Zhang et al. (2011); Hu et al. (2015); Hu and Flynn (2015); Zhao et al. (2015)
	Supplier	Kuei et al. (2001,2002); Bandyopadhyay and Sprague (2003); Lin et al. (2005); Lo and Yeung

Supplier-side SCQM	Selection	(2006); Kannan and Tan (2007); Lo et al. (2007); Yeung (2008); Vanichchinchai, and Igel (2009); Bayo-Moriones et al. (2011); Han et al. (2011); Li et al. (2011); Jayaram et al. (2011); Zu and Kaynak (2012); Zeng et al. (2013); Dellana and Kros (2014); Diaye et al. (2014); Huo et al. (2014, 2015); Hu et al. (2015); Hu and Flynn (2015); Zhao et al. (2015); Quang et al. (2016)
	Supplier Cooperation	Kuei et al. (2001,2002,2005); Flynn and Flynn (2005); Lin et al. (2005); Lo and Yeung (2006); Sila et al (2006); Lo et al. (2007); Yeung (2008); Bayo-Moriones et al. (2011); Zu and Kaynak (2012); Zeng et al. (2013); Dellana and Kros (2014); Huo et al. (2014, 2015); Hu et al. (2015); Hu and Flynn (2015); Quang et al. (2016)
	Supplier Development	Romano (2002); Lo and Yeung (2006); Sila et al (2006); Lo et al. (2007); Bayo-Moriones et al. (2011); Han et al. (2011); Jayaram et al. (2011); Zu and Kaynak (2012); Zeng et al. (2013); Dellana and Kros (2014); Diaye et al. (2014); Huo et al. (2014, 2015); Hu et al. (2015); Hu and Flynn (2015)
Customer-side SCQM	Use of Feedback	Flynn and Flynn (2005); Kannan and Tan (2007); Lo et al. (2007); Terziovski and Hermel (2011); Jayaram et al. (2011); Zeng et al. (2013); Dellana and Kros (2014); Huo et al. (2014, 2015); Ford (2015); Zhuang et al. (2015); Quang et al. (2016)
	Customer Involvement	Sila et al (2006); Han et al. (2011); Jayaram et al. (2011); Zeng et al. (2013); Dellana and Kros (2014); Huo et al. (2014, 2015); Hu et al. (2015); Hu and Flynn (2015); Quang et al. (2016)
	Customer Relationship Development	Kuei et al. (2001,2002); Romano (2002); Sila et al (2006); Hu et al. (2015); Hu and Flynn (2015); Quang et al. (2016)
Performance	Operational performance	Kuei et al. (2001); Romano (2002); Casadesus and de Castro (2005); Kuei et al. (2005); Lin et al. (2005); Robinson and Malhotra (2005); Sila et al. (2006); Kanan and Tan (2007); Kaynak and Hartley (2008); Li et al. (2011); Vanichchinchai and Igel (2011); Soltani et al. (2011); Jraisat and Sawalha (2013); Hu et al. (2015)
	Financial performance	Kuei et al. (2001); Casadesus and de Castro (2005); Lin et al. (2005); Robinson and Malhotra (2005); Kaynak and Hartley (2008); Yeung (2008); Li et al. (2011); Jraisat and Sawalha (2013); Zhuang et al. (2015)

working procedure to guarantee the reliability of production (Kaynak and Hartley, 2008; Quang et al., 2016). Training aims to enhance employees' problem-solving ability, encourages employees to participate in quality programmes, and achieves better employee performance through improving employees' quality knowledge and related skills (Jraisat and Sawalha, 2013; Diaye et al., 2014). Product development practices incorporate design opinions of all related departments and implement standardised design procedures to improve product development performance (Batson and McGough, 2006; Kaynak and Hartley, 2008; Zeng et al., 2013). Quality information practices are the way that the company systematically records the quality data and diffuses timely data to all employees (Vanichichichai and Igel, 2011; Xu, 2011; Ford, 2015). Defect tracking practices represent the way of dealing with the deficiencies in the company (Li et al., 2011; Hu and Flynn, 2015). They serve as recovery measures and feedback mechanisms that provide the foundation for quality improvement (Zhang et al., 2011; Hu et al., 2015; Hu and Flynn, 2015; Zhao et al., 2015).

The successful implementation of companywide QM needs the decomposition of internal departments and consistency of purposes among different functions. It is important as the foundation and the starting point to conduct SCQM (Huo et al., 2014; Hu et al., 2015). A lack of internal integration may cause chaos between different functions, leading to low-quality products, pointless efforts, and wasted resources (Huo et al., 2014). It seems that companywide QM should be simple compared with external SCQM (Hu et al., 2015). However, due to the various objectives and trade-offs of an organisations' departments, the implementation of companywide QM can be very difficult. For example, the manufacturing department focuses on the speed, time, and cost of providing products. The priorities of the manufacturing department are maximizing production, minimizing variability, and standardizing the product. However, the sales department emphasises providing customised offerings to satisfy customers. The priority of the sales department is satisfying customers by quickly responding to customers' requirements, which may need the organisation to prepare more inventories and become more flexible. Hence, the objectives and priorities of some functions of organisations are in sharp contrast. In order to deal with this kind of trade-off, the practices of companywide QM mainly consist of quality-related teamwork (e.g., a cross-functional team and a problem-solving group) and working together.

It is significant that an organisation should first become effective in crossing its internal boundaries (Fawcett and Magnan, 2002; Hu et al., 2015). An organisation with a successful companywide QM is able to achieve internal quality integration that develops common policies and practices across all of its departments (Hu et al., 2015). Effective companywide QM can integrate the departments with contrast priorities, thus building the foundation for cooperating with external SC partners, including both suppliers and customers (Huo et al., 2014). This means that although companywide QM takes place within the company, it is not isolated from the external parties. The external uncertainties and linkages with external SC members should be internally absorbed in the organisation's internal structure (Flynn and Flynn, 2005; Lin et al., 2013; Hu et al., 2015). Thus, only if the companywide QM has been successfully implemented will the company recognise the potential to enhance all of its capabilities through facilitating the resources (Barney and Clark, 2007; Hu et al., 2015).

2.4.2. Supplier-side SCQM

The focus of quality has shifted from the traditional company-centred setting to the whole SC. Traditionally, organisations focused on company-centred issues such as price, product quality, and delivery time. In the modern SCQM paradigm, supplier relationships and jointly making quality products have been regarded as the critical issues (Lin et al., 2005; Lin et al., 2013). Hence, the supplier-side SCQM represents the integration and cooperation between an organisation and its suppliers to enhance performance. Table 2.2 summarises the three most frequently studied supplier-side SCQM practices: supplier selection, supplier cooperation, and supplier development.

The quality of the final products is critically influenced by the raw materials that provided by suppliers (Sila et al., 2006). Organisations therefore need to select and evaluate the suppliers' quality performance very carefully. Hence, the requirement of registering quality certifications, such as ISO 9000 and TS16949, becomes a critical element of supplier-side SCQM as it provides an instrument for a supplier to document its quality system. Suppliers' quality certifications decrease suppliers' opportunistic behaviour and lower the risk of any recalls of the components, leading to building an environment for manufacturing high-quality products. Without ensuring the quality level of suppliers' components or services, activities like involving suppliers in product development will create problems (Noshad and Awasthi, 2015).

However, quality certifications can demonstrate the existence of quality systems but cannot guarantee the suppliers' high-level quality performance. From the perspective of dynamic organisational capabilities, a close relationship and interaction with suppliers may assist an organisation in achieving better flexibility, product design processes, and quality performance (Lo and Yeung, 2006; Kaynak and Hartley, 2008; Huo et al., 2014). Interactions between organisations and suppliers enhance quality among SC members. Hence, integration and collaboration with suppliers is a key SCQM practice (Flynn and Flynn, 2005; Lin et al., 2005; Robinson and Malhotra, 2005; Lo and Yeung, 2006; Foster, 2008; Sroufe and Curkovic, 2008; Prajogo et al., 2012; Zeng et al., 2013; Huo et al., 2014; Hu et al., 2015). Suppliers' involvement in an organisation's strategic quality planning, product development, and quality improvement programme assists the organisation in improving quality-related performance directly by reducing supply risks in the SC and enhancing suppliers' understanding of quality requirements (Fynes et al., 2005; Huo et al., 2014). For example, the collaboration between organisations and suppliers can facilitate suppliers' quality improvement, reduce costs, and enhance components and service quality in terms of the suppliers' performance in serving the organisation (Huo et al., 2014). The improved quality of components and services can in turn positively impact on eliminating variability in organisations' manufacturing (Kaynak and Hartey, 2008; Kuei et al., 2011; Hu et al., 2015).

Furthermore, successful supplier-buyer relationships encourage suppliers to participate earlier in organisations' strategic quality planning, product development, and quality improvement and to offer suggestions (Huo et al., 2014). The solid and long-term relationship with suppliers is the foundation for suppliers' participation in organisations' quality improvement (Sroufe and Curkovic, 2008; Foster, 2008). This can enhance organisations' confidence in suppliers, which leads to less inspections and more cooperation (Wisner and Tan, 2000; Heikkila, 2002; Chen and Paulraj, 2004; Prajogo et al., 2012). Hence, organisations do not simply select suppliers but also build long-term strategic relationships with them (Flynn et al., 2010; Lambrechts et al., 2010; Zeng et al., 2013; Huo et al., 2014). Frequent communications, integrated software, and site visiting are applied by organisations to establish and maintain relationship with suppliers (Shrimali, 2010, Shokri et al., 2010; Noshad and Awasthi, 2015). In this regard, organisations move from an arm's-length relationship to a collaborative

relationship with suppliers. This strengthens the relationships with suppliers by extending it to the strategic level (Prajogo et al., 2012). This in turn ensures that suppliers can provide quality products and services, thus maintaining the mutually beneficial relationships with suppliers (Chen and Paulraj, 2004). Thus, organisations can potentially improve quality, the manufacturing process, and reduce total costs by conducting supplier-side SCQM.

2.4.3. Customer-side SCQM

Customer-side SCQM aims to improve performance by emphasising customers and the cooperating practices with customers. It is a dynamic organisational capability that aims to enhance organisational performance (Huo et al., 2014, 2015). In an effective SC network, all members sustain and share a customer-driven culture, offering the right product in the right place, at the right time and at the right price (Flynn and Flynn, 2005; Zeng et al., 2013). Table 2.2 lists the three most frequently studied customer-side SCQM practices: use of feedback, customer involvement, and customer relationship development.

With a good understanding of customer expectations, organisations can provide quality products and better delivery service to customers in a cost-efficient way (Huo et al., 2014, 2015). Customer feedback permits adjustments to the process to be made immediately, rather than continuing production of unacceptable products. It enables timely corrective action to be applied to the process, product, or service and thus enhancing the conformity (Kannan and Tan, 2007; Kaynak and Hartley, 2008; Terzioviski and Hermel, 2011; Vanichichichai and Igel, 2011). Organisations that test and evaluate products and services from the customers' perspective by reviewing customer feedback always obtain better quality performance (Huo et al., 2014, 2015). Hence, customers are the critical source of information on quality and product design, thus providing a chance for learning in SCs.

In order to effectively learn from customers, customers should be closely involved and provide input in the product design and development process, so that the probability of quality problems would be reduced once full production begins (Lin et al., 2005; Han et al., 2011; Jayaram et al., 2011; Zeng et al., 2013; Huo et al., 2014, 2015). Hence, the customer involvement in the product design phase was a key factor in quality

performance. These customer involvement and cooperation practices satisfy customer's expectation in a controlled and systematic approach.

Furthermore, one of the keys to SCQM is maintaining a close relationship with the customer, in order to fully determine the customer's needs, as well as to receive feedback on the extent to which those needs are being met (Flynn and Flynn, 2005). An environment of mutual trust and support between the organisation and its customers facilitates this interaction (Huo et al., 2014, 2015; Hu and Flynn, 2015; Hu et al., 2015). A long-term cooperative relationship can be achieved through conducting systematically interacting activities with customers (i.e. Customer Conference, Company Open Day) (Vanichichichai and Igel, 2011; Zeng et al., 2013; Huo et al., 2014, 2015). These customer relation practices can then enhance the organisational performance. The ISO9000 also pointed out the significance of customer-side SCQM by indicating that organisations should recognise, meet, and strive to exceed customers' current and future needs (Sroufe and Curkovic, 2008). Hence, downstream SCQM practices with customers can positively improve the operational performance of an organisation (Rungtusanatham et al., 2003; Jayaram et al., 2011; Zeng et al., 2013; Huo et al., 2014, 2015).

2.4.4. SCQM Contents and Performance

Recent research has resulted in the accumulation of knowledge about the influences of SCQM on performance. The most frequently investigated performance contains two groups of indicators, namely operational performance and financial performance. The first group is operational performance. It illustrates the effectiveness of the operation strategy for the organisation (Slack and Lewis, 2015). There are several operational performance indicators that are frequently studied in the literature. The first one is quality. For example, Kuei et al. (2001), Kuei et al. (2005), Lin et al. (2005), Robinson and Malhotra (2005), Sila et al. (2006), Kanan and Tan (2007), Kaynak and Hartley (2008), Li et al. (2011), Jraisat and Sawalha (2013), and Hu et al. (2015) clarified that the effective SCQM implementation can directly enhance quality. Fynes et al. (2005), Lo et al. (2007), Kuei et al. (2011), Diaye et al. (2014) and Zhao et al. (2015) pointed out that both internal SCQM operations and supplier-side SCQM can enhance the quality performance. Jayaram et al. (2011) demonstrated that besides internal and supplier-side SCQM, downstream SCQM (customer-side SCQM) can also improve

quality. However, Romano (2002), Soltani et al. (2011) and Zeng et al. (2013) argued that high-level supplier quality cannot result in better quality performance. Zhuang et al. (2015) also verified that external SCQM (supplier-side and customer-side SCQM) do not positively influence quality. Hence, the relation between SCQM and quality is mixed. The second indicator is inventory. It represents the responsiveness of the organisation. Unlike the mixed result of the relationship between SCQM and quality, the body of SCQM literature shows the positive relationship between SCQM and inventory turnover (Casadesus and de Castro, 2005; Flynn and Flynn, 2005; Lin et al., 2005; Robinson and Malhotra, 2005; Kaynak and Hartley, 2008; Yeung, 2008; Kuei et al., 2011; Soltani et al., 2011; Terziovski and Hermel, 2011; Vanichchinchai and Igel, 2011; Zhao et al., 2015). The third indicator is productivity. It represents the efficiency and flexibility of organisations. Similarly, the SCQM literature clarified a positive relationship between SCQM and productivity (Kuei et al., 2001; Romano, 2002; Casadesus and de Castro, 2005; Flynn and Flynn, 2005; Robinson and Malhotra, 2005; Lo and Yeung, 2006; Yeung, 2008; Jayaram et al., 2011; Kuei et al., 2011; Soltani et al., 2011; Vanichchinchai and Igel, 2011; Zhao et al., 2015).

The second group is financial performance. It represents the achievement of organisations' economic goals in terms of outcome-based indicators (Healy and Palepu, 2012). The most frequently investigated financial performance is in terms of sales (Kuei et al., 2001; Casadesus and de Castro, 2005; Lin et al., 2005; Robinson and Malhotra, 2005; Kaynak and Hartley, 2008; Yeung, 2008; Li et al., 2011; Jraisat and Sawalha 2013; Zhuang et al., 2015), profit (Kuei et al., 2001; Lin et al., 2005; Robinson and Malhotra, 2005; Kaynak and Hartley, 2008; Yeung, 2008; Jraisat and Sawalha, 2013), cost of quality (Kuei et al., 2001; Romano, 2002; Lin et al., 2005; Robinson and Malhotra, 2005; Diaye et al., 2014; Huo et al., 2014; Li et al., 2011; Hu and Flynn, 2015; Zhao et al., 2015), market share (Casadesus and de Castro, 2005; Lin et al., 2005; Robinson and Malhotra, 2005; Kaynak and Hartley, 2008; Yeung, 2008; Soltani et al., 2011; Jraisat and Sawalha, 2013), return on asset/investment (Kaynak and Hartley, 2008; Yeung, 2008; Li et al., 2011; Vanichchinchai and Igel, 2011). However, there is no fixed result as to whether SCQM directly influences financial performance or not. Kaynak and Hartley (2008), Yeung, (2008), Li et al. (2011), Vanichchinchai and Igel (2011), and Zhuang et al. (2015) pointed out the indirect relationship between SCQM and financial performance via operational performance. The other studies mainly

focused on the extent of the impacts (i.e. positive or negative) brought by SCQM on financial performance.

2.5. Current SCQM Research

Both survey and case study research have contributed to the study of investigating and evaluating SCQM. For example, from the perspective of buying firms, a group of survey studies examined how buyers' implementation of SCQM affects their operational and financial performance (Sila et al., 2006; Lo and Yeung, 2006; Bayo-Moriones et al., 2011; Huo et al., 2014; Diaye et al., 2014; Hu et al., 2015). Huo et al. (2014) pointed out that supplier-side SCQM is the most significant factor in enhancing product quality. Based on their model, both internal and external quality integration can significantly reduce the cost of quality. Bayo-Moriones et al. (2011) clarified that quality-based supplier selection could assist buyers in ensuring product quality. Fynes et al. (2005) also clarified the significant impact of buyer-supplier relationship on SCQM implementation. Several case studies explored how quality is managed in the SC context (Schroder and McEachern, 2002; Lin et al., 2005; Robinson and Malhotra, 2005; Romano and Vinelli, 2001; Sroufe and Curkovic, 2008; Terziovski and Hermel, 2011; Soltani et al., 2011, Zhao et al., 2015). Soltani et al. (2011) argued that the company should advance from the traditional mind-set to a more collaborative mode by enhancing cooperation with SC partners to enhance quality performance. Zhao et al. (2015) clarified that a better interorganisational quality control system and a closer supplier relationship can help an organisation to reduce quality risk. Besides the research methodology, the current SCQM literature presents different characteristics from the perspective of research targets (i.e. developed market and developing market).

2.5.1. SCQM in Developed Markets

Table 2.3 lists the related literature that investigated SCQM in developed economies and regions. Based on the "Findings (causal link)" column, the majority of the listed literature identified the relationship between SCQM practices and performance (Flynn and Flynn, 2005; Kaynak and Hartley, 2008; Zeng et al., 2013; Huo et al., 2014). Others did not focus on testing the impacts of SCQM practices on performance (Bayo-Moriones et al., 2011; Foster et al., 2011; Dellana and Kros, 2014). By reviewing all of this literature, integrating quality goals with SCM goals assists in establishing the foundation for achieving other strategic objectives (Flynn and Flynn, 2005; Kuei et al.,

Table2.3: SCQM literature in developed economies and regions

Author	Methodology	Findings (causal link between SCQM practice and performance)	Other Key Findings
Bessant et al. (1994)	Single case study: UK purchaser	Supported	● Cooperation with suppliers are important in managing total quality along the SC.
Forker et al. (1997)	Regression: 292 US electronic manufactures	Partial Supported	● Little use of supplier selection and development activities in improving the quality of parts.
Kuei and Madu (2001)	Structural Equation Modelling (SEM): 100 Taiwanese companies	Supported	● IT, supplier relationship, and customer focus are the most significant elements of SCQM.
Kuei et al. (2001)	SEM： 81 Taiwanese companies	Supported	● High quality can save more cost, increase sales growth, and improve earnings growth.
Romano and Vinelli (2001)	Single case study: one Italian textile company	Supported	● SCM should go beyond integrated logistics and involve quality management.
Claycomb et al. (2002)	Regression: 108 US companies	Supported	● Product quality influences the firm performance. ● Quality knowledge of customer, focal company, and supplier share the same importance in influencing firm performance.
Kuei et al. (2002)	Factor analysis: 108 Hong Kong companies	Supported	● IT-enabled operations and employee's quality ability are the key elements.
Romano (2002)	SEM: 100 Italian companies	Partial Supported	● Firms with a certified initial supplier portfolio are more reliant on their suppliers.
Schroder and McEachern (2002)	Case study: Scottish beef industry.	Supported	● The detailed instruction of quality control implementation is much more important than the writing framework documents.
Briscoe et al. (2004)	Case study: US semiconductor	Supported	● Internal quality practice (e.g. top management commitment) is the key to supplier quality management.

			● Mutual understanding about the quality goals and plans also enhance supplier quality management.
Roethlein and Ackerson (2004)	Case study: Five US companies	Supported	● The communication between manufacturer and supplier and between manufacturer and customer are the foundation of SCQM.
Casadesus and de Castro (2005)	Regression: 399 Spanish companies	Partial supported	● ISO 9000 implementation can benefit to SCM strategies to enhance supplier relationship.
Flynn and Flynn (2005)	SEM: 164 plants across Germany, Italy, Japan, England, and USA.	Supported	● Organisations achieve quality and supply chain goals at the same time. ● The integration of quality goals and SCM assists in achieving cumulative capabilities.
Fynes et al. (2005)	SEM: 2000 Irish electronic companies	Supported	● Suppliers should be involved early, quickly and routinely in the product development process.
Kuei et al. (2005)	Factor analysis: 122 Hong Kong companies	Supported	● Company's managerial foci should consistent with recognised dimensions of SCQM.
Lin et al. (2005)	SEM: 212 Hong Kong and Taiwan companies	Supported	● QM practices are significantly correlated with the supplier selection and participation.
Robinson and Malhotra (2005)	Single case study: One US technology company	Supported	● SCQM can help organisations to re-examine their processes and lead continuous improvements.
Lo and Yeung (2006)	Factor analysis: 90 Hong Kong companies	N/A	● Quality culture is important in ensuring the quality along the SC. ● The effective two-way communication channel can enhance the purchasing practices. ● Buyer-supplier interaction (e.g. reward supplier's achievement) could enhance supplier development.

Sila et al (2006)	SEM: 89 US companies	Supported	● Supplier involvement is important in SCQM. ● Customer's input is significant to the quality design of SCQM.
Kannan and Tan (2007)	Regression: 243 US manufacturers	Supported	● Internal and external quality practices play significant roles in managing quality along the SC.
Kaynak and Hartley (2008)	SEM: 359 US firms	Supported	● Managers should have a SC level vision to manage and control quality. ● It is important to integrate upstream and downstream quality processes.
Sroufe and Curkovic (2008)	Interviews: 14 US companies	Supported	● The ISO standard demonstrates that a quality system exists, but does not guarantee its efficacy.
Yeung (2008)	SEM: 225 electronics firms in Hong Kong; Interviews: 16 firms	Supported	● QM implementation is a key requirement for continuous improvement extending to the SC.
Bayo-Moriones et al. (2011)	SEM: 401 Spanish manufacturing companies	N/A	● Companies that purchase from suppliers located in low-cost countries require suppliers to have established quality systems during the purchasing process. ● Firm size, the technological complexity of the process, and the strategic orientations toward the quality influence the external quality practices.
Foster et al. (2011)	Kruskal Wallis analysis： 30 US companies	N/A	● Operations managers prefer to procedural methods: ISO 9000 and supplier evaluation. ● SC managers prefer to collaborative methods: supplier development and complaint resolution.
Kuei et al. (2011)	Analytic hierarchy process: one Taiwanese company	Supported	● Companies need to undertake extensive strategic evaluation on sourcing quality in SCQM.
Terziovski and Hermel (2011)	Case study: Four French companies.	Supported	● QM practices are used for successful integrated SC.

Prajogo et al. (2012)	SEM: 321 Australian companies	Supported	● ISO 9000 positively impacts on internal, customer, and supplier process management.
Zeng et al. (2013)	SEM: 238 plants across eight developed countries.	Supported	● Internal QM is the foundation of SCQM.
Dellana and Kros (2014)	SEM: 427 US companies	N/A	● Different industries have different supply chain quality practice and maturity. ● The SCQM implementation is influenced by employees' understanding of quality program.
Diaye et al. (2014)	Regression: 7685 French firms,	Supported	● Upstream and internal QM are important in managing quality along the SC.
Huo et al. (2014)	SEM: 291 companies across 10 countries (nine developed countries and one developing country)	Supported	● Internal quality integration influences the external quality integration. ● Internal quality integration is the most important part of SCQM integration.
Huo et al. (2015)	SEM: 317 companies across 10 countries (nine developed countries and one developing country).	Supported	● Different SCQI configurations improve different types of quality-related performance.

2011). For example, SCM goes beyond integrated logistics and involves QM that adds value for the end customer (Romano and Vinelli, 2001). QM practices are applied to successfully integrate SCs (Briscoe et al., 2004; Flynn and Flynn, 2005; Yeung, 2008; Terziovski and Hermel, 2011; Huo et al., 2014). As sourcing quality also plays a critical role in global SCQM decisions in the long run (Kuei et al., 2011), suppliers are involved early and routinely in the product design process, so that quality is designed into the product and improves quality performance (Fynes et al., 2005; Ou et al., 2010). Hence, the supplier participation that influences company outcomes is a key element of SCQM (Lin et al., 2005; Kaynak and Hartley, 2008; Huo et al., 2014). Moreover, the studies, such as Claycomb et al. (2002), Roethlein and Ackerson (2004), Sila et al. (2006), Prajogo et al. (2012), Zeng et al. (2013), and Huo et al. (2014)also clarified the important role of customer-side SCQM in enhancing operational performance and financial performance. Although the importance of SCQM practices has been studied and confirmed extensively in the developed market, it does not mean that all the organisations in developed markets are good at implementing SCQM (Sila et al., 2006). Some companies lack supplier involvement and need to seek more customer input (Sila et al., 2006). Moreover, because of different industry classes and supply chain positions, and perceptions of supplier quality maturity, companies obtain diverse quality performance (Dellana and Kros, 2014). Companies that implement better quality practices within their SCs do better than the companies that conduct loose quality practices in achieving financialgoals (Huo et al., 2014). Similarly, Diaye et al. (2014) identified that different hierarchical positions in the quality SC categories (whether they obtained quality certification or not) could bring various influences on firm performance. Hence, firms implement these SCQM practices depending on the technological complexity of the process or their strategic orientation towards quality (Bayo-Moriones et al., 2011).

2.5.2. SCQM in Emerging Markets and China

Besides the developed markets, emerging markets are also playing important roles in world manufacturing and services (Foster, 2008). Table 2.4 lists the related literature that focused on SCQM in developing economies and regions. Contrary to the relatively unified relation between SCQM practices and business results in developed markets, the known influences of SCQM practices on business results in emerging markets are fuzzy. For example, Soltani et al. (2011) identified that a greater level of cooperation

Table 2.4: SCQM literature in developing economy and region

Author	Methodology	Findings (causal link between SCQM practice and performance))	Other Key Findings
Lo et al. (2007)	SEM: 138 Chinese manufacturers	Supported	● Quality control practices significantly speeds up SCQM implementation. ● Internal quality control practices are the prerequisite of SCQM implementation.
Han et al. (2011)	Factor analysis: 229 Chinese pork companies	Supported	● The buyer-supplier relationship management helps the companies to monitor on their suppliers.
Jayaram et al. (2011)	Regression: 197 Chinese manufacturing companies	Supported	● Firm size brings moderating effect to the relation between Supplier coordination/customer coordination and performance.
Li et al. (2011)	Regression: 232 Chinese companies	Supported	● Better quality improves the revenue.
Prakash (2011)	SEM： 156 practitioners in three Indian automobile-manufacturing companies	Supported	● Internal service quality is the source of external service quality.
Soltani et al. (2011)	Case study: Two athletic and casual sports apparel and footwear manufacturers based in Asia	Not supported	● Both SCM and QM practices must move from traditional firm-driven to an inter-firm mode. ● The cooperation with suppliers and customers is the key to SCQM implementation.
Vanichchinchai and Igel (2011)	SEM: 211 Thai automobile companies. Path analysis: Two automobile suppliers	Not supported	● TQM practices can directly facilitate the implementation of SCM.
Jraisat and Sawalha (2013)	Case study: five fruit companies in Jordan	Supported	● The better cooperation with SC members facilitates the adoption of quality practices.

Hu and Flynn (2015)	SEM: 400 Chinese manufacturing firms	Supported	● Internal quality integration provides a structure for a company and presents a uniform interface with supply chain partners.
Zhuang et al. (2015)	SEM: 560 Chinese manufacturing firms	Not supported	● Customer is an important driver for SCQM integration. ● Quality performance can significantly influence the financial performance.
Zhao et al. (2015)	Case studies: Seven Chinese dairy companies	Supported	● Managers should include quality considerations in making decisions concerning their company's SC design, supplier selection, and QA system.

between both upstream and downstream chains, and a broader vision of traditional QM and SCM, were critical to obtaining competitive advantage in Asian sports footwear companies. However, the cooperation with high-quality, capable suppliers could not benefit downstream companies and final customers. Vanichchinchai and Igel (2011) also found negative relationships between SCQM practices and business results in the Thai automobile industry due to employees' insufficient understanding of SCQM and corresponding requirements. They suggested that companies should be more connected to partners in order to cope with the specific requirements of quality, standards, and customer satisfaction. Further, Zhuang et al. (2015) identified that external SCQM practices cannot improve product quality. These studies show that the verified positive impacts of SCQM practices on operational performance in developed markets are not always presented in emerging markets.

Among the emerging markets, China is the largest developing economy in terms of GDP. Its size and critical role in the global economy, combined with its national culture, lead to many unique research opportunities (Zhao et al., 2006a). However, China, especially mainland China, has not attracted enough academic attention in the field of SCQM. The comparison of the amount of literature in Tables 2.3 and 2.4 confirms that there is limited research focused on the Chinese market in the field of SCQM. Based on Table 2.4, it is clear that, until recent years, the number of SCQM studies in China shows an increasing trend. For the existing literature, similar to the companies in developed markets, Chinese companies also need to conduct QM practices first in order to extend continuous improvement to the supply chain (Lo et al., 2007; Hu and Flynn, 2015). The buyer-supplier relationship is another key to the successful SCQM implementation in China (Jayaram et al., 2011; Jraisat and Sawalha, 2013). The management of supplier relationships helps Chinese companies enhance supplier control by employing contractual mechanisms (Han et al., 2011). Combined with close cooperation established on solid relationships, the supplier can improve quality performance (Han et al., 2011). Thus, sourcing decisions (e.g. supplier selection, supplier cooperation, supplier development) have a significant impact on operational performance (Li et al., 2011; Prakash, 2011; Soltani et al., 2011)). However, although buyer-supplier interaction could eliminate obstacles to supplier development by expressing appreciation for supplier achievement, cost or benefit sharing in SCQM is still not fully adopted in the majority of Chinese companies (Lo et al., 2007). On the

other hand, Chinese firms did not pay enough attention to customers in the early 2000s (Lau et al., 2004; Lu et al., 2014). However, with increasingly fierce competition, Chinese firms have recently started cooperating with their customers more closely (Hu and Flynn, 2015). With Chinese firms recognizing the significant influence of customers' input (e.g. reducing production uncertainty, strengthening responsiveness), they communicate with customers more frequently, involve customers' input earlier in manufacturing, and continuously seek to strengthen relationships with customers (Jayaram et al., 2011). This shows that they are starting to treat customer-side SCQM with the same importance as supplier side SCQM in improving both operational and financial performance (Hu and Flynn, 2015). However, as mentioned in the previous paragraph, Zhuang et al. (2015) did not find a relationship between customer-side SCQM and operational performance. Hence, the influence of SCQM on performance in China is still not clear.

2.6. SCQM Literature Summary

SCQM is the system-based approach to continuous improvement through the cooperation of all SC members (Robinson and Malhotra, 2005; Foster, 2008; Hu et al., 2015). Even though SCQM has attracted academics' attention, this topic still remains largely unexplored. Most of the previous studies focused on upstream and companywide SCQM (Zeng et al., 2013). For example, Lo et al. (2007) identified that both internal and supply-side quality practices could significantly enhance organisational quality performance in Chinese manufacturing firms. Quality-conscious practices, supplier selection practices, supplier development practices and supplier integration practices were investigated as independent variables in their work. Bayo-Moriones et al. (2011) clarified that companies bought more components from certified suppliers than from non-certified suppliers to ensure product quality. They mainly focused on the factors of supplier quality practices and supplier localisation. Moreover, Diaye et al. (2014) claimed that the high hierarchical quality positions of the company and its supplier (i.e. both of them obtained ISO9000 certification) positively affected firm performance. The existence of quality certification in buyers and suppliers were investigated as independent variables in their studies. Dellana and Kros (2014) emphasised the internal quality practices and upstream quality practices to clarify the importance of supplier quality in influencing the buyers' SCQM. These papers enhance our understanding of SCQM through identifying some indicators of upstream and

companywide SCQM and clarifying the relationship between parts of SCQM practices and performance.

However, SCQM is a customer-driven management philosophy (Foster, 2008; Robinson and Malhotra, 2005). To achieve successful SCQM, SC members should cooperate under the guidance of customer-driven quality goals (Kuei et al., 2011). The customer integration and collaboration activities assist companies in meeting customer requirements under a structured approach (Zeng et al., 2013). Although some studies mentioned the importance of downstream SCQM practices, they implemented only one customer-related SCQM practice in their research. For instance, Han et al. (2011) studied customer involvement; Huo et al. (2014) investigated customer coordination; Sila et al. (2006) researched customer relations. However, the customer feedback is also a significant hard quality component that provides an opportunity for the company to learn within the SC (Hu et al., 2015). Moreover, Sila et al. (2006) suggested that greater information sharing with customers could enhance customer focus. Furthermore, a close customer relationship allows an organisation to amplify the value that it provides to customers and to enhance customer loyalty (Soosay and Hyland, 2015). Hence, the current SCQM literature cannot provide a clear explanation to the customer feedback application, the customer communication channels and frequency, and the detailed customer development approaches. This means that the previous literature has not paid enough attention to the customer-side SCQM practices, which makes the studied SCQM practices incomplete. Thus, the first research gap identified can be articulated as: *the studied SCQM indicators are incomplete.* To fill this gap, the research aims to explore SCQM by answering the following research question:

- RQ1: What are the main factors impacting on SCQM in the Chinese automobile industry?

Moreover, most of the previous studies focused on developed countries, leaving emerging countries overlooked. China became the largest automobile producer and consumer in 2009. However, based on Table 2.2, there is no study mainly focused on the Chinese automobile industry in the field of SCQM. The lack of Chinese automobile market studies renders SCQM understanding insufficient in explaining the globalised SC (Foster, 2008). It is true that some scholars summarised the development of Chinese automobile industry in detail. Nonetheless, they focused more on the macro

perspectives, such as national industry policy. For example, Holweg et al. (2009) analysed the past, current, and future of the Chinese automobile industry in the fields of national policy and geographic distribution of assemblers, component suppliers and dealers. Lu et al. (2014) summarised China's national automobile policy and clarified the strategic choices of CSBs and Joint Ventures (JVs) in the Chinese market. These works provided a solid understanding of the overall development of the Chinese automobile industry. However, the detailed operations-related issues, such as SCQM practices in CSBs and the difference between CSBs and JVs in SCQM implementation, were scarcely explored.

Even though some other studies paid attention to quality issues in the Chinese automobile industry, they barely emphasised SCQM and automobile quality along CSBs' SC. For example, Aoki (2008) found that team-based suggestion schemes, multi-skills workers, and frequent shop floor visits conducted by managers were the three successful factors of diffusing Japanese Kaizen-related management practices in Japanese auto-parts overseas plants operating in China. Lockström et al. (2010) summarised that buyer-side leadership was the key to building trust and commitment among suppliers, which in turn enabled suppliers to build collaborative capabilities and achieved successful supplier integration in foreign automobile companies' Chinese subsidiaries. Kim et al. (2011) studied the evolutionary role of component suppliers in the Chinese automobile industry from the perspectives of foreign companies' subsidiaries. They insisted that the task assigned by headquarters, the subsidiary's choice, and the local environment together determined the evolution of subsidiaries' roles. Even though these works clarified several enablers and inhibitors of quality-related development in foreign automobile manufacturers and suppliers, none explored SCQM from CSBs' perspectives. Hence, the second research gap that emerges from the literature review is that *no study has focused on SCQM from the perspective of CSBs in the Chinese automobile industry.* To fill this gap, the research aims to empirically explore the SCQM by answering following research questions:

- RQ2: What are the differences between CSBs and JVs in the field of SCQM?
- RQ3: Why do such differences occur?

2.7. Underpinning Theory

RBV can provide insights to clarify the strength and capability which exists in the organisation and can lead the organisation to obtain sustainable competitiveness (Lewis, 2000, Priem and Butler, 2001). It indicates that the competitive power of the organisation is derived from its ability to assemble and exploit an appropriate combination of resources (Wernerfelt, 1984). Resources can include capital, human, equipment and knowledge, and information technology resources. They can be grouped into tangible (equipment and assets) and intangible (knowledge and intellectual property) dimensions (Wernerfelt, 1984, Eisenhardt and Martin, 2000). Barney (1991) stated four critical attributes of a firm's resource: 1) it must be valuable in that it exploits opportunities and/or neutralises threats in the firm's environment; 2) it must be rare among the firm's competition; 3) it must be imperfectly imitable; and 4) it cannot be substituted strategically. These four attributes can be viewed as indicators to show how heterogeneous and immobile resources are for generating sustained competitive advantages (Barney, 1991). Hence, RBV attempts to explain firm's sustainable competitive advantage as firm resources are rare, valuable, hard or impossible to duplicate or imitate, and hard to substitute. Recently, many research studies have attempted to adopt RBV to provide a better understanding of competitive advantage in different areas. For example, green SC (Sarkis et al., 2010); lean (Parry et al., 2010); innovation practice (Terziovski, 2010); and supplier selection (Koufteros et al., 2012). In these studies, RBV assists researchers in understanding how competitive power is generated through the resources, and how these resources positively impact on a firm's performance.

RV indicates that relation-specific assets, knowledge sharing paths, complementary resources and capabilities, and effective governance between associated partners can define inter-organisational competitive advantages (Dyer and Singh, 1998, Hult et al., 2006). The aim of RV is to move away from an arm's-length relationship, because competitors can easily replicate the same relationship, which does not have unique interactions between buyer and seller. RV emphasises how relational rents, can be gained through specific inter-firm linkages (Dyer and Singh, 1998). Given the increasing importance of collaboration among SC partners, the issue of how relational competencies (i.e. inter-organisational practices) generate sustainable strategic advantage has attracted a lot of attention from academics (Dyer and Singh, 1998; Kale

et al., 2000; Paulraj et al., 2008). The development of relational competencies requires organisations to adopt a collaborative managerial mind-set for constructing strategic advantage and form strategic partnerships to obtain or access unique resources that they lack (Eisenhardt and Schoonhoven, 1996). Thus, firms that emphasise cooperation among SC partners may achieve greater benefits compared to those isolated from upstream suppliers and downstream customers (Paulraj et al., 2008). For example, Töyli et al. (2013) identified that communicative and cooperative relationships have a positive effect on SC resilience based on RV. Zhou et al. (2014) suggested the organisation recognises the advantages and disadvantages of relational ties in obtaining specific knowledge.

2.8. Chapter Summary

This chapter describes and explains the formation of SCQM by investigating the challenges in both QM and SCM. By clarifying and combining the characteristics of SCQM, this chapter also provides a specific definition of SCQM. The four SCQM elements (i.e. companywide QM, supplier-side SCQM, customer-side SCQM, and performance) are also discussed in detail. From the perspective of research methodology and research target, the current SCQM literature is categorised and critically discussed. Based on the systematic literature review, in Section 2.6 this chapter also summarises two literature gaps. First, the studied SCQM practices and performance are incomplete because the majority of previous research has focused on the company internally or upstream SC. Second, no study has focused on SCQM from the perspective of CSBs. This section provides further support for identifying the two key research gaps in Section 1.3, and provides further justifications to the relevance of the three research questions mentioned in Section 1.3 in the previous chapter. Further, the two underpinning theories, RBV and RV are discussed in detail.

Chapter Three: Methodology

3.1. Chapter Introduction

This chapter describes the methodology adopted in this research. It covers the philosophical stances, methodology selection, research design, sample justification, data collection, and analysis techniques and procedures that were executed in this research. Methodology can be regarded as a research strategy in which epistemological and ontological principles are playing their roles in conducting this study (Sarantakos, 2013). Ontology represents the nature of reality and the meaning of reality to the people. Epistemology can be defined as the scope of knowledge and concerns what constitutes acceptable knowledge in a field of study (Cunliffe, 2011; Saunders et al., 2015). Hence, this study is guided by philosophical and theoretical assumptions which relate to the nature of reality (i.e. ontology), the knowledge of that reality (i.e. epistemology) and the paths of knowing that reality (i.e. methodology) (Guba, 1990). As stated in Section 2.6, there are two literature gaps: 1) limited study has focused on SCQM from the perspective of CSBs; and 2) the investigated SCQM practices and performance are incomplete. Hence, in order to cover the literature gaps and answer the three RQs that were proposed in Section 1.3, this study investigated and determined the SCQM practices and performance of the Chinese automobile industry in the first place (Phase One: Fact-finding Case Study). Secondly, this study examined the impacts of SCQM practices on the SCQM performance and compared the different SCQM implementation between CSBs and JVs (Phase Two: The SCQM Practices in the Chinese Automobile Industry**)**. Thirdly, this study clarified the reasons for different SCQM implementation between CSBs and JVs (Phase Three: Root Causes of SCQM Practices**)**. A mixed research method was employed by conducting a three-phase study that includes both qualitative and quantitative approach. In the following sections, the philosophical stance, research philosophy, methodology selection and research design of each phase of study will be discussed in detail. For the research design of each phase study, the purpose, the research approach, sample justification, data collection, and analysis techniques will be explained.

3.2. Philosophy Stance

Ontology and epistemology are two ways to explain the research philosophy. Ontology focuses on the questions of whether social entities can be considered objective as having a reality external to social actors or should be regarded as subjective as based on the perception of social actors (Bryman, 2016). There are two ontological positions. The first is objectivism; it represents the position that social phenomena exist as a reality external to and independent of social actors (Bryman, 2016; Saunders et al., 2015). Objectivism implies that social entities confront researchers as external facts which are beyond any influences. The second one subjectivism; it asserts that social phenomena are built based on the perceptions and actions of social actors (Saunders et al., 2015). Subjectivism means social entities are continually being revised and formalised by social actors (Sarantakos, 2013; Bryman, 2016). In the social sciences, epistemology emphasises the question of whether social entities can be investigated by the same principles and procedures as the natural sciences. There are three epistemological positions. The first is positivism, also known as a natural science epistemology (Bryman, 2016; Sauders et al., 2015). Positivism collects data of observable reality and examines the causal relationship to generalise law-like results (Gill and Johnson, 2010). The second is interpretivism, which focuses on the subjective meaning of social actions because of the different perceptions between social actors (Bryman, 2016). This emphasises the difference between conducting research among people rather than the objects of natural science (Patton, 2015; Saunders et al., 2015). The third position is realism, which also asserts that social entities are independent of researchers' minds (Bryman, 2016). However, it also insists that all theory can be revised and continually research is the way to confirm whether the reality exists or not (Patton, 2015; Saunders et al., 2015).

3.3. Research Philosophy

From the perspective of ontology, epistemology, research approach, and data collection method, Table 3.1 summarises the essential characteristics of the four major research philosophies or research worldviews. This research aims to study SCQM, which is a relatively new and developing theory in the context of the Chinese automobile industry as explained in sections 2.2 and 2.3. As stated in Section 1.7, the Chinese automobile industry has more than 100 automobile brands and hundreds of different automobile models. Under this contextual background, SCQM in CSBs and JVs is very complex,

and each kind of brand has its specific SCQM implementation. Moreover, the nature of the three RQs and the research aims proposed in sections 1.4 and 2.6 also indicate that only one philosophy stance cannot appropriately guide the research. For example, due to the very limited literature focused on this topic, the researcher needs to obtain an initial understanding of SCQM in China by conducting interviews and observations. Based on the exploratory findings, the most suitable SCQM measurements and hypotheses can be generated. Therefore, in order to answer RQ1 and RQ2, a case study and a survey research need to be conducted sequentially. For RQ3, a follow-up approach by conducting interviews is needed to better interpret the quantitative results obtained from the survey analysis. Hence, pragmatism is the most suitable research philosophy or worldview that informs the mixed research method of this research.

Table 3.1: Characteristics of Research Philosophies

Element	**Philosophies**			
	Positivism	**Interpretivism**	**Realism**	**Pragmatism**
Ontology	Real, External, Singular reality	Socially constructed, Complex, Multiple realities	Independence of human thoughts	Complex, External, Singular and multiple realities
Epistemology	Only observable phenomena can provide credible data, Scientific method, Measurable fact, Casual relationship, Law-like results	Subjective meaning, Details of the situation, subjective understanding of actions	Observable phenomena can provide credible data, Continually research	Practicality, Problem solving
Research Approach	Deductive, Highly structured	Inductive, A range of forms	Deductive or Inductive	Following RQs, Combining
Data Collection Method	Quantitative, Large samples, Measurements	Qualitative, Small samples, in-depth investigation	Qualitative or quantitative	Quantitative and qualitative, Mixed, Multiple

Sources: Saunders et al., (2015); Cresewell and Plano Clark, (2011)

3.4. Methodology Selection

After obtaining a clear understanding of the philosophical foundation of this study, the next step is to choose the appropriate research methodology. Quantitative research can help researchers answer the questions of "what happened?" and "how often did things happen?" through quantifying people's choices (Cooper and Schindler, 2011). Moreover, qualitative research can delve more deeply into people's interpretations and understandings to answer the question of "how and why did things happen?" under particular circumstances (Yin, 2013). By considering the nature of this study and the characteristics of the RQs as discussed in Section 1.3, the appropriate research methodology was then selected. From the perspective of the nature of this study, SCQM is a relatively new theory and it is still not well studied under the contextual environment of the Chinese automobile industry. Hence, this research is considered as exploratory and aims to use interviews and observations that are embedded in the qualitative approaches to understand SCQM in the Chinese automobile industry at the first stage (Creswell, 2014). On the other hand, the study also intends to test the relationships between SCQM practices and performance and generalise the findings based on the exploratory study by conducting a large-scale survey. Hence, the mixed research was selected to develop a holistic understanding of SCQM in the Chinese automobile industry. From the perspective of the characteristics of RQs, RQ1 and RQ2 aim to clarify the application and influence of SCQM practices and performance. They are 'what'-type questions. RQ3 aims to find the root causes of different SCQM implementation. It is a 'why'-type question. Compared to the quantitative research and the qualitative research, the mixed research method can answer a broader and more complete range of research questions by providing the strengths of quantitative and qualitative methods. Table 3.2 clearly summarises the advantages and disadvantages of these three methods.

The mixed research method is known as the "third methodological paradigm" (Johnson and Onwuegbuzie, 2004). At first, the mixed research method only meant the mixing of research methods but not the philosophy (Greene et al., 1989). Its definition shifted to the mixture of all the phases of the research (including both methods and methodology) afterwards (Tashakkori and Teddlie, 1998). Hence, scholars started to treat the mixed research method as multiple ways of recognising the social world. Tashakkori and Creswell (2007) defined the mixed research method

Table 3.2: The advantages and disadvantages of research methods

	Quantitative Methodology	Qualitative Methodology	Mixed Research Methodology
Strengths	•Testing and validating constructed hypotheses and theories. •The generalization of the result is high. • Provide quantitative predictions. •High credibility if researcher implements the method in a good manner. •Less time consuming. •Relatively independent of the researcher •Useful for studying large samples.	•Responsive to specific local context. •In-depth study on a limited number of complex cases. •Generate a tentative but explanatory theory. •The researcher identifies contextual factors and can study dynamic processes. •Determine idiographic causation.	•Words, pictures, and narrative can add meaning to numbers. •Generate and test a theory. •Use the strengths of an additional method to overcome the weaknesses in another method. •Provide stronger evidence for a conclusion through convergence and corroboration of findings. •Produce a complete knowledge necessary to inform theory and practice.
Weaknesses	•May not reflect respondents' understandings. • The risk of missing out phenomena occurring. • The results are too abstract and general.	•Weak generalization. • Difficult to test hypotheses and theories. •Lower credibility. •Easily influenced by the researcher's bias.	•Difficult for a single researcher. •More expensive. • More time consuming.

Source: Johnson and Onwuegbuzie (2004), Bryman (2016)

as researchers collecting data, analysing models, and generating findings by conducting both quantitative and qualitative methods in a single programme. Creswell and Plano Clark (2011) also indicated that the core of the mixed research method is combining quantitative and qualitative approaches to providing a better understanding of research problems than either method alone. Therefore, the mixed research method is a good choice when only one sort of data is insufficient to answer the RQs, exploratory results need to be generalised, and research aims can be better achieved by multiple phases (Creswell and Plano Clark, 2011). By summarising the opinions of Greene et al. (1989), Johnson et al. (2007), and Creswell and Plano Clark (2011), the mixed research method has the following characteristics.

a) Based on the RQs, it collects, analyses, and interprets the quantitative and qualitative data thoroughly.

b) It integrates the two kinds of data by combining them simultaneously or building one on the other sequentially.

c) The research should allocate suitable priority to the two forms of data according to research aims.

These characteristics make the mixed research method overcome the weakness of quantitative and qualitative methods. For the quantitative approach, researchers can argue the contextual information of the study and criticise the in-depth meaning of the questionnaire answers. Moreover, the survey participants' responses are transformed to numerical data to then be analysed. However, the mixed research method can make up for these weaknesses by conducting interviews and observations. On the other hand, qualitative research can be questioned because of the bias in researchers' interpretations, the limited participants, and the difficulty of generalising the finding (Creswell and Plano Clark, 2011). However, the mixed research method can address these disadvantages by conducting a large-scale survey and carrying out the normalised mathematical analysis. Furthermore, the mixed research method allows researchers to use all kinds of data collection tools rather than limiting researchers to utilise the certain types of data collection tools that are only associated with quantitative and qualitative research. Hence, the mixed research method can provide more information and evidence for research. In addition, the mixed research method helps the researcher to answer RQs that cannot be explained only by quantitative or qualitative research. It means that mixed research is more flexible and practical to solve problems by combining inductive and deductive research process and integrating the data in terms of statistical figures and narrative words. Furthermore, the mixed research method considers multiple philosophical stances rather than the limited philosophical stances that are associated with the quantitative and qualitative research methods (Creswell, 2014). This characteristic fits to the multiple research aims of this study. For each research aim, adopting the particular philosophical stance assists the researcher in viewing the nature of the research objectives, focusing on the accomplishment of the research phenomena, collecting credible data, and conducting a suitable research approach.

For the mixed research method, the six research designs proposed by Creswell and Plano Clark (2011) are the most commonly used in the literature (Bryman, 2016). Due

to the different causality, priority, and role of qualitative and quantitative approach in one study, Creswell and Plano Clark (2011) provided "Convergent Design", "Explanatory Design", "Exploratory Design", "Embedded Design", Transformative Design", and "Multiphase Design". Table 3.3 summarises the characteristics of these six mixed method designs. As emphasised in Section 3.3, due to the two literature gaps, the researcher should conduct three phases of study in sequence to answer the research questions. Only by allocating equal weight to each phase of study, implementing the appropriate research method in each phase, and seamlessly combining these three phases, could the research aims of this study be achieved. Hence, the "Multiphase Design" is the most suitable design of this research. Figure 3.1 shows the flow of the doctoral research, which is divided into three stages.

Table 3.3: Characteristics of Mixed Methods Designs

	Design Purpose	**Paradigm Foundation**	**Priority of the Strands**	**Timing of the Strands**
Convergent Design	Validate quantitative scales	Pragmatism	Equal	Concurrent
Explanatory Design	Explain quantitative results	Positivist in Phase 1 and Constructivist in Phase 2	Quantitative	Sequential: quantitative first
Exploratory Design	Test qualitative exploratory findings	Constructivist in Phase 1 and Positivist in Phase 2	Qualitative	Sequential: qualitative first
Embedded Design	Need preliminary exploration before a trial	Worldview may reflect the primary approach	Either quantitative or qualitative	Either concurrent or sequential
Transformative Design	Conduct research that challenge social injustices	Transformative worldview	Not fixed	Either concurrent or sequential
Multiphase Design	Implement multiphase to address a research objective	Pragmatism; Positivist for quantitative component and Constructivist for qualitative component	Equal	Multiphase combination

Source: Creswell and Plano Clark (2011)

3.5. Phase One: Fact Finding Case Study

3.5.1. Purpose of Phase One Study

The development of the SCQM framework, the generation of SCQM measurements, and the interpretation of the relationships between SCQM practices and performance require the researcher to have a comprehensive and in-depth understanding of SCQM in the Chinese automobile industry. However, after the systematic literature review, the two literature gaps represented the very limited information in this research field. Hence, the research needed to conduct qualitative research in the first place to explore the SCQM practices in the Chinese automobile industry. This exploratory phase aimed to obtain a comprehensive understanding of the SCQM and its implementation in the Chinese automobile industry, identify the key SCQM practices that were adopted in the Chinese automobile companies, and provide evidence to propose suitable hypotheses. Hence, the insights from this research phase worked as the foundation of answering RQ1 and RQ2.

3.5.2. Case Study Design

In order to build theory and to clarify the key variables of SCQM in the Chinese automobile industry, case study was chosen as the research method. Case study is appropriate to be applied to uncover contextual aspects and relationships (Voss et al., 2002; Yin, 2013). At the beginning of the second year of study, the case study was conducted. The cases of this study were selected based on two criteria: a) they are major automobile companies in the Chinese automobile industry; b) their ownership type is either CSB or JV. Hence, the participating automobile companies are representatives of the Chinese automobile industry.

To enhance data reliability and validity, data triangulation was implemented by conducting semi-structured interviews, reading company documents (i.e. annual reports, internal SCQM memos), and observing manufacturing process (i.e. site visits to the Press Shop, Welding Shop, Paint Shop, and Assembly Shop). To ensure a smooth and rigorous environment for the interview and keep focusing on the RQs, an interview protocol that consisted of 36 interview questions was developed from the literature. These questions are all open-ended, such as “Could you please introduce the supplier selection process in your company?”. Meanwhile, the interview was conducted in each case with sufficient flexibility to allow emergent themes to surface.

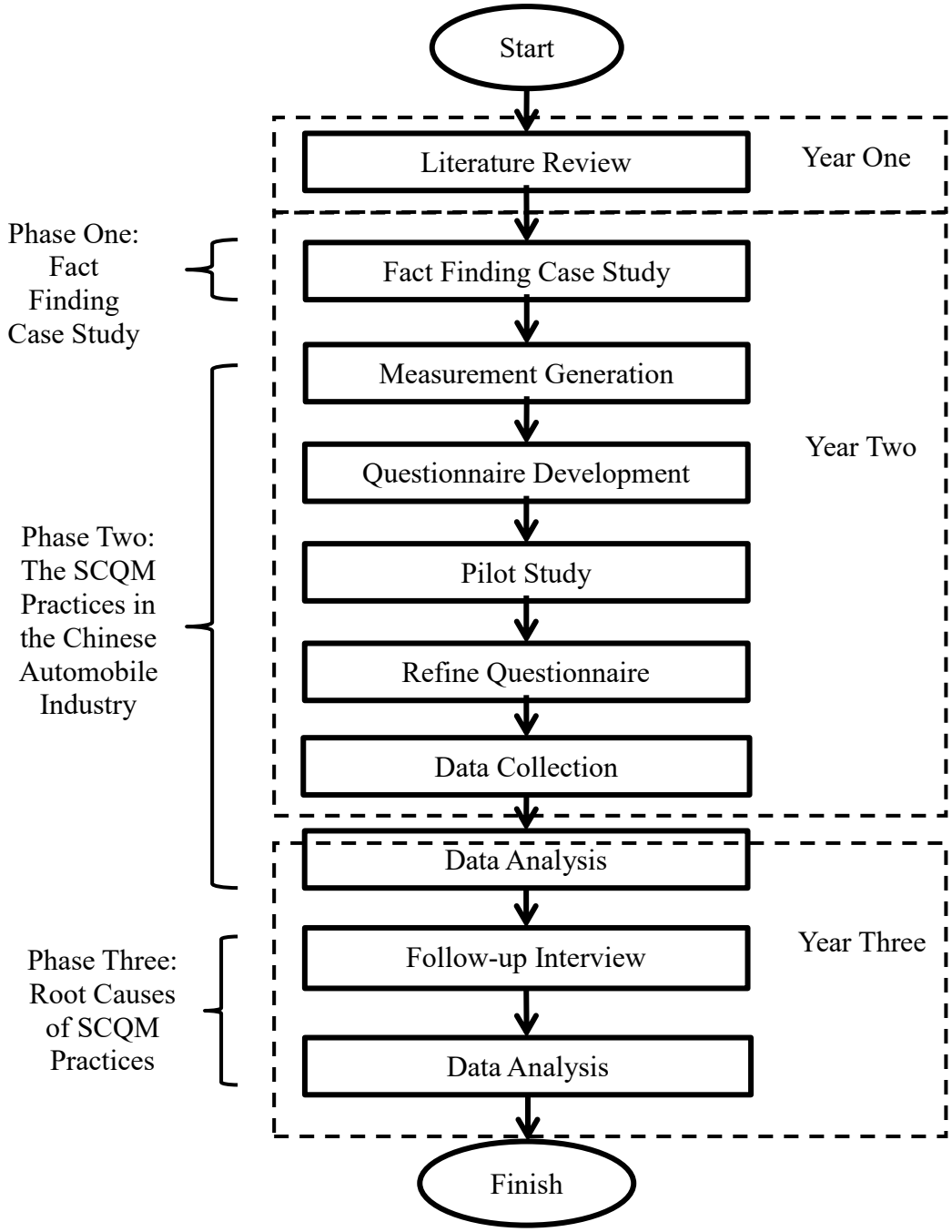


Figure 3.1*: Research design*

The Interview Protocol is presented in Appendix 1. These questions were divided into four sections: Company Introduction, Companywide QM, Supplier-side SCQM, Customer-side QM, and SCQM performance. Due to the strong professional content of the interview questions, the interviewees were mid- and high-level managers who were in charge of SCQM in their organisations. In order to enhance the accuracy and reduce bias of data analysis, the data analysis process of Miles and Huberman (1994) (i.e. data reduction, data display, and conclusion drawing) was employed. The within-case

analysis was conducted to categorise the SCQM practice and the performance of each company. Cross-case analysis was then applied to compare the differences between CSBs and JVs in the field of SCQM implementation and generate the influential factors that affect the SCQM implementation.

3.5.3. Data Collection

The interview protocol worked as guidance to prepare conversations and conduct discussions with the case study participants. All the 36 interview questions were generated consistently with the literature review in order to ensure the theoretical foundation of this research. As shown in Appendix 1, the 36 questions are categorised into four groups. 'Company Introduction' includes three questions about the enterprise profile and overall SCQM implementation. It aims to help the researcher obtain the real time SCQM practices of these automobile companies other than the stories reported in the news. 'Companywide QM' contains 12 questions about how the departments of automobile companies conduct SCQM and enhance performance at the company level. This group of questions focuses on the participation of each member of staff and department of automobile companies in SCQM implementation (Akgün et al., 2014; Hu et al., 2014; Zeng et al., 2015; Zhang et al., 2011). 'Supplier-side SCQM' includes seven questions about how automobile companies work with suppliers to conduct SCQM. It emphasises the cooperation and mutual understanding between automobile companies and suppliers in the field of SCQM implementation (Hu and Flynn, 2014; Huo et al., 2014; Soosay et al., 2008; Theodorakioglou et al., 2006). 'Customer-side SCQM' contains five questions about how automobile companies collect, apply, and transmit customer opinion in SCQM implementation (Foster et al., 2011; Hu and Flynn, 2015; Huo et al., 2014; Kaynak and Hartley, 2008). This kind of question focuses on the collaboration between automobile companies and customers in conducting SCQM. 'SCQM Performance' covers nine questions about the operational performance and financial performance of automobile companies (Foster, 2008; Kaynak and Hartley, 2008; Kuei et al., 2011; Sila et al., 2006). It focuses on automobile companies' achievements in economic goals and operational strategy effectiveness. Due to the different structure of each company, 15 interviews were conducted in total. The participants are summarised in Table 3.4. Two interviews were undertaken in $CSBPM_1$, $CSBPM_2$, CSBSM, CSBSL, CSBPL, and JVL_1 respectively. Three interviews were carried out in JVL_2 respectively. All the interviews were audio recorded and saved on

a laptop for further transcription and analysis. These interviewees had expert knowledge and were highly familiar with their company. Instead of maximizing the numbers of interviews, purposive sampling could help the researchers to obtain sufficient in-depth information (Eisenhardt, 1989; Padgett, 2016).

Besides the data collected by conducting semi-structured interviews, the researcher also visited the workshops and observed the manufacturing processes of all seven automobile companies. Based on the observation, the researcher gained deeper understanding of the SCQM implementation in each case. The participants showed the researcher all the operating procedures from ordering components to delivering assembled automobiles. The researcher also viewed the operation of ERP systems. Hence, the site visits helped the researcher gain a better understanding of SCQM by visualizing the SCQM implementation practices. Moreover, the interviewees also provided internal SCQM memos and annual reports to the researcher. Based on the written records and the financial numbers, the researcher can better evaluate the SCQM practices of each automobile company.

Table 3.4: Participants of the Case Study

Company Name	**Ownership Type**	**Size***	**Interviewee**
$CSBPM_1$	CSB	Medium	SLY (Quality Chief)
			ZXB (Quality Manager)
CSBSM	CSB	Medium	LQC (Quality Manager)
			WZ (Quality Manager)
$CSBPM_2$	CSB	Medium	LWQ (Quality Chief)
			HQL (Quality Manager)
CSBSL	CSB	Super Large	ZH (Senior Quality Manager)
			CZA (Quality Manager)
CSBPL	CSB	Super Large	YZL (Quality Manager)
			DYZ (Quality Chief)
JVL_1	JV	Super Large	ZJE (Quality Manager)
			WG (Quality Chief)
JVL_2	JV	Super Large	XHG (Quality Manager)
			MFX (Quality Manager)
			DCF (Quality Chief)

** Based on the number of employees.*

3.5.4. Data Analysis

The purpose of data analysis is to gain insights from the collected data. It is the process of structuring and extracting the meaning of all the collected data. It is the practice of breaking down the complex data set into constituent parts (Ghauri and Gronhaug, 2010). During this procedure, researchers reduce, sort and integrate the data to gain understanding, clarify root causes, and test relationships. In this research, first, the transcripts were generated by translating all the interviewees' audio recordings into English. Second, the triangulation was done by combining the transcripts with the site visiting notes and the records of internal SCQM memos. This procedure was carried out in all seven cases to set up a database that contains all the empirical data. However, this database contained too much information to be directly used in data analysis. Miles and Huberman (1994)'s data mining approach was then utilised to purify the original database. Categorization aims to classify units of data. It identifies a unit of data as belonging to or representing some more general theory. During the categorization, the code works as the device to label and separate data. By listing key codes, such as "supplier selection", "quality training", and "customer feedback" that were extracted from interview protocol, the necessary data was drawn from the original database.

The extracted data was then analysed in two stages. In the first stage, a within-case analysis was carried out to examine SCQM practices in the single context. Within case analysis is a process of data reduction and every case has been summarised to identify key findings. It helps the researcher to gain familiarity with data and preliminary theory generation (Creswell, 2014). Within case analysis aims to make a detailed description of the case. The researcher needs to establish patterns and re-organise the data in a more meaningful way. During this process, abstraction was carried out to collapse more empirically grounded categories into higher-order conceptual constructs. Abstraction is more than identifying the patterns in the data. It groups the previously identified categories into a more general theoretical group. The subheadings of the interview protocol (company introduction, supplier-side SCQM, companywide QM, customer-side SCQM, and SCQM performance) were used in building categories. The pattern matching process (Eisenhardt, 1989) was then used for refining the concepts with the empirical evidence. The detailed descriptions of each case and the emerging patterns are mentioned in Chapter 4.

The second analysis stage is cross-case analysis. During the cross-case analysis, data was reduced further in order to derive commonalities and differences among the seven cases and display the data in meaning for a format (Yin, 2013). Therefore, the categories from the within-case analysis have been used to cluster the data from each case into one dataset. Similar expressions, comments, and findings have been grouped into a single category. This process forces the researcher to look beyond initial impressions and see data through multiple stances. A table and a figure were created to display the comparisons among the seven cases. These comparisons summarised three reasons that cause companies to implement different SCQM practices. The detailed cross-case analysis is presented in Chapter 4.

3.5.5. Design Test

Lincoln and Guba (1985) suggested testing three aspects to ensure the credibility, transferability, and dependability of the qualitative research. These aspects are internal validity, external validity, and reliability. For internal validity, it represents the truth of data and the corresponding interpretation. Internal validity was increased by combining data from multiple interviewees with differing roles in their firm's SCQM activities, and combining the semi-structured interviews with additional sources of data, such as site observations and documentary evidence. Moreover, the researcher also presented the case description and data analysis to the participants of case studies to review and verify (Eisenhardt, 1989; Voss et al., 2002; Yin, 2013). Furthermore, the data analysis procedure carefully followed the suggestions of Miles and Huberman (1994) and Ghauri and Gronhaug (2010). The pattern matching technique and the explanation building process of data analysis can also improve the internal validity of this research. Confusion and misunderstanding were gradually removed by the iterative process of data analysis. For external validity, it is concerned with the generalisability of the findings of the study. The theoretical generalisation was achieved by adopting a multiple case study approach (Yin, 2013). External validity was addressed by including case studies spanning a range of SCQM practices. The thick description of these SCQM practices and performance in each case enables the evaluation of the applicability of the variables to other contexts. For reliability, it emphasises the repeatability of the research by providing the same participants with the same background (Creswell and Plano Clark, 2011). Reliability was improved by developing the interview protocol and using it as the case study guidance in each instance. The protocol works as the principle of

the case study to lead the data collection step-by-step. Moreover, the standardised data analysis procedures also can help to repeat the research.

3.6. Phase Two: The SCQM Practices in the Chinese Automobile Industry

3.6.1. Purpose of Phase Two Study

After obtaining a comprehensive understanding of SCQM practices in the Chinese automobile industry and the characteristics of the SCQM implementation of Chinese automobile companies, a quantitative research approach was chosen as the research methodology in the Phase Two study for investigating the key SCQM factors and their impact on the SCQM performance. Moreover, the influences of ownership and firm size on the relationships between SCQM practices and performance were also tested in the Phase Two research. There are several reasons to support the appropriateness of adopting quantitative methodology in this phase:

a) The multidimensional SCQM concept can be measured by conducting quantitative research;

b) A large-scale survey is needed to validate the proposed SCQM practices and performance and confirm their generality;

c) The dimensions of SCQM can be tested by utilizing scientific methods through an objective perspective;

d) The objectivist perspective of the quantitative approach can reflect the reality and represent a generalizable result;

e) The hypotheses that related to the relationships among SCQM practices, performance, ownership, and firm size can be formulated and examined by adopting quantitative research.

Hence, RQ1 and RQ2 can be answered by conducting this quantitative approach. The following sections cover the procedures of generating measurements, designing the questionnaire, conducting a pilot study, collecting data, and analysing data by utilizing Structural Equation Modelling (SEM).

3.6.2. Measurement Generation

There are two fundamental principles in measurement and scale development. The first is to select the appropriate measurements to cover the aspects of constructs (Menor and Roth 2007). The second is to reduce measurement error by including a more robust

combination of items (Drolet and Morrison, 2001). By following these two principles, the Phase Two quantitative research utilised the measurement generation procedures of the works of (Kaynak and Hartley, 2008; Huo et al., 2014; Zeng et al., 2015). The conceptualizations of the constructs need to be based on a thorough literature review (Hair et al., 2014). This conceptualization step provides the conceptual model in which item measurement and scale development take place. These measurement scales aim to reflect that SCQM practices and performance. Moreover, the measurement items are derived from two sources. First, the majority of measurements were adapted from literature. In order to ensure the high quality of measurements, the researcher adopted the items from literature that was published in high impact journals. Second, some specific SCQM practices and performance measurements were generated based on the first phase qualitative research. These two sources of measurements ensure the conceptual domain of constructs as specified can be captured, and measurement items can be generated to represent these conceptual domains (Churchill, 1979; Hinkin, 1995).

From the measurement perspective, the construct can be categorised into the reflective or formative group (Diamantopoulos and Winklhofer, 2001). The reflective construct is typically regarded as the underlying factor that causes consequence (Fornell and Bookstein, 1982). On the other hand, the formative construct reflects the impression that the indicators are causing the latent variable (MacCallum and Browne, 1993). Roberts et al. (2010) reviewed the structural equation model studies in operation management and found that 97% of the latent construct were reflective. The small number (3%) of studies that investigate formative constructs shows the misunderstanding of the constructs. This "specify problem" can lead to Type I or Type II errors (Peng and Lai, 2012). The errors will inflate or deflate the structural model (Jarvis et al., 2003). Therefore, the constructs should be carefully specified before analysing the data. Jarvis et al. (2003) proposed a guideline that contains four points for identifying the property of construct. The first point is the direction of causality between the construct and its indicators. For the formative construct, the direction of causality flows from the indicators to the construct. For the reflective construct, changes of construct cause changes of indicators. The second point is the interchangeability of the indicators. The indicators are not interchangeable for formative constructs. The indicator should not be replaced by other indicators. However, for the reflective constructs, the indicators share the same theme. The third point is the covariation among

the indicators. Covariation among the indicators is not implied by the formative construct. It means the change in one indicator should not cause change in another indicator. However, covariation among the indicators is a character of the reflective construct. The fourth point is related to the antecedents and consequences of the indicators. For the formative construct, the indicators do not share the same antecedents and consequences due to their different focusing aspects of the construct. However, for the reflective construct, the indicators have the same antecedents and consequences.

3.6.3. Questionnaire Design

As measurements were mainly derived from literature in the English language, the initial questionnaire was developed in English. Because the target respondents were managers in Chinese firms, the initial questionnaire was translated into Chinese. Two practitioners in China were consulted to ensure the measurement items in Chinese presented the original meanings. The Chinese questionnaire was then translated back into English with the help of another practitioner to guarantee the accuracy of the translation (Brislin, 1980). These two English questionnaires were carefully compared so that there was no significant change in the English wording after the backward translation. Besides the language issue, the researcher also paid much attention to the number of items of the construct, the selection of a Likert scale, and the negative wordings in order to enhance the reliability of the questionnaire (Hinkin, 1995).

3.6.4. Pilot Study

Pre-test and pilot study are two trial instruments employed before the actual data collection to ensure that the main study and its tools are correct, suitable, reliable and valid. A pre-test is a small test of the single element of a research instrument that is used to check its mechanical structure (Sarantakos, 2013). It aims to ensure that the question should be clear, and the response category should be sufficient to cover all possible answers. Greenfield (1996) suggested that researchers can pre-test part of a questionnaire but a pilot survey is usually best. A pilot study is a small-scale replica and a rehearsal of the main study which aims to fine tune a design (Sarantakos, 2013). It focuses administrative and organisational problems of the main study and the respondents. It provides advance warnings about where the main research project could fail, where research protocols may not be followed, or whether proposed methods are inappropriate. For the questionnaire study, researcher should record the cost and time

spent on completing the questionnaire, ask the respondents for feedback to identify ambiguous questions, remove all unnecessary and ambiguous questions, assess the range of responses for each question, and revise any questions that cause difficulty in answering (Bryman, 2016; Sarantakos, 2013).

However, simply going through the pilot study procedures with a respondent often leads the researcher to mistakes, so it is better to pilot with two or more colleagues as respondents (Grennfield, 1996). Moreover, the pilot study should not be carried out on people who might be the samples in the full study (Alasuutari et al., 2008). Otherwise, it will affect the employment of probability sampling of the subsequent sample (Bryman, 2016). Therefore, it is best to find a small set of respondents who are comparable to the population of the full study (i.e. similar age, job, and education).

According to the previous literature, there is no clear guidance on how many pilot studies should be done. For example, Flynn et al. (1995) did 12 pilot studies before collecting 763 questionnaires in America. Samson and Terziovski (1999) conducted six pilot studies before sending questionnaires to 4000 companies. Altayeb and Alhasanat (2014) conducted 20 pilot studies before collecting 98 questionnaires in Palestine. In order to avoid any potential problems in the main study, the respondents of the pilot study in this research involved five academics and fifteen practitioners (quality or SC managers from Chinese subsidiaries of American, German, and British automobile companies). These respondents can provide fruitful suggestions from the angles of fulfilling study objectives, preventing questions that reveal the ignorance of the researcher, and improving the instructions for completing the questionnaire. The questionnaires were distributed to respondents through the Internet (i.e. www.SurveyMonkey.com), email, and mail.

The respondents of the pilot study were asked to evaluate how adequately each indicator measures the dimension to which it has been assigned. For each indicator, the respondents were asked to reply on a seven-point scale with “1” representing “weak” and “7” representing “strong”. Based on the respondents’ input, the average adequacy score and the standard deviation of adequacy score for each indicator were calculated and evaluated. This approach has been successfully conducted by Rungtusanatham et al. (1999) to summarise the 14 dimensions of SPC implementation. Similarly, Wu et al.

(2010) also used the adequacy score to test the buyer-supplier relation's constructs. According to the work of Rungtusanatham et al. (1999), the cut-off value of high average adequacy score is above 3, and the cut-off value of small standard deviation is below 1.00. Based on this approach, the face validity of the indicator was determined. Face validity is the extent to which the indicator appears to measure the construct (Nunnally and Bernstein, 1994). It shows the degree to which the respondents judge that the indicator is appropriate to the targeted dimensions (Nevo, 1985; Forza, 2002). Therefore, face validity is the prerequisite of content validity which will be evaluated in the data analysis stage (Hardesty and Bearden, 2004).

In conclusion, the pilot study in this research aimed to ensure the face validity of each indicator through calculating the adequacy score and corresponding standard deviation. Moreover, the pilot study also assisted the researcher to remove ambiguous questions and add the omitted indicators. Furthermore, based on the provided suggestions, more accurate wording of the indicators was adopted.

3.6.5. Data Collection

According to "The Proclamation of Automobile Manufacturing Enterprise and Product in 2011" which was published by the Ministry of Industry and Information Technology of the PRC in 2011, 1164 companies had the ability to build passenger vehicles and commercial vehicles in China. Based on the different sizes and structures of the companies, the questionnaire was completed by those people who have a comprehensive understanding of SCQM in the company (e.g. quality manager, general manager, SC manager). The researcher collected multiple replies from each participating organisation in order to improve the accuracy and to reduce random errors (Cao and Zhang, 2011).

The Hebei Quality and Technical Bureau and Hebei Federation of Trade Union (government departments that have a close relationship with automobile company) provided a part of contact details of potential automobile companies and issue the reference letters to ask potential automobile companies to participate in the research. The researcher also purchased contact information from the database providers (China Association of Automobile Manufactures and China YP) in order to contact more respondents. These institutions issue a catalogue of automobile enterprise with the

Ministry of Industry and Information Technology of China every year. The catalogue includes the telephone numbers, email addresses, and fax numbers of all the automobile companies operating in China. The respondents received a URL (Internet link) for the questionnaire through email and were then contacted by telephone to ask them to complete it. Respondents not familiar with the online survey were sent the survey by mail.

3.6.6. Analysis Technique Selection

In social science research, SEM is a commonly used analysis method to conduct the study (Peng and Lai, 2012). Operations management (OM) researchers have also used SEM to a great extent (Shah and Goldstein, 2006). OM researchers have mainly adopted covariance-based SEM (CBSEM) methods through using software such as LISREL and AMOS (Peng and Lai, 2012). However, the partial least squares (PLS) method has not received the same level of attention as CBSEM from OM researchers. PLS was first introduced to the academic world in the 1960s (Wold, 1966). SmartPLS and PLS-Graph are the representative software. PLS has the advantage at estimating models through using small samples that do not have strict distribution and analysing both reflective and formative constructs within the same model. Based on Hair et al. (2014) and Peng and Lai (2012), the major differences between CBSEM and PLS are listed in Table 3.5.

Table 3.5: Comparison of PLS and CBSEM

	PLS	CBSEM
Research Objective	• Exploratory • Prediction-oriented	• Confirmatory • Parameter-oriented
Sample Size	• 10 multiply the number of the most complicated relationship • That relationship is the larger value between largest measurement equation and the largest structural equation	• The ratio (5 to 20) multiply the total number of parameters estimated
Model Complexity	• Highly complex models • Testing the magnitude of moderation effects • Performing between-group comparisons	• Directly impact sample size adequacy
Data Property	• Involves no assumptions about the population of measurement • Consequently works with non-normally distributed data	• Covariance matrix as data input • Multivariate normal distribution

Construct Property	• Mix of formative and reflective measures	• Reflective measures
Algorithm	• Iterative algorithm • Separately solve the model • Predict path coefficients • Ordinary least square regression • Maximise R^2 in endogenous constructs	• Maximum likelihood estimation method • Optimise an unique global scalar function and minimise the Chi-square difference • Error terms require additional specification

Sources: Hair et al. (2014); Peng and Lai, (2012)

To select between PLS and CBSEM, researchers should take the objectives of study, the characteristics of the model, and the conceptualization and formulation of the constructs into consideration. SCQM theory is a relatively new theory and it is not well conceptualised like other matured theory (e.g. Deming's 14 Points). Moreover, no study has emphasised SCQM in the Chinese automobile industry through comparing CSBs and JVs. Therefore, this study is exploratory in nature and performs between-group comparison. Furthermore, the potential respondents of this research are the managers in CSBs and JVs, and the sample size is much smaller than the marketing study or education study, which selects regular customers and students as the target. In addition, because of the different SCQM culture and different SCQM implementation in the CSBs and JVs, the answers of questionnaire usually do not present a multivariate normal distribution (Peng and Lai, 2012). Furthermore, this research not only includes the reflective constructs (e.g. Training, Process Management) but also includes the formative constructs (e.g. Operational Performance, Financial Performance). All of these characteristics show that PLS is a better choice to analyse the data and model in this research.

Figure 3.2 shows the analysis procedures suggested by Hair et al. (2014). It was used as the analysis guideline of the Phase Two study. All the valid data was then inputted in SmartPLS 3.0. Due to the different algorithm and statistic properties between PLS and SBSEM, the specific rules for initializing the PLS algorithm were specially emphasised in Stage 4. Based on the suggestions of Hair et al. (2014), the path weighting scheme was selected as the weighting method. The z-standardize (i.e. mean value of 0, standard deviation of 1) was selected as the data metric option. +1 was also chosen as the initial value for all outer weights, and 10^{-5} was chosen as the abort

criterion. Finally, the maximum iterations were set to above 300. After setting up the software, the data can be initially analysed and the model can be estimated.

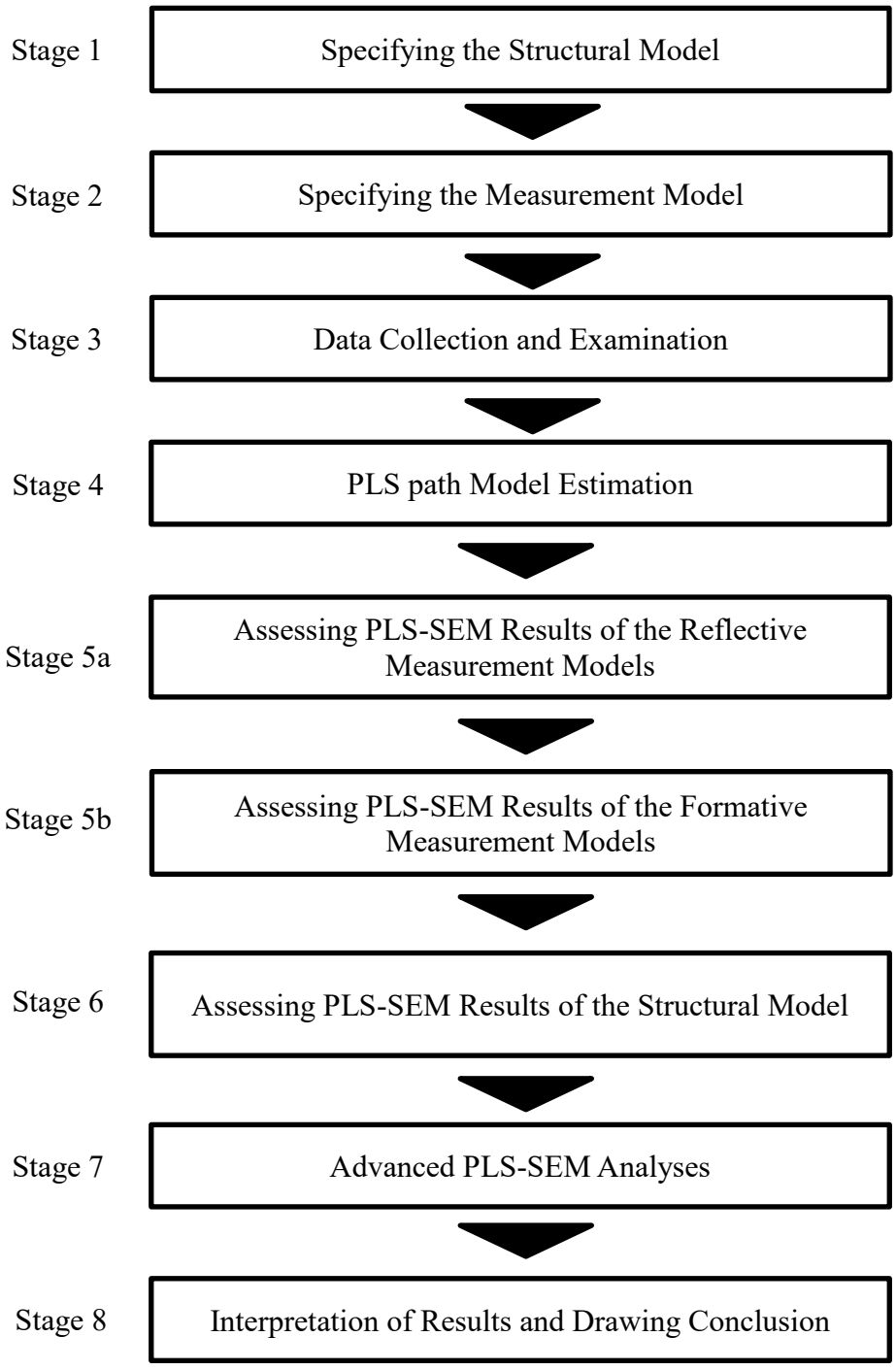


Figure 3.2: PLS Execution Procedures

Source: Hair et al. (2014)

3.6.7. Measurement Analysis

After understanding how to build the model and estimate the model, the quality of the results should be assessed. Because the formative construct and reflective construct have significant differences in characteristics and properties, researchers should conduct different measurement analyses to test their reliability and validity. In Stage 5a the reflective indicators were tested. Firstly, the internal consistency reliability should be evaluated (Hair et al., 2014). Cronbach Alpha is the most widely used reliability coefficient that assesses the consistency of the entire scale (Peterson, 1994). Based on the suggestions of Nunnally and Bernstein (1994) and Hair et al. (2014), the Cronbach Alpha values between 0.7 and 0.9 can be regarded as satisfactory. It means that the set of items is closely related to a group, and the reliability of the model is high. Values below 0.6 indicate a lack of internal consistency reliability. Furthermore, the values above 0.9 suggest that researchers may use redundant indicators by rephrasing the same measurement.

Second, the convergent validity should be tested. Convergent validity is the extent to which an indicator correlates with other indicators of the same construct (Hair et al., 2014). In order to establish convergent validity, the desirable levels of indicator reliability and average variance extracted (AVE) are necessary. The communality value is one of the criteria of indicator reliability evaluation. The communality explains whether the indicator's variance is shared with other indicators (Hair et al., 2006). Communality values above 0.5 can be regarded as satisfactory (Hair et al., 2014). Communality values below 0.5 indicate the measurements are not well explained in the model and are better deleted. Moreover, the outer loading plays the role of each item in defining the corresponding factor. Because the squared loading is the amount of items' variance accounted for by the factor, 0.4 is chosen as the minimal level of interpretation of structure (Hair et al., 2006). AVE is defined as the mean value of the indicators' squared loadings within the construct (Hair et al., 2014). As suggested by Fornell and Larcker (1981), AVE values above 0.5 indicate that the items of the corresponding factor are highly correlated, and they share a high proportion of variance in common.

Third, the discriminant validity should be evaluated. It shows whether the construct is unique and distinct from others (Hair et al., 2014). In order to establish discriminant

validity, the Fornell-Larcker criterion is generated. It compares the square root of AVE for the factor with the highest correlation value between that factor and other factors (Fornell and Larcker, 1981). If the square root of AVE is larger than the highest PHI value, it verifies that the construct shares more variance with its indicators than with other constructs.

After assessing the reflective indicators, the formative indicators were examined in Stage 5b. The convergent validity should be tested in the first place. The desirable strength of the path coefficient linking these two constructs should be above 0.8 (Chin, 1998). If the formative construct is a lack of convergent validity, the conceptual refining is needed.

Second, the multicollinearity should be evaluated. High multicollinearity suggests that some indicators may be redundant. To detect multicollinearity, the variance inflation factor (VIF) is commonly analysed. VIF is defined as the reciprocal of the tolerance. Hair et al. (2011) suggested a VIF value of 10 or higher indicates a potential multicollinearity problem. In order to avoid the multicollinearity problem, researchers can remove the highly correlated indicators, convert the construct into a multidimensional construct, or collapse the highly correlated items into a composite index (Hair et al., 2014; Peng and Lai, 2012). Besides VIF, the condition index and the correlation matrix should also be examined by researchers (Götz et al., 2010; Peng and Lai, 2012).

Third, researchers should evaluate each formative indicator's contribution to the formative index. A formative index is the sum of item weights of all the formative items. For formative items, researchers should examine item weight rather than item loading (Peng and Lai, 2012). The item should have a statistically significant weight, the underlying theory should support the sign of the item weight, and the magnitude of the item weight should be larger or equal to 0.10 (Andreev et al., 2009). For the non-significant items, it should not automatically be interpreted as poor items or deleted. Researchers should consider the absolute importance (i.e. outer loading) of these items, and the cut-off value is 0.5 (Hair et al., 2014). If the nonsignificant item's outer loading is above 0.5, the item is absolutely important but not relevant important. Thus, this item

should be retained. If the nonsignificant item's outer loading is below 0.5, researchers should consider removing it.

3.6.8. Structural Model Analysis

After establishing the measurement validity and reliability, the model analysis was carried out in Stage 6. First, researchers should also apply the same multicollinearity test as in the formative measurement analysis. Researchers need to make sure there are no significant levels of multicollinearity between each set of predictors (Hair et al., 2014). Second, the path coefficients should be assessed. The significant path coefficients can be verified if the t value is above 1.96 at 5% significant level in the two-tailed test (Hair et al., 2014). Third, the predictive power of the research model should be evaluated. The researcher should check the coefficient of determination (R^2) of the endogenous constructs (Peng and Lai, 2012). R^2 indicates the level of variance explained in the endogenous variables. Based on the suggestion of Chin (1998), 0.67, 0.33, and 0.19 represent substantial, moderate, and weak, respectively. Fourth, Cohen's f^2 should be tested to assess the effect size of the predicting constructs (Cohen, 1988). The effect size is calculated as "the increase in R^2 relative to the proportion of variance that remains unexplained in the endogenous latent variable (Peng and Lai, 2012; p.473). Based on the suggestion of Cohen (1988), 0.35, 0.15, and 0.02 are regarded as large, medium, and small, respectively. Fifth, the predictive relevance should be assessed. If the model has predictive relevance, it can accurately predict the data in the endogenous constructs (Hair et al., 2014). Stone-Geisser's Q^2 is commonly calculated to evaluate the predictive relevance, and it can be generated through the blindfolding procedure (Geisser, 1975; Stone, 1974). 0 is the cut-off point, which means that the model is regarded as having predictive relevance if Q^2 is above 0.

3.6.9. Moderation and Mediation Test

After conducting the overall model analysis, some of the complex relationships (e.g. moderation effect, mediation effect) in the model can also be easily tested in PLS compared with CBSEM. Models include moderation analyses and mediation analyses can largely increase the sample size and the total number of parameter estimates, thus causing the model identification and convergence problems in CBSEM (Peng and Lai, 2012). Therefore PLS, which uses the iterative algorithm to predict factor loadings and structural paths blocks by blocks, is more suitable to test the complex model.

A moderator is a qualitative (e.g., sex, race) or quantitative (e.g., level of reward) variable that affects the strength of the relation between a predictor variable and a dependent variable (Baron and Kenny, 1986). Figure 3.3 shows the illustration of moderation effect, where X presents the predictor, Z presents the moderator, and Y presents the dependent variable. The relation among these 3 variables can be written as:

$$Y = \beta 0 + \beta 1X + \beta 2Z + \beta 3XZ$$

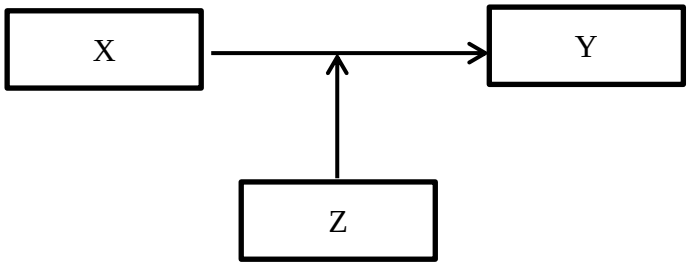


Figure 3.3: Illustration of Moderation Effect

If β_2 equals 0, Z can be regarded as the pure moderator. If β_2 does not equal 0, Z can be regarded as the quasi moderator (Sharma et al., 1981; Baron and Kenny, 1986). In PLS, the model estimates for the subsamples are usually compared by conducting multigroup analysis (MGA). MGA enables the researcher to test for differences between identical models estimated for different groups of respondents. It aims to find whether there are statistically significant differences between individual group models. In order to calculate the empirical t value, the number of respondents (i.e. $n^{(1)}$, $n^{(2)}$), the path coefficients (i.e. $\tilde{\theta}^{(1)}$, $\tilde{\theta}^{(2)}$), and the standard errors (i.e. $se_{\theta^{(1)}}$, $se_{\theta^{(2)}}$) of two groups are needed (Keil et al., 2000; Chin, 2000; Nitzl, 2000; Hair et al., 2014). The calculation of *t* can be written as:

Equal standard errors:

$$t = \frac{\tilde{\theta}^{(1)} - \tilde{\theta}^{(2)}}{\sqrt{\frac{1}{n^{(1)}} + \frac{1}{n^{(2)}}} \sqrt{\frac{(n^{(1)} - 1)^2}{n^{(1)} + n^{(2)} - 2} * se_{\theta^{(1)}} + \frac{(n^{(2)} - 1)^2}{n^{(1)} + n^{(2)} - 2} * se_{\theta^{(2)}}}$$

Unequal standard errors:

$$t = \frac{\tilde{\theta}^{(1)} - \tilde{\theta}^{(2)}}{\sqrt{\frac{n^{(1)} - 1}{n^{(1)}} * se^2_{\theta^{(1)}} + \frac{n^{(2)} - 1}{n^{(2)}} * se^2_{\theta^{(2)}}}}$$

Mediation emphasises the theoretically established direct path between predictor and criterion, and on a mediator, which brings impact on the direct path through its indirect effect (Hair et al., 2014). Figure 3.4 shows the illustration of mediation effect. X represents the predictor, Y accounts for the criterion, and M serves as the mediator. By following Preacher and Hayes (2004)'s procedure, the direct relationship "a" should be firstly tested. The direct relationship needs to be significant; otherwise, there is no mediating effect. Second, the mediator (M) should be included in the model. The indirect relationships "b" and "c" should also be significant; contrarily, there is no mediation effect. Third, the variance accounted for (VAF) values should be calculated to determine the size of the indirect effect in relation to the total effect. According to Hair et al. (2014), VAF values above 80% are considered as full mediation, VAF values between 20% and 80% are regarded as partial mediation, and VAF values below 20% are rated as no mediation. In this research, whether the upstream SCQM and downstream SCQM have mediation effects or not will be tested strictly following the above procedures.

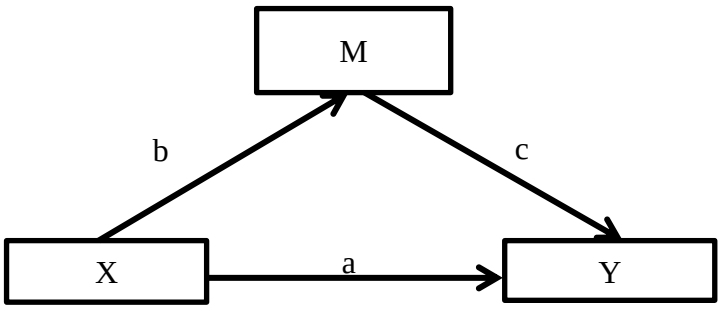


Figure 3.4: Illustration of Mediation Effect

3.7. Phase Three: Root Causes of SCQM Practices

The numerical results of PLS analysis can answer RQ1 and RQ2. However, RQ3, which concerns the root causes of different SCQM implementation in the Chinese automobile companies, cannot be interpreted by the statistical results. The survey research approach

lacks the ability to interpret the causes of forming quantitative findings in detail (Creswell and Plano Clark, 2011). Hence, after conducting model analyses and evaluations, follow-up interviews with questionnaire respondents were conducted by telephone. The aims of these interviews included: 1) to interpret the key SCQM factors in the Chinese automobile industry; 2) to explain the relationship between SCQM practices and performance; 3) to clarify the influences that are brought by ownership and firm size on SCQM implementation. An interview protocol was developed based on the statistical results of PLS. The open-ended questions of this protocol are shown in Appendix 2. It includes ten open-ended questions that were generated from the results of the Phase Two study. The ten questions cover three aspects: 1) overall SCQM practices (four questions); 2) the relationship among companywide QM, supplier-side SCQM, and customer-side SCQM (three questions); 3) the influences of companywide QM, supplier-side SCQM, and customer-side SCQM on performance (three questions). During the telephone interviews, the interview protocol worked as a guideline to help the researcher to find the root causes of different SCQM implementation in those cases. Because these questions closely related to the strategy of the automobile companies, the researcher chose the senior level staff in the Quality Department of the automobile companies as the interviewees. Moreover, the automobile companies of the 'Phase Three Study' were also selected on purpose. The case selection was based on three criteria: a) they are major automobile companies in the Chinese automobile industry; b) their ownership type is either CSB or JV; 3) their firm size is either super large or smaller size. Hence, due to the time and access limitation, six automobile companies were selected. From the perspective of ownership, two out of six were JVs and the other four were CSBs. From the perspective of firm size, three out of six were super large automobile companies and the other three were smaller automobile companies. The participating interviewees and automobile companies are listed in Table 3.6. Those participating automobile companies are located throughout China and all of them produce several famous vehicle models in the Chinese market. Hence, they can be regarded as representatives of the Chinese automobile industry. By following the same data analysis procedures in Section 3.5.4, RQ3 was answered based on the fruitful qualitative information.

Table 3.6: Participants of Follow-up Interview

Automobile company	Size	Ownership	Interviewee
$JVSL_1$	Super large	JV	MZX (Quality Engineer)
$CSBSL_2$	Super large	CSB	CXD (Former Quality Chief)*
$JVSL_2$	Super large	JV	ZHY (Quality Manager)
$CSBO_1$	Smaller	CSB	SKR (Quality Chief)
$CSBO_2$	Smaller	CSB	LBX (Quality Manager)
$CSBO_3$	Smaller	CSB	LSZ(Quality Chief)

**: Mr. CXD was promoted to vice-general manager at the interview time.*

3.8. Chapter Summary

Table 3.7 summarises the research design of this study. The nature and characteristics of this research determine that pragmatism is the research philosophy or the worldview that underpins this study. This chapter highlights the functions of the mixed research method and the design of the three-phase research. Compared to quantitative and qualitative research, the mixed research method can answer more complex research questions by collecting and analysing all kinds of data. It can provide a more comprehensive and rich description and explanation to help the researcher to achieve the research objectives in a very complex environment. In order to answer the three RQs of this research, the 'Multiphase Design' was implemented. Firstly, the qualitative research approach was implemented in seven major Chinese automobile companies to help the researcher to gain a deeper understanding of the SCQM practices in the Chinese automobile industry and build the foundation to develop the measurements, hypotheses, and the conceptual framework. The detailed procedures of the fact-finding case study will be discussed in Chapter 4. Secondly, a large-scale survey was carried out to examine the SCQM measurements, validate the SCQM framework, and test the proposed hypotheses. Based on the property of the SCQM constructs, PLS was chosen as the analysis technique to verify the data obtained from the questionnaire. Chapter 5 will describe the detailed procedures of model construction, measurement generation, pilot study, measurement and model analysis and discussion. Thirdly, six follow-up interviews were conducted to answer RQ3. This qualitative approach was designed to collect more fruitful data to help the researcher to explain the results of the large-scale survey. The detailed research procedures of Phase Three will be presented in Chapter 6.

Table 3.7: Research Design

Mixed Methodology	**Research Philosophy: Pragmatism**			
Multiphase Design	**Ontological Assumption**	**Epistemology Assumption**	**Data Collection**	**Aim**
Phase One Study	Subjectivism	Interpretivism	Semi-structured interviews; company documents; site visit	Summarise the suitable SCQM indicators and assist to hypotheses proposition
Phase Two Study	Objectivism	Positivism	Survey	Test relationships between SCQM practices and performance; Compare the different SCQM implementation between CSBs and JVs
Phase Three Study	Subjectivism	Interpretivism	Semi-structured interviews	Clarify the root causes of the different SCQM implementation

Chapter Four: Phase One: Fact Finding Case Study

4.1. Chapter Introduction

This chapter describes the detailed process about how to conduct the 'Phase One: Fact Finding Case Study'. It covers the review of the research design, within-case analysis, cross-case analysis, the SCQM practices in the Chinese automobile industry, and the discussion of the function of the 'Phase One Study'. As mentioned in sections 3.1 and 3.2 and Table 3.6, the purpose of the 'Phase One: Fact Finding Case Study' is to recognise the SCQM practices in the Chinese automobile industry. Moreover, it also aims to assist the researcher in generating the most suitable SCQM indicators and proposing the hypotheses. As explained in sections 3.1 and 3.5.1, this phase of study was exploratory in nature and needed to analyse the data that were generated from the perceptions of the managers in the Chinese automobile companies. Hence, case study was chosen as the research method

4.2. Review of Research Design

Combine the research aim in Section 3.1 with the case selection principles in Section 3.5.2, seven major automobile companies (five CSBs and two JVs) were selected to fulfil objectives of this phase of study (i.e. recognise the SCQM practices in the Chinese automobile industry; help to generate the most suitable SCQM indicators and propose the hypotheses). Because the seven participating automobile companies are different in size, production, sales, ownership, and location, they can be regarded as representative of the Chinese automobile industry. In order to enhance the data reliability and validity, the triangulation was implemented by conducting semi-structured interviews, reading the company documents, and visiting the workshops as discussed in Section 3.5.3. Due to the different business structure of the case companies (i.e. the different responsibility of quality managers), 15 interviews were conducted in August 2014. The interview protocol in Appendix 1 worked as the instruction to guide the conversations with the participants. All of the interviews were audio recorded, and the average duration was 80 minutes. Table 4.1 summarises the basic information about case companies and

interviews. The archived company documents included the annual reports and the internal SCQM memos (e.g. quality meeting records). The site visiting was conducted in the four major workshops of each automobile company to investigate their daily operations and SCQM programmes. For example, the researcher learned the assembly workstation's quality control process in detail (e.g. quality tools application; quality training sessions) by observing the production in assembly workshops. As explained in Section 3.5.4, the within-case analysis and cross-case analysis were utilised to summarise and compare the SCQM practices in each automobile company after collecting the necessary data.

Table 4.1: Case Company Categorisation

Company Name	Ownership Type	Size*	Interviewee	Duration (mins)	Location	Date
$CSBPM_1$	CSB	Medium	SLY (Quality Chief)	68	Quality Department	11/08/ 2014
			ZXB (Quality Manager)	76	Quality Department	11/08/ 2014
CSBSM	CSB	Medium	LQC (Quality Manager)	62	Assembly Workshop	08/08/ 2014
			WZ (Quality Manager)	70	Welding Workshop	08/08/ 2014
$CSBPM_2$	CSB	Medium	LWQ (Quality Chief)	86	Welding Workshop	15/08/ 2014
			HQL (Quality Manager)	82	Assembly Workshop	15/08/ 2014
CSBSL	CSB	Super Large	ZH (Senior Quality Manager)	93	Assembly Workshop	18/08/ 2014
			CZA (Quality Manager)	65	Quality Department	18/08/ 2014
CSBPL	CSB	Super Large	YZL (Quality Manager)	76	Stamping Workshop	05/08/ 2014
			DYZ (Quality Chief)	72	Assembly Workshop	05/08/ 2014

JVL_1	JV	Super Large	ZJE (Quality Manager)	88	Assembly Workshop	20/08/ 2014
			WG (Quality Chief)	96	Quality Department	20/08/ 2014
JVL_2	JV	Super Large	XHG (Quality Manager)	102	Assembly Workshop	24/08/ 2014
			MFX (Quality Manager)	83	Assembly Workshop	24/08/ 2014
			DCF (Quality Chief)	81	Quality Department	24/08/ 2014

***** *Based on the number of employees.*

4.3. Within-case Analysis

$CSBPM_1$ (*CSB, Medium*) is located in Zibo with more than 1,500 full-time employees. At present, the company focuses on producing electric cars. For the companywide SCQM, $CSBPM_1$ has operated under ISO 9000 for 20 years. $CSBPM_1$ sets up an annual quality target (e.g. annual *first time through* (FTT) target) by combining average past quality performance with planned quality improvement. However, this quality target cannot be broken down into sub-targets at the individual staff level. In day-to-day operations, the company allocates the so-called "double-check point" to ensure the quality of core producing procedures. The "double-check point" means another worker will conduct the 100% inspection for the corresponding working procedures and products. Moreover, $CSBPM_1$ recently launched "Speak Out" events encouraging workers, by awarding small monetary bonuses, to point out quality problems at any moment. However, ZXB (*Quality Manager, $CSBPM_1$*) also claimed that *"because of the heavy monetary investment and the limited knowledge of quality techniques, we mainly use basic spreadsheets to deal with the quality data"*. This statement indicates that although $CSBPM_1$ encourages employees to take part in the quality improvement programme, it still lacks quality knowledge and skills. The automobile company mainly applies the very basic approach to record the quality data. Compared to companywide SCQM, $CSBPM_1$ does not pay so much attention to upstream and downstream SCQM. For the supplier-side SCQM, $CSBPM_1$ selects suppliers predominately based on cost. It communicates with suppliers through monthly and annual meetings. However, SLY

(*Quality Chief, CSBPM$_1$*) also claimed that *"we also want to use high-quality components, but they are too expensive. Customers will not buy our product if we raise our price"*. This shows that CSBPM$_1$ cannot put quality first when selecting suppliers. Cost is the most significant supplier selection criterion in CSBPM$_1$. For customer-side SCQM, the sales subsidiaries and maintenance stations of CSBPM$_1$ collect customer feedback. The company also holds an annual conference for dealers, which mainly focuses on market information.

CSBSM (*CSB, Medium*) is located in Dingzhou with around 1,500 employees. For the companywide SCQM, the company level quality target is resolved to individual staff level step-by-step. CSBSM implemented TS16949 to supervise manufacturing quality. The five major TS16949 tools play important roles in the company. The Production Part Approval Process (PPAP) is managed by the cross-functional team, by which Cpk (1.33) and Ppk (1.67), are strictly applied and supervised. The Advanced Product Quality Planning (APQP) is managed by the Design Department and Technique Department. The frequent communication with the major suppliers facilitates the APQP work. The SPC and Measurement System Analysis (MSA) work is done by the Quality Department. However, the Quality Department only uses spreadsheets to deal with the data. Three employees from Quality Department are in charge of the Failure Mode and Effects Analysis (FMEA) works. It looks like CSBSM has a comprehensive quality control system, but the automobile company faces the problem of the shortage of quality professionals. As LQC (*Quality Manager, CSBSM*) stated: *"they (i.e. the three employees of FMEA) do not have the ability to discover all the potential problems, evaluate the weight of the problems, calculate the frequency of the problems, and provide the solutions".* Moreover, the CEO invented the "T-Card" that can show the quality improvement plan, process, and anticipated the result. The company also established the "Learning Dojo" in each workshop. This includes the training tables, modification boards, and product decomposition exhibitions. For the supplier-side SCQM, CSBSM requires suppliers to obtain TS16949 certification. The company conducts the so-called "Come in and Go out" event to enhance the communications with suppliers. WZ (*Quality Manager, CSBSM*) explained that "*the 'Come in' part involves suppliers coming in to discuss new requirements of quality and share development plans. The 'Go out' part aims to send employees to the suppliers to solve the problems together*". CSBSM also establishes Variability Reduction Teams (VRTs)

for different components to improve quality. The VRTs comprise employees from the company and corresponding suppliers. They hold weekly telephone meetings to discuss quality issues. For customer-side SCQM, CSBSM makes limited efforts in cooperating with customers compared to companywide and supplier-side SCQM. It applies the customised Dealership Management System (DMS) to collect feedback. The feedback contains market trends and customer satisfaction data. However, the function of the customised DMS is not well approved by employees. For example, LQC (*Quality Manager, CSBSM*) claimed: *"this electronic system does not work very well. We are learning and developing other investigation methods"*.

$CSBPM_2$ (*CSB, Medium*) is a newly established company that is located in Xingtai. It focuses on producing micro electric cars. For the companywide SCQM, it develops company level quality targets that can only be broken down to workshop level. $CSBPM_2$ has operated under ISO 9000 for five years and does not plan to apply for TS16949 certification. For example, LWQ (*Quality Chief, $CSBPM_2$*) stated: *"We work well under ISO9000. It helps us a lot in regulating the manufacturing process and improving product quality"*. The company implements a professional electronic system to collect and share quality information. However, quality training rarely receives attention; as LWQ (Quality Chief, $CSBPM_2$) claimed: *"frontline workers don't care and don't want to attend the quality training. We think the investment in training is not valuable*". The resistant attitude of employees towards quality training directly causes the automobile company to allocate insufficient focus and resource to provide quality training sessions. Compared to companywide SCQM, supplier-side and customer-side SCQM receive limited attention in $CSBPM_2$. For the supplier-side SCQM, $CSBPM_2$ particularly emphasises cost and delivery when selecting suppliers. HQL (*Quality Manager, $CSBPM_2$*) explained the automobile company's supplier selection by claiming "*we can easily find 20 more suppliers for the same components in this country because of the low technical content. It's not necessary to ask for quality certification for the suppliers*". For the customer-side SCQM, the sales subsidiary is in charge of collecting feedback through a customised DMS. The sales subsidiary handles the complaints representing $CSBPM_2$.

CSBSL (*CSB, Super Large*) is located in Tianjin with more than 7,700 full-time employees. At present, CSBSL is following Toyota's method of QM due to top

managers' requirement of "learning from a foreign exemplary". However, the quality system implementation is not executed well. For the companywide SCQM, CSBSL only utilises the seven basic quality tools to supervise quality-related work. The company arranges the so-called "quality battle" programme every year to encourage employees to provide quality improvement innovations, however, as ZH (*Senior Quality Manager, CSBSL*) claimed: "*the frontline workers do not care about this programme so much, and their proposed innovations usually do not contain too much value*". This shows that the outcome of the "quality battle" is not as expected. Moreover, the top managers strategically link the quality plan with the company business plan. However, due to the lack of understanding of quality improvement, top managers are eager to pursue the advanced quality system without a comprehensive consideration. For example, CZA (*Quality Manager, CSBSL*) stated: *"In the past our CEO decided to stick to "independent innovation", so that we changed from Toyota's way to FAW's QM. However, after two years, top managers decided to learn from a 'foreign exemplary'. We then changed back to Toyota's way"*. The frequently change of the quality control system shows the top managers' misunderstanding of the nature and the function of quality improvement. For the supplier-side and customer-side SCQM, CSBSL does not allocate as much resource as it distributes to the companywide SCQM. For the supplier-side SCQM, CSBSL selects suppliers based on their capacity of stable delivery but not component quality. The communications with suppliers are limited to the delivery schedule and price. For the customer-side SCQM, CSBSL implements a customised Management Information System (MIS) to collect dealers' feedback. However, the feedback emphasises market-related information (e.g. sales and price).

CSBPL (*CSB, Super Large*) is located in Baoding with around 60,000 employees. For the companywide SCQM, the company level quality target is divided into the individual staff level. CSBPL strictly operates under the TS16949, and it also obtained Vehicle Type Approval from the European Union. Moreover, the top managers give a great deal of attention to the quality works. For example, YZL (*Quality Manager, CSBPL*) stated: "*our CEO sometimes tests the newly assembled cars by himself. If our CEO can do it, there is no reason for us not to work hard for quality improvement*". This is the evidence to show the significant exemplary effect of top managers in the fields of encouraging employees to join the quality improvement programme. The company holds a morning and an evening meeting every day to discuss quality issues. CSBPL implements the so-

called “quasi-military management” in the company. The “quasi-military management” in CSBPL means to focus on hard work by following strict rules and enhancing cohesion and execution by leveraging internal cooperation. CSBPL designs the fixed operating actions for the workers to reduce potential mistakes. The quality inspectors do a tour inspection every 15 minutes. CSBPL requires all the employees to provide one quality improvement suggestion per month and the selected ones will be displayed at the so-called “Creative KongFu Kanban”. It is an A1 size Kanban, which shows the selected quality improvement advice that brings proven outcomes. Furthermore, the company has invested 2.6 billion Chinese Yuan in building a technique centre. It hires more than 1,000 professional technical and quality employees with at least a bachelor degree. The company also holds an annual technical conference to display and share innovative automobile techniques and advanced SCQM experience. For the supplier-side SCQM, CSBPL is the parent company of over 85% of its component suppliers. It builds a component park to allocate its supply subsidiaries. CSBPL requires all of its suppliers to obtain TS16949 certification. DYZ (*Quality Chief,* CSBPL) further stated that: “*we record the quality data of suppliers every day by our particular Enterprise Resource Planning (ERP) system, which will be evaluated quarterly by the Quality Department*”. This indicates that CSBPL also focuses the quality information sharing by utilising modern information technology. To communicate better with its suppliers, CSBPL asks all the CEOs of supply subsidiaries to attend the quality evaluation meeting each Thursday morning to discuss the quality situation and any problems. For the powerful external suppliers, the company will promote communication through joint research projects. However, for the customer-side SCQM, CSBPL does not perform as well as it does in companywide and supplier-side SCQM. The most significant customer-side SCQM practice in CSBPL is to hold an annual dealer conference to reward best performing dealers and share marketing philosophy.

JVL_1 (*JV, Super Large*) is located in Tianjin with more than 12,000 employees. For the companywide SCQM, the cross-functional team sets up the quality target and then divides it into individual staff level. JVL_1 has implemented the Toyota Production System to supervise manufacturing for the last 14 years, as well as the Andon system to notify team leaders and quality managers in the workshop of quality problems. JVL_1 encourages employees to solve quality problems and to innovate in quality improvement through conducting Quality Control Circle (QCC) activities. The

company holds two QCC competitions every year to reward the best QCC and encourage quality improvement. Moreover, JVL_1 has held the so-called "Creative KongFu" programme since 2002 to inspire employees to provide quality improvement suggestions. The company provides sufficient quality training for all employees. As ZJE (*Quality Manager, JVL_1*) claimed: "*we have weekly training classes for workers in different jobs. The classes include theory explanation and practical problem solving. We also sent some managers to our Japanese parent company to visit, work, and learn with the Japanese staff*". For the supplier-side SCQM, JVL_1 only selects suppliers that obtain TS16949 certification. JVL_1 sends the Quality Department's staff to suppliers to jointly solve quality problems or invites suppliers to its workshop and supervises their manufacturing process. For example, during the site visiting at JVL_1's assembly workshop, the researcher found that one of the door suppliers set up a production line in the JVL_1's workshop. ZJE (*Quality Manager, JVL_1*) explained that the supplier was urged to work in JVL_1's workshop to jointly solve the problem of the 'loose door' (i.e. the door cannot perfectly match the automobile framework). Moreover, JVL_1 treats its suppliers as its employees through providing technical and financial support to enhance a stable relationship with them. For the customer-side SCQM, JVL_1 established the Dealer Support Department (DSD) to handle quality issues. It provides maintenance sessions to dealers to help them solve potential quality problems. Moreover, WG (*Quality Chief, JVL_1*) indicated that: "*for some selected dealers, we also provide "One-Stop" financial support to help them provide better service to the final customers. In return, they will make more effort in collecting customer feedback and transmitting it to us*". This represents that JVL_1 not only provides technical support but also helps dealers by lending money. The financial support in turn enhances the utilisation of customer feedback in JVL_1.

JVL_2 (*JV, Super Large*) is located in Guangzhou. At present, it has more than 8,000 employees. It sets up results-oriented (e.g. annual FTT target) and process-oriented (e.g. stick mirrors on the assembly line to increase the successful rate of installing screw) quality targets. Both of these are divided into individual staff level targets. JVL_2 operates under its own quality system to supervise manufacturing. In each workshop, there are two inspectors to test and record quality data for each production line. One multi-functional worker will work as the instructor to supervise the quality test work. To enhance the quality level and quality awareness of workers, JVL_2 conducts the so-

called “Quality Adoption Plan”. XHG (*Quality Manager, JVL₂*) explained: *“each frontline worker needs to take responsibility for the quality of one particular component”.* The company also makes several modifications to reduce the potential quality problems. For example, it designed a cover for the workers’ uniform buttons and replaced the metal “waste test” tube by a rubber tube to avoid vehicle scratches. Moreover, JVL_2 provides a three-month quality assurance training for new workers and sends managers to Japan to accumulate advanced QM experience. For the supplier-side SCQM, JVL_2 requires all the suppliers to have TS16949 certification. It also jointly set up quality targets with suppliers and then breaks them down to component level for corresponding suppliers. The company evaluates the quality of suppliers every month by testing the 5M1E (Man, Machine, Material, Method, Measure, and Environment). JVL_2 also selectively invests in some suppliers to help them upgrade machines and technology. Furthermore, MFX (*Quality Manager, JVL₂*) stated that: “*we implement the Quality Control Data Distribution System to promote communication with suppliers. It can carefully record the quantity of defects, the responsible factory, located region, and the solution*”. This indicates JVL_2’s emphasis on utilising information technology in the fields of quality information sharing with suppliers. JVL_2 also holds an annual supplier conference, in which a Quality Forum is arranged. For the customer-side SCQM, DCF (*Quality Manager, JVL₂*) explained the specific approaches in the automobile company: “*we established the Total Customer Service Department (TCSD) that contains three individual divisions to take responsibility to collect customer feedback. According to the different kinds of quality problems, the three divisions will clarify their corresponding responsibility and then issue the solutions*”. This shows that besides cooperating with dealers, JVL_2 starts to communicate with final customers through its own employees. Moreover, TCSD labels the collected feedback at four levels of severity. The collected data will be carefully recorded in the Quality Information System. Furthermore, JVL_2 is also developing a mobile app to communicate with its customers.

4.4. Cross-case Analysis

The specific characteristics of SCQM of each case are listed in Table 4.2. Data presents that each company implements SCQM in their particular way which leads to different SCQM performance. JVs perform better than CSBs in FTT probably because of high quality awareness, close upstream and downstream quality cooperation, and the well-

implemented internal quality system. On the other hand, CSBs focus more on companywide SCQM practices. The downstream SCQM does not attract enough attention in CSBs probably because of the inadequate customer focus. Moreover, the low-quality awareness, the lack of quality knowledge, the outdated equipment, and inactive learning attitude of CSBs impede their SCQM implementation. Tables 4.2 and 4.3 provide detailed comparisons among the case companies. During the interviews, this study found that only *sales* and *profit* were used as financial performance indicators in the case companies. Moreover, interviewees used FTT of finished automobiles to describe the quality performance. The refinement of performance indicators assisted the researcher to better focus on the SCQM practices in the case companies. By comparing the SCQM practices of participating cases in Table 4.3, the Phase One research clarified the different SCQM implementation between CSBs and JVs. JVs were consistently applying a comprehensive SCQM except regularly involving customers in quality improvement. However, CSBs focused more on implementing companywide SCQM in different ways. Only two CSBs actively integrate suppliers into SCQM implementation. Through continually comparing the SCQM practices in the two groups, three major factors that influence SCQM implementation are clarified, namely quality improvement motivation, company capability, and adoption of advanced practices and techniques.

4.4.1. Quality Improvement Motivation

All of the interviewees claimed that quality is the most significant concern in their companies. However, quality was not the priority in some CSBs. Interviewees from these CSBs emphasised the specific market condition when introducing their quality policies. For instance, LWQ (*Quality Chief, $CSBPM_2$*) mentioned: "*We know that our product quality is not good. However, if we can still earn considerable revenue by selling the existing products, why should we improve quality? We will never sacrifice the contract and production to exchange the misty quality*". Similarly, SLY (*Quality Chief, $CSBPM_1$*) indicated: "*Our high-end product does not sell well because customers do not think our products are worth the price. Investing more in quality is not that attractive". Based on the interviewees' responses and the SCQM practices in the company, overlooking the importance of quality commonly exists in CSBs. It is true that improving quality will increase the investment and the benefit*

Table 4.2: Specific SCQM Practice and Performance of Cases

Case	Companywide SCQM	Supplier-side SCQM	Customer-side SCQM	SCQM Performance
CSBPM$_1$	Implements ISO9000; "Double Check-Point" Style production; "Speak Out" activity.	Supplier selection: Cost; Monthly and annual meeting.	Annual conference: Collects market information.	FTT: 80%; P: 96000/year; I: 5days; S: 70000/year (↓); Profit: ↓.
CSBSM	Implements TS16949; Can't apply five major tools well; "T Cards"; "Learning Dojo".	Supplier selection: Quality; "Come in & go out"; VRTs.	Problematic customised DMS: Collects market trend and customer satisfaction.	FTT: 65%; P: 160000/ year; S: 150000/year (↑); I: 3Days; Profit: ↔
CSBPM$_2$	Problematically run ISO 9000; No quality training.	Supplier selection: Cost.	Sales subsidiary handles customer complaints.	FTT:70%; P:100000/year; I: High; S: 50000/year (↔); Profit: ↓.
CSBSL	Follows TPS; Basic seven quality tools; "Quality Battle" activity.	Supplier selection: Delivery.	Customised MIS: Collects market-related data.	FFT: 63%; P: 72000/year; I: High; S: 48% ↓; Profit: ↓.
CSBPL	Follows TS16949; Military-style management; "Creative Kongfu" activity; Starts investing in quality intelligence.	Supplier selection: Quality; Weekly quality meeting; Joint research project.	Annual conference: Shares market philosophy.	FTT: 96%; P: 730800/year; I: 5Days; S: 730600/year (↔); Profit: ↔.
JVL$_1$	Follows TPS; QCC competition; "Creative Kongfu" activity; Quality education in Japan.	Supplier selection: Quality; Joint problem-solving; "Employee Style" supplier.	DSD: Collects customer feedback; Quality training and financial support.	FTT: 99%; P:450000/year; I: 5 Days; S: 450000/year (↑); Profit: ↑
JVL$_2$	Operates ANPQP; "Quality Adoption Plan"; Targeted practice modifications; Quality education in Japan.	Supplier selection: Quality; Communicate through QCDDS; Quality Forum.	TCSD: Handles customer feedback through QIS; Mobile APP.	FTT: 99.58%; P: 1100000/year; I: 8-10 Days; S: 954000/year (↑); Profit: ↑.

TPS: Toyota Production System; ANPQP: Alliance New Product Quality Procedure; QCC: Quality Control Circle; MIS: Management Information System; DMS: Dealership Management System; QCDDS: Quality Control Data Distribution System; DSD: Dealer Support Department; TCSD: Total Customer Service Department; QIS: Quality Information System; FTT: First Time Through; P: Production; I: Inventory; S: Sale; ↓: Declining; ↑: Increasing; ↔: Stable.

Table 4.3: The Comparison of SCQM Practices

Evaluation Aspects		Companies						
		$CSBPM_1$	**CSBSM**	**CSBPM2**	**CSBSL**	**CSBPL**	**JVL1**	**JVL2**
Supplier-side SCQM	The company builds quality-based supplier selection standard.	×	√	×	×	√	√	√
	The company uses efficient ERP system to share quality data with suppliers.	×	√	×	×	√	√	√
	The company communicates frequently with suppliers about quality.	×	√	×	×	√	√	√
	The company provides quality training to suppliers.	√	√	×	√	√	√	√
	The company provides financial support to suppliers.	×	×	×	×	√	√	√
	The company builds a long-term relationship by mutual learning and support with suppliers.	×	√	×	×	√	√	√
	The company relies on several key suppliers to improve quality and stabilise manufacturing.	×	√	×	×	√	√	√
Company wide SCQM	Top managers provide adequate support and resources to quality improvement.	√	√	×	√	√	√	√
	The company builds strategic quality plan.	√	√	×	√	√	√	√
	The company motivates all employees to participate in continuous improvement.	√	√	×	√	√	√	√
	The company allocates corresponding quality responsibility to every employee.	×	×	×	×	×	√	√
	The company implements the fundament seven quality tools to guide manufacturing process	√	√	√	√	√	√	√
	The company implements advanced SPC techniques to supervise the manufacturing process.	×	×	×	×	√	√	√
	The company provides sufficient resources to hold scheduled companywide quality training.	√	√	×	√	√	√	√
	The cross-functional team is in charge of product design work.	√	√	√	√	√	√	√
	The company systematically records statistical data and diffuses them in a timely manner to all employees.	×	√	×	√	√	√	√
	The company establishes defect tracking system, which systematically records the supplied components and finished automobiles.	√	√	√	√	√	√	√
Customer-side SCQM	The company establishes a mature system to effectively collect customer feedback.	×	×	×	×	×	√	√
	The company transmits feedback to corresponding department or employee.	×	×	×	×	×	√	√
	The company regularly involves customers in product design and quality improvement.	×	×	×	×	×	×	×
	The company holds annual customers conferences to discuss market information with customers.	√	√	√	√	√	√	√
	The company listens frequently to customers' quality related voices and stays highly responsive to customer complaints.	×	×	×	×	×	√	√

(√: Evidence for the corresponding practice; ×: No evidence for the corresponding practice)

may not be achieved in the short-term. However, the underestimation of quality will significantly hit the brand recognition, and it is not easy to rebuild customer confidence (Tse and Tan, 2012). For instance, several years ago, the N3 model's engine of CSBSL was reported as having problems of abnormal noise and leaking. However, the company did not solve the root causes but only replaced the engine for the limited number of complaining customers. ZH (*Senior Quality Manager*, CSBSL) argued that it is such 'passive reaction practices' in the company that have resulted in a massive decline in sales and profits (Shown in Table 4.2).

4.4.2. Company Capability

This research found clear gaps in the fields of production equipment, quality knowledge of employees, and technology investment and ability between JVs and CSBs. Several examples illustrate JVL_2's high technology capacity and advanced automation: for instance, the newly designed stamping dies, the imported painting machine from Daiki Sha, the 277 fully-automatic welding machines, the high-tech AGVs, and the hybrid assembly line. These can directly guarantee the desired quality level. Moreover, besides mastering the fundamental seven quality tools, the quality managers could operate SPC software and conduct FMEA. The frontline workers also had an awareness of reading the posted quality data and had the ability to understand it. These were the results of the various quality training sessions and the high recruitment requirements of the company. For example, XHG (Quality Manager, JVL_2) claimed*: "The minimum education requirement for frontline workers is a bachelor degree. We will train new employees for three months for quality assurance and corresponding production procedures. Our quality managers will learn quality knowledge and master quality tools in Japan"*. A similar claim was also made by ZJE (Quality Manager, JVL_1): *"We design a comprehensive training path for our employees to enhance their working ability and quality knowledge. It includes the internal quality sessions, quality control circle competitions, and Creative Kongfu presentations"*. Therefore, the quality managers can operate SPC software and conduct FMEA, and the frontline workers have the awareness and ability to read and understand the posted quality data in JVs.

However, the CSBs did not perform well in these fields. For instance, $CSBPM_2$ only had two stamping machines, both of them made in the 1980s. Nearly half of the moulds were gathering rust. There were no computer numerical control systems, except for the

ones for the overhead transmission chains. Moreover, LWQ (*Quality Chief, CSBPM$_2$*) claimed: "*I do not think the five tools of TS16949 are suitable for the automobile company. It is very hard to identify and numerically represent the related parameters*". However, TS16949 is specifically designed for the automobile industry. This reply expresses low quality awareness and insufficient quality knowledge in CSBPM$_2$. Furthermore, the frontline workers hired by CSBPM$_2$ were from a nearby village; their education level was very low. Based on the researcher's observation, the workers even spent time chatting during production. For example, during the site visiting at a stamping workshop, the researcher found that the frontline workers were discussing the movie they watched last night when operating the stamping machine. Moreover, LWQ (*Quality Chief, CSBPM$_2$*) further claimed: "*Our frontline employees only watch the working procedures on the Kanban. They do not pay attention to the listed quality data and do not want to take quality training*". Similarly, LQC (*Quality Manager, CSBSM*) complained: "*How can we clearly know our quality situation through using Excel as the only statistical tool? How can we build a functional FMEA database with only three young staff without knowledge to identify the occurrence and severity of quality problems?*" These two statements also clearly indicate the low quality awareness and the insufficient quality skills of CSBs' employees.

4.4.3. Adoption of Advanced Practices and Techniques

SCQM requires companies to continually seek the nature of quality improvement but not randomly upgrade machinery and the management system (Hu et al., 2015). However, ZH (*Senior Quality Manager*, CSBSL) said: "*After 30 years' learning from foreign companies, we still stop at the superficial level of the foreign advanced management……What have we learned? Yes, we have changed the title of workers from "Gong Ren" (Chinese translation of worker) to "Staff". But so what? The so-called "learning and modification" is entirely symbolic*". This indicates the top managers only want to show the society and customers that CSBSL has advanced QM in the company but do not want to concentrate on applying the advanced practices in detail. CZA (*Quality Manager, CSBSL*) further claimed: "*Toyota may have 20 or 50 records about one minor door problem in their FMEA database due to its annual accumulation of quality records. However, look at us, we have already changed our quality system three times after reorganisation for the so-called "learning" purpose. How can we build up our quality database?*" This statement clearly represents that they keep abreast of

fashion by randomly adopting quality systems that cannot bring benefits to the company. The "symbolic adoption" is not a random case that only happened in CSBSL. For example, LQC (*Quality Manager, CSBSM*) illustrated the negative example in his company: "*To show our progress in integrating information technology, the DMS was designed by our IT employees who lack quality knowledge (in production). Frankly speaking, this system contributes a very tiny amount"*. During the site visit at CSBPL, the systematic 5S in workshops, the good maintenance of melting and assembly machines, and the strict production procedures revealed the company's efforts to adopt advanced management practices. However, the release of its flagship model had been delayed twice because of the bad quality of the retarder and severe mismatching problems among several essential components. It indicates that to transform quality investment into "visible" quality performance is still a significant concern to CSBs. However, JVL_2 set a good example for CSBs. It co-developed the AGV with Tsinghua University, which reduces workers' unnecessary movement and distraction. After the invention, JVL_2 kept learning the technique of AGV and finally mastered all the principles. At present, JVL_2 has upgraded the AGV and reduced almost 60% of related production cost. This learning process demonstrates how the right attitude and spirit of adoption of advanced practices and tools can benefit the company.

4.5. SCQM Practices in the Chinese Automobile Industry

Both the within-case and the cross-case analyses provided strong evidence that the case companies implement different SCQM strategies with a portfolio of initiatives and innovations that can provide a competitive edge. Based on the previous analyses, four SCQM strategies implemented in the Chinese automobile industry are summarised.

4.5.1. Inward Facing SCQM

It is an SCQM implementation strategy with the purpose of continually improving operational and financial performance by instigating cooperation within the company. For such an approach to be effective, all of the departments and individual employees should clearly understand their SCQM responsibility and share the same quality culture. During the fieldwork, this phase of study found that CSBSL, $CSBPM_1$, and $CSBPM_2$ are typical examples implementing an inward facing SCQM strategy. Due to the specific product positioning strategy (e.g. focusing on keeping prices low) and limited company capabilities (e.g. outdated company equipment and low quality awareness),

these companies endeavour to improve performance looking internally rather than enhancing cooperation with suppliers and customers at the current business stage. Low cost is usually their first concern. For instance, as shown in Tables 4.2 and 4.3, CSBSL and $CSBPM_1$ do not consider implementing advanced SPC software because of the heavy investment associated with it. Moreover, $CSBPM_2$ does not provide scheduled training courses because the company considers the cost performance of quality training to be too low. Further, $CSBPM_1$ and $CSBPM_2$ regard cost as the most important factor when selecting suppliers. For the downstream SCQM, these companies also do not put effort into cooperating with customers. For instance, CSBSL and $CSBPM_1$ mainly discuss market-related issues with their customers and ignore the importance of quality-related information. Even though $CSBPM_2$ collects quality-related feedback from customers, it seldom transmits this information to the corresponding departments and employees. Thus, these companies do not have enough motivation in improving performance by jointly developing with suppliers and customers. The main concerns for these companies are increasing performance by strictly following manufacturing procedures to eliminate non-value-added manufacturing activities, procuring cheaper suppliers to achieve high cost performance, and building good business relationships with customers to sign more contracts (Table 4.3). However, because of the complexity of the automobile SC, inward facing SCQM cannot bring benefit to these companies in the long term. Given the comparative performance in Table 4.2 and the evidence for the companies pursuing this strategy (CSBSL, $CSBPM_1$, and $CSBPM_2$), the high-quality components, as well as timely customer feedback, are playing more and more important roles in achieving better performance. It will become more difficult for a company to improve operational and financial performance only through its own strength. Thus, expanding communication, cooperation, and integration with suppliers and customers is the improvement direction for inward facing SCQM. In summary, the inward facing strategy is the fundamental stage of SCQM. To achieve successful SCQM, this strategy needs to be expanded from both the supplier-side and customer-side.

4.5.2. Supplier Facing SCQM

It is an SCQM implementation strategy that seeks to continually improve operational and financial performance by predominantly collaborating with suppliers and companywide cooperation. Nowadays, companies buy not only the components but

also the capability of suppliers. For instance, CSBPL jointly built a laboratory with suppliers to improve component quality (Table 4.2). Manufacturers cannot continuously produce high-quality products without active collaboration with suppliers (Kannan and Tan, 2010), especially in the highly collaborative automobile industry. Due to the numerous components assembled in a vehicle, manufacturers need to strictly follow the principles of supplier selection, frequently communicate with suppliers, and continually carry out mutual support and learning with suppliers. However, they spend more energy on working with suppliers, but neglect (or do not have enough capability to emphasise) the importance of customer-side cooperation. CSBSM and CSBPL are typical examples of pursuing supplier facing SCQM strategy. Based on Table 4.2, they implemented and operated according to TS16949 to perform companywide quality improvement work. Moreover, they also set up rigorous supplier selection policies (i.e. require quality certification for suppliers), implemented applicable digital systems to share real-time quality and supply information with suppliers (i.e. apply a customised ERP system), and sent capable employees to guide, as well as to learn from suppliers. CSBSM and CSBPL's efforts on supplier-side SCQM help the manufacturers to achieve better quality performance and more stable financial performance (Table 4.2). On the contrary, these two manufacturers do not have a professional and efficient department to deal with customer-side SCQM. Due to the inadequate quality understanding, the customised DMS in CSBSM, which aimed to collect customer feedback, did not work effectively. Moreover, CSBPL only provides maintenance courses to customers but does not conduct mutual sharing of quality improvement works. To enhance the performance of companies that implement supplier facing SCQM strategy, manufacturers need to disregard the old philosophy that the dealer is only in charge of selling automobiles, and to recognise customers as valuable input and involve them in SCQM works through efficiently collecting feedback and utilising this information in decision making. To summarise, supplier facing SCQM is a more advanced SCQM strategy than inward facing SCQM. However, to achieve a comprehensive SCQM, companies that implement a supplier facing strategy need to focus more on the customer-side.

4.5.3. Outward Facing SCQM

It is an SCQM implementation strategy that seeks to continually improve operational and financial performance by involving all parties of the SC in measuring, analysing

and continually improving products, services, and processes. Implementing outward facing SCQM needs the joint efforts of the manufacturer, supplier, and customer. If a party operates in isolation, the outward facing SCQM strategy cannot be effectively implemented. CSBSM and CSBPL are the typical examples of lacking customer-side SCQM concerns. The involved SC members should set up quality goals and principles together and share the same quality culture to keep the same pace in SCQM works. JVL_1 and JVL_2 are the typical manufacturers conducting outward facing SCQM. Both of them establish an appropriate quality system (TPS in JVL_1 and a customised quality system in JVL_2) and have followed it strictly for more than ten years in the company. Moreover, JVL_1 and JVL_2 also provide sufficient support from top managers to hold scheduled training courses (shown in Table 4.3). It helps every department and all staff in JVL_1 and JVL_2 to clearly understand their quality responsibility and share the same quality culture. Moreover, they also set up quality targets jointly with suppliers and build long supplier relationships by providing technical and financial support. For instance, JVL_1 treated suppliers as employees to jointly develop their capabilities. JVL_2 established QCDDS to share quality issues and supply information to suppliers. Furthermore, JVL_1 and JVL_2 established specific departments to fully manage customer-related quality issues. For instance, JVL_1 arranges DSD to provide quality training and monetary support. JVL_2 sets up TCSD to handle customer feedback and provide the proper solution to customers based on its Q-Speed system. Due to successfully implementing outward facing SCQM strategy, JVL_1 and JVL_2 obtained the highest quality performance, increasing sales, and growing profits (shown in Table 4.2). In summary, outward facing SCQM is the most advanced SCQM strategy which can bring the best quality and financial performance.

4.5.4. Customer Facing SCQM

That is an SCQM implementation strategy with the view of continually improving operational and financial performance by predominantly collaborating with customers and companywide cooperation. Because SCQM is a customer-driven management philosophy, recognising customer requirements and making quick corresponding responses are two significant practices to continually improve performance. Thus, a mature system to collect, analyse and transfer customer feedback is an essential factor of customer-side SCQM. For instance, JVL_1 and JVL_2 assign a particular department to build efficient customer feedback collection and a transmission system to handle

customers' opinions. In addition, efficiently utilising customer input in product design and quality improvement work can help manufacturers to take the customer into account earlier. Just as with JVL_1 and JVL_2, the two automobile companies employ customer input in continuous improvement at regular intervals. On the other hand, building a robust customer relationship by remaining highly responsive to customer complaints, holding scheduled customer conferences, and conducting customer support services can motivate customers to continually provide input to SCQM works. Even though all of the case companies hold customer conferences regularly, only JVL_1 and JVL_2 are collecting quality-related issues besides market information from customers. However, no case in this study has applied a customer facing SCQM strategy. It is mainly due to the large number of components required in assembling an automobile. Even for one component, manufacturers may need to negotiate with several tiers of suppliers to ensure quality and production. Therefore, nowadays it is almost impossible for an automobile manufacturer to improve operational and financial performance by mainly relying on customer-side SCQM. Nonetheless, McKinsey (2015) clarified that the development of digital technology could help automobile manufacturers to collect more real-time customer information that can lower development costs and speed up the time to market by big data simulations and virtual modelling. Furthermore, with the help of advanced online platforms, manufacturers can accurately supervise the performance of a vehicle and its components, which could suggest directions and opportunities for eliminating anything the customer does not value from design and manufacturing (McKinsey, 2015). Hence, with the development of the Common Technology Platform and information technology, there might be some manufacturers chasing better operational and financial performance by implementing a customer facing SCQM strategy. In fact, Alibaba, one of the most successful Internet companies in the world, has started cooperating with SAIC Motor to produce the AliCar from 2014 by applying a customer-side SCQM strategy (Sina, 2014). Alibaba emphasised developing the YUN OS system based on big data to collect, analyse, and utilise customer information and building an ePlatform to provide service to customers. The manufacturing process and the collaboration with suppliers were conducted by SAIC Motor.

4.5.5. SCQM Strategy Taxonomy

Figure 4.1 summarises the corresponding SCQM strategy that is implemented in the case companies. This taxonomy also classifies the performance level of each SCQM strategy. The dashed arrows indicate the potential SCQM advancement direction of automobile brands in the Chinese automobile industry without confirmed evidence in the current automobile industry. Based on this taxonomy, JVs implemented more advanced SCQM strategy than CSBs and obtained better operational and financial performance. From the perspective of firm size, super large automobile companies expressed more potential to apply advanced SCQM strategy than smaller automobile companies in the Chinese automobile industry. Due to the limited SCQM research in the Chinese automobile industry, this taxonomy enhanced the researcher's understanding of SCQM practices in automobile companies that operate in China by pointing out the different focus of automobile companies in the field of SCQM implementation. This taxonomy provided empirical information to assist the researcher to propose hypotheses in the Phase Two study (i.e. Chapter Five).

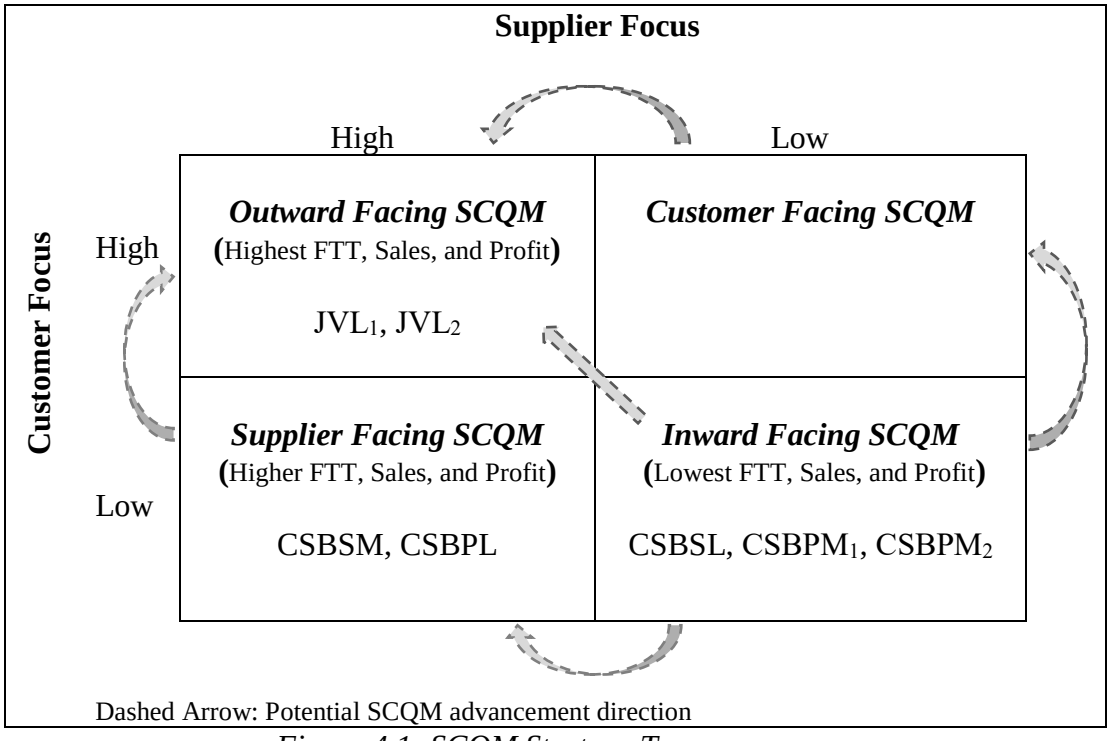


Figure 4.1: SCQM Strategy Taxonomy

4.6. The Function of the Phase One Study

Based on the within-case and cross-case analyses, the 'Phase One Study' described the very different SCQM implementation in the different Chinese automobile companies

and summarised three SCQM implementation inhibitors. It also helped the researcher to categorise four SCQM strategies and a taxonomy to better recognise the SCQM in the Chinese automobile industry. However, the 'Phase One Study' not only assisted the researcher to gain a comprehensive understanding of SCQM practices in the Chinese automobile industry but also made contributions to the measurement generation and hypotheses building. For measurement generation, the researcher found that ROA, ROI, and market share were not familiar to Chinese quality managers during this stage of research. Using them as the financial measurements will mislead the respondents. The researcher found that only sales, profit, and cost of quality are used as financial performance indicators in the case companies. Moreover, interviewees used FTT of finished automobiles to describe the quality performance. Furthermore, because there is a lack of SCQM studies in the Chinese automobile market, some specific SCQM items of CSBs and JVs are still isolated from current knowledge. For example, besides posting quality data (e.g. FTT) on the Visual Kanban, Chinese companies also display frequently occurring problems and corresponding solutions on the Visual Kanban near workstations. Therefore, the fieldwork helped the researcher to refine the measurements through deleting ambiguous items and adding new specific ones. This kind of newly added measurement is highlighted by the word "Empirical Data" in the corresponding tables (please refer to Section 5.3). For hypotheses building, Phase One qualitative research helped the researcher to build the model through providing empirical data from automobile companies. Because the previous SCQM studies analysed different data from various industries and countries, their results were not exactly same. For example, Soltani et al. (2011) argued there was no positive relation between supplier quality capability and organisational performance (e.g. product quality, customer satisfaction) in the manufacturing industry. However, Noshad and Awasthi (2015) identified that the supplier quality significantly affected product quality in both manufacturing and service sectors. The mixed results bring difficulties to hypotheses building. The empirical data from fieldwork provided support to initially verify the relationships among the different SCQM practices and performance, thus enhancing the reliability of the hypotheses building in this research (please refer to Section 5.2).

4.7. Chapter Summary

This chapter aims to recognise the SCQM practices in the Chinese automobile industry and helps to generate the most suitable SCQM indicators and propose the hypotheses

in Chapter 5 by providing fruitful qualitative data. Based on Table 4.1, this chapter describes the basic information about the seven case companies (i.e. size and ownership) and interviews (i.e. interviewees, duration, place, and date). This provides clear background information about the 'Phase One Study'. By conducting the within-case analysis, the specific SCQM practices of different Chinese automobile companies are summarised. Table 4.2 shows the exemplary SCQM approaches for each case. By conducting cross-case analysis, Table 4.3 indicates the different SCQM implementation in Chinese automobile companies. Moreover, the cross-case analysis also develops three SCQM inhibitors (i.e. quality improvement motivation, company capability, and adoption of advanced practices and techniques) in the Chinese automobile industry. According to within-case and cross-case analyses, this chapter also frames an SCQM strategy taxonomy by discussing the four SCQM strategies implemented in the automobile companies. For example, some CSBs lack capability to implement a comprehensive SCQM strategy but concentrate on companywide QM improvement (i.e. inward facing SCQM strategy). The specific SCQM practices, the different SCQM implementation process, and the SCQM strategy taxonomy together provide the researcher with a clear understanding of the SCQM practices in the Chinese automobile industry. Furthermore, based on the triangulation data (i.e. archived company documents, site observations, and interviews) collected in the 'Phase One Study', the researcher can propose more appropriate hypotheses in Section 5.2 and generate more suitable SCQM indicators in Section 5.3. Hence, this chapter is the solid foundation of the 'Phase Two Study' and plays the role of a connecting link between preceding and the following stages in this PhD research.

Chapter Five: Phase Two: The SCQM Practices in the Chinese Automobile Industry

5.1. Chapter Introduction

In this chapter, hypotheses building, measurement development, measurement analysis, and model analysis for SCQM are discussed. After understanding the general SCQM practices in the Chinese automobile industry by conducting the 'Phase One Study', quantitative research was carried out to test the relationships between SCQM practices and performance and investigate the influences of ownership and firm size on SCQM implementation. As stated in Section 3.6.6, the first step of conducting the 'Phase Two Study' (survey research) was to build the structural model. It was based on the hypotheses that represent the assumed relationships among SCQM practices, performance, and control variables. The second step was to establish the measurement model. Measurement is an essential element for extending the fundamental body of knowledge in SCQM of the Chinese automobile industry. An effective measurement instrument is a prerequisite for good empirical science (Menor and Roth, 2007; Hair et al., 2014). It should cover the content domain of each construct (Li et al., 2005). The third step was to design the questionnaire and collect the necessary data. Based on the nature of this study and the characteristics of the measurements, PLS was utilised to test the measurements and hypotheses in the fourth step. After determining the most appropriate SCQM measurements, the structural model analysis was carried out to answer RQ1 and RQ2.

5.2. Model Construction

An automobile is normally composed of more than 5,000 different components (He and Bai, 2012). As the assembler is usually in charge of assembling and stamping works (Womack et al., 2007), the supply of components becomes an indispensable process of ensuring desirable quality. Moreover, the dealer takes the assembler's job to sell automobiles to final customers (Womack et al., 2007). Therefore, this research starts from the perspective of the automobile company to investigate both internal QM and external QM for the whole SC. The framework is categorised into four parts: companywide QM practices, supplier-side SCQM practices, customer-side SCQM

practices, and SCQM performance that is composed of operational performance and financial performance.

This research adopts the RBV and RV as the theoretical lenses to analyse the effects of SCQM patterns on performance and the relationship among SCQM patterns. The underlying argument of the RBV is that valuable, rare, and imperfectly imitable resources can bring competitive advantages (Barney, 1991). A bundle of resources that are inter-connected and demonstrate synergistic effects is most effective in gaining competitive advantages (Black and Boal, 1994). In this research the SCQM practices are regarded as resources. RV proposes that the greater the SC partners' investment in inter-firm knowledge-sharing routines and relation-specific assets, the greater the potential for relational rents. Based on the merits of RBV and RV, the researcher argues that it is the overall configuration of SCQM that creates competitive advantages. In other words, a single SCQM dimension, such as companywide QM, is not sufficient for competitiveness. The overall configuration of SCQM is valuable because it is embedded in the processes of SCM. It is rare because the development processes require the SC partners to provide extensive effort, time, and money. It is difficult to imitate an SCQM pattern because it is not easy to identify how the SC members interact to create a collaborative QM system. Competitors can hardly imitate without knowing how the system is organised. Moreover, as the establishment of an SCQM pattern is path dependent, competitors are precluded from immediate imitation. Hence, the researcher concludes that the configuration of SCQM may create inter-connected resources that enable a manufacturer to outperform others (Sinha and Ven, 2005; Huo et al., 2015).

5.2.1. Companywide QM and Operational Performance

Companywide QM recognises that all the departments and employees within a firm should conduct quality-related activities as part of an integrated process. This indicates integration and cooperation among departments and employees within a single firm (Koufteros et al., 2010). Companywide QM links all the quality practices that operated within the organisation into a seamless process to meet and exceed customers' expectation (Chen et al., 2009; Alfalla-Luque et al., 2015). It removes departmental obstacles and leads cooperation to satisfy customers' expectation, rather than working within the single department. It emphasises cross-functional communication and

coordination (Huo et al., 2016). Moreover, companywide QM encourages all related activities and departments to work together by information sharing, joint planning, and cross-functional team formation (Flynn et al., 2010). These cooperation activities integrate individual departments to a combinative organisation (Kahn and Mentzer, 1996). This helps an organisation recognise and satisfy customers' changing requirements more quickly. Moreover, companywide QM also motivates employees from different functions to work together to solve conflicts and satisfy customers collaboratively. Hence, companywide QM urges the departments to work cooperatively under the same quality policy and pushes everyone in an organisation to take responsibility for QM. Hence, better companywide QM results in a deeper understanding of the product quality and a clearer direction for improvement (Hu and Flynn, 2015). The company needs to undertake its strategies, practices, and procedures across various internal hierarchies and departments into synchronised and collaborative processes, with the objective of satisfying the requirements of customers (Flynn et al., 2010; Stank et al., 2001). As managerial commitment is assigned to quality strategies, employee participation through training and empowerment is fostered (Zeng et al., 2013). It helps to design quality into process, products and services by better sharing and applying the quality information, which leads to better product quality, fewer inventories, and higher productivity (Kaynak and Hartley, 2008; Vanichchinchai and Igel, 2011; Sabella et al., 2014). Hence, companywide QM can be regarded as a driver of operational performance (Huo et al., 2014).

Several studies have investigated the relationships between companywide QM and performance. Sroufe and Curkovic (2008) verified that integrated internal processes benefit an organisation's effectiveness and efficiency. Flynn et al. (2010) also confirmed that companywide QM approaches, along with SCM, can enhance operational performance. Huo et al. (2016) also clarified that the use of the enterprise resources planning system and coordination of product improvement and innovation by different departments assists companywide QM and positively influence operational performance. The lack of these kinds of internal integration practices becomes the biggest obstacle to enhancing operational performance by conducting collaborative activities (Baihaqi and Sohal, 2013). Ineffective internal integration may cause conflicts between different departments and employees, leading to defective products, pointless efforts, and wasted resources (Pagell, 2004). Moreover, during the 'Phase One Study',

the interviewees also explained their understanding about the relationship between companywide QM and operational performance. For example, YZL (Quality Manager, CSBPL) stated: "*The presentation of our Creative Kongfu Kanban activity motivates our employees in participating continuous quality improvement. This definitely helps our company to achieve better quality performance*". Moreover, WG (Quality Chief, JVL1) also emphasised: "The advanced quality tools and information system implemented in our company assist us in enhancing production and stabilise product quality to meet customers' requirements". These two statements show that companywide QM practices may enhance operational performance in the Chinese automobile industry. Therefore, based on the literature and the fact-finding case study, the following hypothesis is generated:

H1a: Companywide QM is positively related to operational performances.

5.2.2. Companywide QM and External SCQM

The successful SCQM implementation requires companies to establish continuous linkages with suppliers and customers along with internal departmental synergy (Robinson and Malhotra, 2005; Flynn et al., 2010). Even though companywide QM practices are performed within the company, they are not isolated from upstream suppliers and downstream customers. The importance of integration among the various organisations has been recognised as a means of delivering enhanced supply chain performance (Potter et al., 2004). Supplier-side SCQM indicates that organisation should closely cooperate with key suppliers to achieve better operational performance (Alfalla-Luque et al., 2015). Customer-side SCQM aims to obtain a better understanding of customers' requirements and integrate customers' input to the organisation's business processes (Thun, 2010). This shows that integration is no longer constrained by organisational boundaries, and extends to both suppliers and customers (Potter et al., 2004). Although external SCQM plays an important role in SCQM implementation, companywide QM is the foundation of SCQM (Chen et al., 2009; Hu and Flynn, 2015). The experience and knowledge that are generated from companywide QM can assist in cooperating with and developing relationships with suppliers and customers through modern information and communication technology (Gunasekaran and Ngai, 2004; Kaynak and Hartley, 2008; Huo et al., 2014). Only if companywide QM has been successfully implemented can the firm recognise the potential to enhance

its capabilities through facilitating external resources (Barney and Clark, 2007). Hence, the company is more capable of achieving external SCQM when it obtained the internal coordination capabilities. The internal communication and coordination capabilities assist the company in learning from external partners and their businesses to facilitate external integration (Huo et al., 2014). For example, a company is less likely to share information and communicate with external partners if it does not have a mature information system to collect and share data among its own departments and employees. If the company has established an effective internal information system, it is more willing to connect with external partners by modifying the internal information system (Zhao et al., 2011). If the inter-departmental information sharing is ineffective, the company will meet difficulties in fully understanding and closely working with SC partners. Moreover, organisations can improve capabilities in solving problems with suppliers and customers based on the effective internal teamwork. For instance, cross-functional teams in the company take the responsibility to solve the supplier quality problems and customer complaints (Kaynak and Hartley, 2008; Zhao et al., 2011). Hence, the researcher argues that a company performing well in companywide QM will be more likely to cooperate with suppliers and customers. The literature also proposes that companywide QM is a prerequisite for external SCQM with suppliers and customers (Flynn et al., 2010; Huo et al., 2014; Hu and Flynn, 2015) and should be well established before organisations cooperate with SC partners (Cagliano et al., 2006; Alfalla-Luque et al., 2015). Hence, external SCQM can be viewed as an extension of companywide QM (Huo et al., 2014; Hu and Flynn, 2015). The company will meet problems in conducting external SCQM if it does not follow companywide QM strictly (Huo et al., 2014).

The literature provides empirical evidence for positive relationships between companywide QM and external SCQM from different aspects (Koufteros et al., 2005; Flynn et al., 2010; Zeng et al., 2013; Huo et al., 2014; Hu and Flynn, 2015). From the perspective of SC integration, Koufteros et al. (2005) found that internal integration can enhance supplier-side product and process integration and customer-side integration. Zhao et al. (2011) verified that internal integration significantly impacts on external integration with suppliers and customers. Zeng et al. (2013) empirically demonstrated that companywide QM has positive influences on upstream and downstream QM. Huo et al. (2014) verified the positive influence of internal quality integration on both

supplier-side and customer-side quality integration. Similarly, Hu and Flynn (2015) also clarified that companywide QM positively affected supplier selection, supplier development, and customer development through survey research. From the perspective of organisational capability, Lane et al. (2006) indicated that companywide QM is an absorptive capability of learning from external partners. Huo et al. (2014) verified that companies that have absorptive capability prefer to learn and work with external partners in order to achieve external SCQM. Moreover, during the 'Phase One Study', the interviewees also verified the close relationship between companywide QM and external SCQM practices. For example, XHG (*Quality Manager, JVL_2*) mentioned: "*We always bear our quality development goals in mind when selecting the suppliers. It helps us to choose the correct suppliers and save the time and cost. It also helps us to generate clear supplier cooperation plans*". Moreover, ZJE (*Quality Manager, JVL_1*) also indicated: "*The clear and achievable quality plans and goals can attract customers. They prefer to provide feedback to the company which can accomplish the promised quality commitment*". These two statements provide evidence that a well-established companywide QM is the solid foundation of conducting both upstream and downstream side SCQM. Hence, the researcher believes that companywide QM helps a company cooperate well with external partners. Based on previous literature and empirical data, the following hypotheses are generated:

H1b: Companywide QM is positively related to supplier-side SCQM.
H1c: Companywide QM is positively related to customer-side SCQM.

5.2.3. Supplier-side SCQM and Operational Performance

Suppliers play a significant role in achieving effective SCQM by providing intermediate materials (Robinson and Malhotra, 2005; Hu and Flynn, 2015). Without ensuring the desired quality level of suppliers' products and services, supplier-side SCQM will not be successful and activities like involving suppliers in quality improvement programme will be problematic (Noshad and Awasthi, 2015). For example, in Section 4.3, JVL_2 selectively invests in some suppliers in order to upgrade their machines and technology. This in turn helps JVL_2 conduct supplier-side SCQM more smoothly. The effective supplier-side SCQM can reduce differences in the quality of raw materials and parts and ensure that suppliers meet the quality standards. By requiring suppliers to obtain quality certifications, the opportunistic behaviours of

suppliers will be decreased and the high-quality product will be ensured (Huo et al., 2014). Hence, the company should effectively cooperate and integrate with suppliers to add the values of suppliers (e.g. suppliers' input of quality improvement) into the final product (Lii and Kuo 206). The development of a solid partnership with suppliers will help them to understand, anticipate, and meet the ever-changing requirements of the buyer. By developing a clear understanding of the buyers' needs, suppliers can help buyers to improve performance (Flynn et al., 2010). Furthermore, a long-term relationship with suppliers ensures a company's commitment to quality and improves SC performance (Gunasekaran et al., 2004; Fynes et al., 2005; Vereecke and Muylle, 2006; Srinivasan et al., 2011). The close relationship and frequent communication with suppliers assist the buyer in enhancing product design processes, quality improvement programmes, and inventory management. For example, by sending professional staff to assist suppliers in improvement, the suppliers' product and service will be enhanced. These in turn result in higher final product quality, less inventory, and more production (Huo et al., 2014). Moreover, collaboration with the supplier in a new product design is conducive to achieving higher product quality (Fynes et al., 2005; Ou et al., 2010). Huo et al. (2016) verified that suppliers' involvement in buyers' product development helps buyers improve product quality directly. A closer cooperation with suppliers results in a better acquisition of the external source (Robinson and Malhotra, 2005), thus a desirable procurement can provide adequate resources to support operational practices. However, cooperation activities with suppliers are not cost-free. They require focus on relationships with key suppliers. This focus serves to reduce the complexity of the SC (Swink et al., 2007).

Previous studies have identified mixed results in relationship between supplier-side SCQM and operational performance (Tracy and Tan, 2001; Lin et al., 2005; Sila et al., 2006; Lo and Yeung, 2007; Kaynak and Hartley, 2008; Soltani et al., 2011; Lin and Chai, 2012; Huo et al., 2014; Hu and Flynn, 2015; Zhuang et al., 2015). For example, Soltani et al. (2011) found suppliers with high quality capability cannot be of benefit to the manufacturer. Zhuang et al. (2015) also did not find a positive relationship between supplier-side SCQM and performance. However, Lin et al. (2005) found that supplier participation in product design and Kaizen projects improve quality and inventory performance directly. Sila et al. (2006) asserted the positive relationship between supplier-side SCQM and production and quality. Lo and Yeung (2007) recognised the

significant impacts of supplier integration on supply quality management. Kaynak and Hartley (2008) verified that suppliers' QM practices improve inventory management performance directly. Lin and Chai (2012) also proved that a partnership with the supplier is a critical factor in improving SCQM performance. Huo et al. (2014) also confirmed the close relationship between supplier-side SCQM and quality performance. Moreover, during the 'Phase One Study', LQC (*Quality Manager, CSBSM*) also explained the relationship between supplier-side SCQM and operational performance: "*We choose the big names as our suppliers of the key components. They have much more professional people, knowledge, and experience than us in producing these components. It can improve our quality and productivity*". Furthermore, DYZ (*Quality Chief, CSBPL*) also stated: "*The reason for our company building a component park to locate our suppliers is to bring convenience to cooperate with our suppliers. The cooperation with suppliers will significantly benefit the product quality and production*". These two statements provide evidence that the selection of suppliers and the cooperation with suppliers may bring benefits to the Chinese automobile companies in the fields of operational performance. This evidence also identify that the knowledge and efforts generated from supplier-side SCQM can be used to improve the ability to manufacture. Hence, the researcher argues that supplier-side SCQM helps companies to conduct timely production, control the inventory, and enhance product quality. Combining the literature and empirical data, the following hypothesis is generated:

H2: Supplier-side SCQM is positively related to operational performances.

5.2.4. Customer-side SCQM and Operational Performance

The customers' requirement can be systematically satisfied by integrating and collaborating with customers (Zeng et al., 2013). Companies should regularly evaluate customer requirements through surveys, personal meetings, etc. Efforts should also be made to incorporate customer requirements in the product by integrating customer feedback in strategic quality planning (Lii and Kuo, 2016). For example, the results of customer surveys should be regarded as one of the core sources of establishing quality plans. Because customer-side SCQM creates opportunities for utilising the knowledge of collaborative processes, it assists organisations in quickly detecting quality problems and improving operational performance (Flynn et al., 2010). A close relationship between customers and the manufacturer offers opportunities for reducing the

manufacturer's product design time and inventory obsolescence and allowing the manufacturer to be more responsive to customer requirements (Flynn et al., 2010). The benefits of implementing customer-side SCQM are new knowledge creation, the establishment of cooperative practices, solid relationship formation, and complexity reduction (Swink et al., 2007). The customer-side SCQM practices that facilitate the collaboration with customers into manufacturers' planning and producing processes improve the manufacturer's employees by creating new knowledge. These downstream SCQM practices also lead to more efficient problem solving because of the cooperation with customers through jointly planning and mutual learning (Frohlich and Westbrook, 2001; Swink et al., 2007; Flynn et al., 2010).

Just as with the supplier-side SCQM, customer-side SCQM represents an organisational capability that aims to improve operational performance (Hu and Flynn, 2015). Previous studies have indicated a positive relationship between customer-side SCQM and operational performance (Rungtusanatham et al., 2003; Koufteros et al., 2005; Flynn et al., 2010; Koufteros et al., 2010; Huo et al., 2014; Hu and Flynn et al., 2015; Lii and Kuo, 2016). For example, Rungtusanatham et al. (2003) highlighted that downstream linkages with customers could bring better operational performance that would benefit an organisation. Koufteros et al. (2005) found a positive relationship between customer-side SCQM and product quality improvement. Flynn et al. (2010) emphasised the significant impact of customer-side SCQM on production. Huo et al. (2014) verified that customer quality integration benefits inventory performance of the final product. Hu and Flynn (2015) also verified the positive relation between downstream SCQM and quality performance. Similarly, Lii and Kuo (2016) found that effective communications with customers enhance product quality. Moreover, during the 'Phase One Study', ZJE (*Quality Manager, JVL_1*) stated: "*Our DSD assists dealers in providing better services to final customers. This kind of collaborative practice can help us to obtain more accurate customer feedback to enhance the product quality*". Further, XHG (*Quality Manager, JVL_2*) indicated: "*The actively communication with final customers through our TCSD helps us to better recognise customers' needs. This assists us in setting up quality goals and adjusting production plans*". These two statements clearly specify that customer-side SCQM can help Chinese automobile companies to better understand customer requirements, thus designing a more accurate and achievable quality goal. Establishing a clear quality goal is one of the prerequisites

of enhancing operational performance in SCQM (Kaynak, and Hartley, 2008; Huo et al., 2014). Therefore, based on the literature and the fact-finding study, the following hypothesis is generated:

H3: Customer-side SCQM is positively related to operational performances.

5.2.5. Operational Performance and Financial Performance

Better quality performance can improve sales, profit, and other market performances through delivering high-quality products, reducing waste and rework, and improving productivity (Dick et al., 2008). Moreover, a smaller inventory can also reduce the holding costs (Kaynak and Hartley, 2008). Kaynak (2003) found support for quality performance being related to higher financial performance. On the one hand, quality can increase customers' perception of the brand, which allows a company to increase selling price. This, in turn, can increase the sales revenue. On the other hand, better quality can assist companies to reduce costs, leading to higher profit margins. Ahire and Dreyfus (2000), Yeung (2008), and Kaynak and Hartley (2008) also clarified the positive relationship between quality performance and financial performance. Moreover, improving efficiency in the use of machines and equipment can meet the customer demands. It means that the high production can increase sales (Alfalla-Luque et al., 2015).

In addition, during the 'Phase One Study', some interviewees also explained the relationship between operational performance and financial performance from the perspective of the practitioner. They claimed that high financial performance was based on desirable operational performance. For example, ZJE (*Quality Manager, JVL_1*) mentioned: "*A general manager of a CSB once asked me why he cannot sell his products as well as our company. I think this question is hilarious, because how can he compare with us if our FTT is 10% higher than his?*". Moreover, LWQ (*Quality Chief, $CSBPM_2$*) illustrated: "*Compared with other CSBs at the same process level, the product quality of our models is better. The customer prefers our vehicles to others. In the period of September and October, dealers need to bring cash to ask our company to deliver vehicles to their shops*". These two statements clearly indicate that the better-quality performance guarantees higher sales in the Chinese automobile industry. Automobile companies with better product quality have more advantages in competing

with other companies and negotiating with dealers. Therefore, based on the literature and empirical data, the following hypothesis is generated:

H4: Operational performances are positively related to financial performances.

5.2.6. Control Variables

The contingency perspective argues that the successful implementation of a quality system is dependent on contextual factors (Jayaram et al., 2011). As a form of control and governance, ownership has significant implications for organisational control, risk sharing, resource allocation, bargaining power, and managerial decision making (Zhao and Luo, 2002; Zhao et al., 2011). Firms with different ownership adopt diverse operations strategies, which result in the implementation of various manufacturing practices (Chen and Tan, 2013). Ownership represents the identity of a firm's owners (Shleifer and Vishny, 1994). Based on the ownership types, companies in China have different cultures and management philosophies (Delios et al., 2006; Zhao et al., 2011). For the automobile brands that operate production plants in China, many of them are totally owned and controlled by domestic shareholders (CSBs), but others are partially controlled by the foreign shareholders (JVs). The differences between these ownership structures can explain why companies implement management practices in various ways. JVs may hire better quality managers because of their access to greater resources, and they may have better opportunity to recognise and apply the best practice due to their access to different management practices (Agarwal et al., 2013). The superior skills, advanced technologies, and stronger management capability of the foreign parent companies shift to the local market by transferring best practice to local firms through the employees and knowledge relocation and business transactions (Lu et al., 2014). On the other hand, the insufficient company capability and manager's ability weaken CSBs' management practices to some extend (Agarwal et al., 2013).

Some literature studied the moderating effects of ownership on the relationship between quality systems and performance in China. Zhao et al. (2006b) identified that companies of different ownership adopt and implement quality practices at various levels because of their diverse cultures and history. Chen and Tan (2013) further clarified that JVs control resources better and have higher manufacturing diversification than Chinese domestic companies. Lu et al. (2014) argued that JVs apply more

advanced technology and employ more skilled staff in the Chinese automobile market. On the other hand, CSBs experience less managerial culture conflict than JVs but lack the resources to apply advanced manufacturing technology and managerial practice (Chen and Tan, 2013). However, none of the previous studies paid attention to the moderating effects of ownership on SCQM in the Chinese automobile market. Moreover, the SCQM taxonomy that was proposed in Section 4.5.5 also provides evidence to show the different SCQM practices between CSBs and JVs. As these aspects of ownership are conceptually and empirically distinct, the researcher proposes the following hypothesis:

H5: The total effects of SCQM practices on operational and financial performances that can vary according to ownership.

Firm size is a significant indicator of organisation resources to influence the cooperation with SC partners. A small firm may not able to make suppliers to implement more cooperative activities and it may not have sufficient skills and resources to build cooperative relationships with suppliers as well (Koufteros et al., 2007; Tsinopoulos and Mena, 2015). It may not have enough capability to apply the formal activities to evaluate, monitor, and train suppliers. However, small firms have more agile organisational structures and more communication methods enabling more efficient quality system implementation compared to large firms (McAdam and McKeown, 1999; Jayaram et al., 2010). On the other side, large firms have more capital and expertise in ensuring smooth quality system implementation (Shah and Ward, 2003; Zhao et al., 2011; Agarwal et al., 2013). They also have the resources and motivations to implement better management due to their demand that caused by their complex organisational structure (Agarwal et al., 2013). Larger firms are also more likely to formalise goals, measures, and organisational procedures (Chen and Hambrick, 1995; Lu et al., 2014). As a result, larger firms may achieve a higher level of management implementation in comparison to smaller companies. Bloom and Van Reenen (2010), Bayo-Moriones et al. (2011), and Agarwal et al. (2013) verified a correlation between firm size and management practices performance. Moreover, Koufteros et al. (2007) and Jayaram et al. (2010) found that large firms have more effective supplier integration that enhances quality. However, Devaraj et al. (2007) indicated that supplier integration in small and medium firms can bring better quality performance than that in large firms.

Moreover, Zsidisin and Ellram (2003) found firm size does influence the levels of management techniques and occurrence probability of supply risk. They indicated that the application of approaches that reduce the supply risk, such as evaluating and strengthening suppliers, often need considerable amount of investment in human and financial resources.

Some literature studied the moderating effects of firm size on the relationship between the quality system and performance in China (Kull and Wacker, 2010; Jayaram et al., 2011). However, the results are mixed. For example, Kull and Wacker (2010) indicated that firm size does not significantly influence the relationship between QM and operational performance. However, Jayaram et al. (2011) asserted that firm size positively influences the impacts of supplier-side and customer-side coordination on quality performance. Moreover, the SCQM taxonomy that was proposed in Section 4.5.5 also provides evidence to show the different SCQM focus and performance between super large and smaller automobile companies. Due to the mixed results of the moderating impact of firm size, the researcher tentatively proposes the following hypothesis:

H6: The total effects of SCQM practices on operational and financial performances that can vary according to firm size.

Based on above discussion, the structural model of this study is showed in Figure 5.1.

5.3.Measurement Generation

Due to the contextual environment of the Chinese automobile industry and the very limited literature that focuses on the Chinese automobile industry in the field of SCQM, it is not appropriate to directly use the measurements summarised from previous literature that investigated other countries and industries. As discussed in Chapter 3, the literature review and the qualitative research are the two sources of the measurement generation in this study. Combining the data of qualitative research and the literature review, the reliability and validity of the measurements can be enhanced. The detailed measurement generation is presented in the following sub-sections.

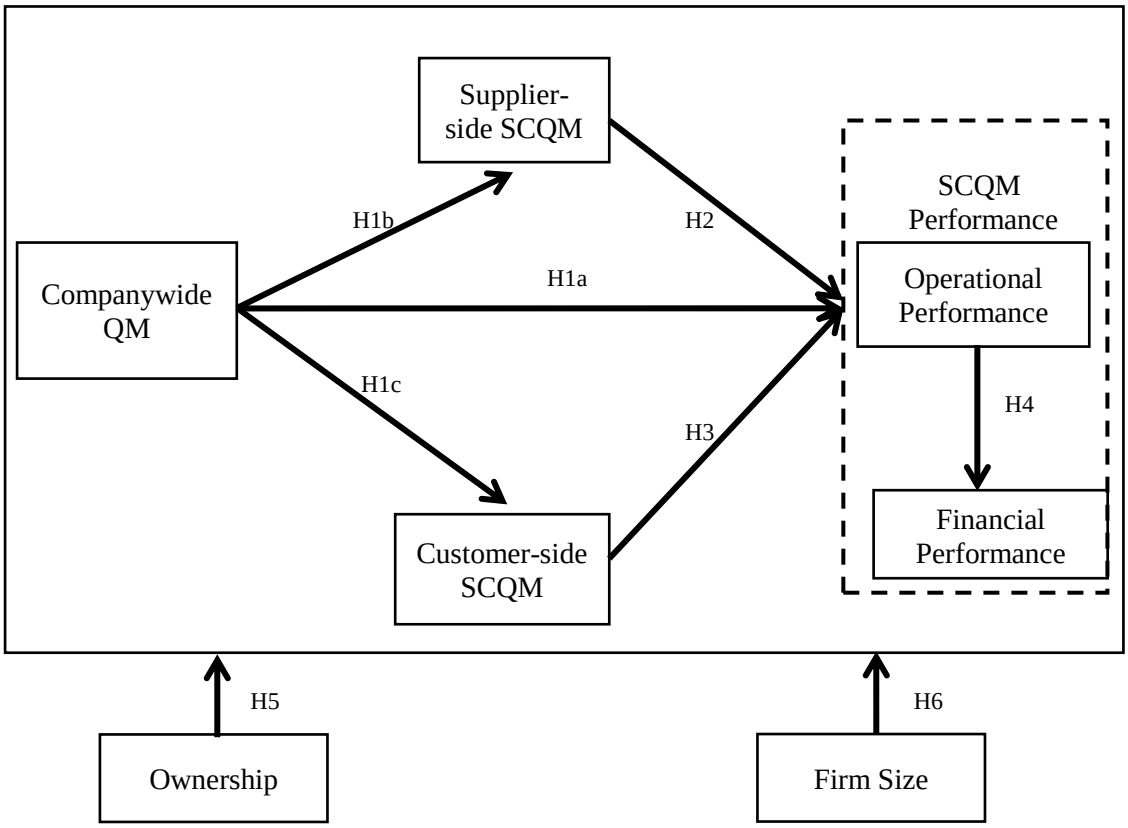


Figure 5.1: Structural Model

5.3.1. Companywide QM Practices

The aim of companywide QM practices is to improve product quality through enhancing the cooperation between each department: everyone in the company should accept their responsibility for quality improvement in order to achieve the common quality goals (Kaynak and Hartley, 2008). Through reviewing and consolidating the literature (please refer to Table 2.2), the eight most frequently used companywide QM constructs will be studied in this research: top management commitment to quality; strategic quality planning; employee management; process management; quality training; product development; quality information; and defect tracking (Li et al., 2011; Zhang et al., 2011; Hu and Flynn, 2015).

5.3.1.1. Top Management Commitment to Quality

Top management commitment to quality is defined as "*encompassing the conscious choice of quality initiatives as operational and strategic options, and engaging in activities such as providing visible quality leadership and resources for the adoption and implementation of quality initiatives*." (Ahmed and Parasuraman, 1994; p.45). It

goes beyond slogans and provides practical efforts that enhance quality improvement. Top managers should regard quality as a strategic issue and set clear quality goals for the whole SC. Moreover, higher priority should be provided for quality over cost and production; thus superior quality will return better cost saving performance (Chowdhury et al., 2007). Furthermore, top managers need to allocate adequate resources to guarantee internal quality improvement and influence other SC members' practices on quality programmes (Hu and Flynn, 2015). They also need to take part in the quality programmes (e.g. provide quality improvement suggestions), and their performance should also be assessed (Kaynak and Hartley, 2008).

Therefore, the top management commitment to quality in this research is measured through the following aspects: the formulation of quality goals (TMC1), the priority of quality (TMC2, and TMC3), the allocation of resource towards quality (TMC4), top managers' participation in quality work (T5), and the evaluation of top managers (TMC6). Table 5.1 lists the six measurements of top management commitment to quality.

Table 5.1: Measurement of Top Management Commitment to Quality

Top Management Commitment	Measurement Items	References
TMC1	Our company has clear quality goals, which are identified by top managers.	Saraph et al., 1989; Kaynak and Hartley, 2008; Bou-Llusar et al., 2009; Yu et al. 2012; Zeng et al., 2013.
TMC2	Top managers view quality as being more important than cost.	Flynn et al., 1995; Jun et al., 2006; Kaynak and Hartley, 2008; Talib et al., 2013.
TMC3	Top managers view quality as being more important than meeting production schedules.	Ahire et al., 1996; Zeng et al., 2013.
TMC4	Top managers allocate adequate resources to improve quality.	Jun et al., 2006; Kaynak and Hartley, 2008; Jayaram et al., 2010; Yu et al., 2012; Quang et al., 2016.
TMC5	Considerable quality issues are reviewed in top managers' meetings.	Saraph et al., 1989; Kaynak and Hartley, 2008; Talib et al., 2013; Quang et al., 2016.
TMC6	Top managers' promotion and salary closely associate with	Kaynak, 2003; Kaynak and Hartley, 2008; Jayaram et al., 2010;

	their performances in quality programmes.	

5.3.1.2.Strategic Quality Planning

Strategic quality planning regards customer-driven quality and operational performance excellence (e.g. fewer inventories) as key strategic issues of overall business planning (Samson and Terziovisky, 1999). During the qualitative research, the quality managers YZL from CSBPL introduced the quality planning system of his company: "*The cross-functional team issues the quality plans and designs the approaches to accomplish the goals. The issued quality plans will then be discussed among the top managers of each department*". This statement shows the approach of designing and applying the strategic quality planning in the Chinese automobile industry. The integration of goals from different functions and the allocation of goals to each department are the key elements of strategic quality planning. Moreover, strategic quality planning incorporates the development and deployment of quality plans, improves companies' relationships with customers and suppliers, and assists companies to achieve short- and long-term goals (Ebrahimi and Sadeghi, 2013). In order to build an effective SC that focuses on improving product quality and avoiding potential quality risk, the design of the SC structure becomes the key issue. The company must decide the daily manufacturing jobs and effectively cooperate with the right SC members (Hu and Flynn, 2015). Therefore, the strategic quality planning in this research is measured through the following aspects: the formalised and structured planning procedure (SQP1, SQP2, SQP3, and SQP4) and the consideration of stakeholders' capabilities and requirements (SQP5). Table 5.2 lists the five measurements and the corresponding references of strategic quality planning.

Table 5.2: Measurements of Strategic Quality Planning

Strategic Quality Planning	Measurement Items	References
SQP1	Our company has a formal strategic planning process, which results in written strategies for implementation.	Samson and Terziovisky, 1999; Sila and Ebrahimpour, 2005; Phan et al., 2011; Zeng et al., 2013; Akgün et al., 2014.
SQP2	Our company follows a comprehensive and structured planning process that sets and reviews quality goals regularly.	Samson and Terziovisky, 1999; Talib et al., 2013; Zeng et al., 2013; Akgün et al., 2014.

SQP3	Our company follows an arbitrary quality planning process.	Reverse code.
SQP4	Our company closely aligns business practices and missions with quality improvement goals.	Samson and Terziovisky, 1999; Bou-Llusar et al., 2009.
SQP5	Our company actively incorporates customer expectation and supplier capabilities during quality plans development.	Samson and Terziovisky, 1999; Bou-Llusar et al., 2009; Akgün et al., 2014.

5.3.1.3. Employee Management

Employee management develops committed employees who are keen on quality improvement in the company (Zu et al., 2008). It covers a variety of aspects including allocation of quality responsibility to each employee (Zu et al., 2008; Dubey and Gunasekaran, 2015), small group problem-solving (Yusuf et al., 2007; Zeng et al., 2015), employee suggestion (Martinez-Lorente et al., 2000; Phan et al., 2011), and recognition and reward of employees' contribution to quality improvement (Akgün et al., 2014). Allocating quality responsibility to employees aims to diffuse the organisational quality goals companywide and strengthen employees' quality awareness. Small group problem-solving is an effective approach to promote the efficiency of problem solving and quality improvement through teamwork and cooperation (Linderman et al., 2004). Employee suggestions encourage employees to provide advice on quality improvement through referring to their working experience and retained quality knowledge (Zeng et al., 2015). The recognition and reward of employees' quality contribution motivates employees' participation in quality improvement and enhances their loyalty to the company (Zu et al., 2008). Therefore, good employee management practice effectively improves the company's operation and has a great effort on product quality (Tarí et al., 2007; Ebrahimi and Sadeghi, 2013). In this research, employee management practice is measured through the following aspects: allocation of quality responsibility (EM1); team-based working (EM2 and EM3), the use of employee suggestion (EM4 and EM5), and the reward system (EM6). Table 5.3 presents the six measurements and corresponding references of employee management.

Table 5.3: Measurements of Employee Management

Employee Management	Measurement Items	References
EM1	Our employees clearly understand their quality responsibility.	Sila and Ebrahimpour, 2005; Kaynak and Hartley, 2008; Bou-Llusar et al., 2009; Zeng et al., 2013.
EM2	Our company organises employees in teams, e.g. quality control circle.	Saraph et al., 1989; Jun et al., 2006; Bou-Llusar et al., 2009; Jayaram et al., 2010; Dubey and Gunasekaran, 2015.
EM3	The majority of quality problems are solved by team-based quality meeting.	Flynn et al., 1995; Zhang et al., 2012; Zeng et al., 2013; Huo et al., 2014.
EM4	Our company encourages employees to provide suggestions about quality improvement.	Phan et al., 2011; Vanichchinchai and Igel, 2011; Talib et al., 2013; Zeng et al., 2013.
EM5	Our company evaluates and implements the employees' quality improvement suggestions every month.	Ahire, 1996; Kaynak and Hartley, 2008; Yu et al., 2012; Talib et al., 2013.
EM6	Our company has an effective reward system to encourage employees to devote to quality improvement.	Jun et al., 2006; Bou-Llusar et al., 2009; Talib et al., 2013; Zeng et al., 2015; Peng and Prybutok, 2015.

5.3.1.4. Process Management

Process management contributes to quality performance by reducing process variance, which leads to fewer scraps and reworks (Yeung, 2008; Phan et al., 2011). Because the business processes are interlinked, the improvement of the manufacturing process will then enhance the general organisational performance (Fening et al., 2008). The process management construct can be further broken down into the following categories: process design (Bou-Llusar et al., 2009), process control (Zeng et al., 2015), and housekeeping (e.g. 5S) (Phan et al., 2011). Process design strives to improve manufacturing capability by employees' clear understanding of working procedure, the design of the mistake-proof process, and large-scale automation (Sila and Ebrahimpour, 2005; Zu et al., 2008). Process control aims to track process performance, identify quality problems, and correct these problems through implementing statistical tools (Ahire and O'Shaughnessy, 1998; Salaheldin, 2009). Housekeeping aims to avoid machine breakdowns and help employees to accomplish their jobs faster through organising and maintaining the machinery and workplace (Schonberger, 2007).

Therefore, in this research, process management is measured through the following aspects: the structured process design (PM1, PM2, and PM3), the condition of process control (PM4), and the extent of housekeeping (PM5). Table 5.4 shows the five measurements and corresponding references of process management.

Table 5.4: Measurements of Process Management

Process Management	Measurement Items	References
PM1	Our employees clearly understand their working procedures.	Bou-Llusar et al., 2009; Akgün et al., 2014; Quang et al., 2016.
PM2	Production processes are designed to be mistake-proof.	Saraph et al., 1989; Flynn et al., 1995; Kaynak, 2003; Kaynak and Hartely, 2008; Jayaram et al, 2010; Baird et al., 2011; Talib et al., 2013; Akgün et al., 2014; Quang et al., 2016.
PM3	The degree of automation in our company is high.	Saraph et al., 1989; Kaynak and Hartley, 2008; Baird et al., 2011; Talib et al., 2013; Quang et al., 2016.
PM4	Statistical tools are used for conducting inspection, identifying problems, and correcting mistakes during production.	Sun et al., 2006; Kaynak and Hartley, 2008; Phan et al., 2011; Akgün et al., 2014; Quang et al., 2016.
PM5	Our machinery and workplace are kept neat and tidy.	Flynn et al., 1995; Phan et al., 2011; Zeng et al., 2015.

5.3.1.5. Quality Training

The employee that has adequate quality knowledge and expertise can enhance the effectiveness of quality programmes and accelerate process improvement (Phan et al., 2011). Therefore, quality training is conducive to reducing defects and improving productivity (Ahire and Dreyfus, 2000; Kaynak, 2003). The achievement of desirable training outcomes is driven by the amount of resources provided by the company, the delivery of training sessions, and the employees' attitude toward training sessions (Roth et al., 2008; Zhang et al., 2012). For example, in Section 4.3, the manager from $CSBPM_2$ stated that their employees do not care and do not have the awareness to attend quality training sessions. This directly caused the automobile company to allocate very limited resources to quality training. Therefore, quality training in this research is measured through following through the following aspects: the support from the company (QT1), the delivery of training sessions (QT2 and QT3), and the employees'

recognition of the effect of training sessions (QT4). Table 5.5 lists the four measurements and corresponding references of training.

Table 5.5: Measurements of Training

Quality Training	Measurement Items	References
QT1	Our company provides sufficient resources to support quality training.	Saraph et al., 1989; Kaynak and Hartley, 2008; Talib et al., 2013;
QT2	Our company provides scheduled and a companywide quality training session.	Ahire et al., 1996; Jayaram et al., 2010; Phan et al., 2011; Zhang et al., 2012; Zeng et al., 2013.
QT3	Various quality training sessions are provided to employees based on their different roles in the company.	Kaynak, 2003; Sila and Ebrahimpour, 2005; Phan et al., 2011; Talib et al., 2013; Zeng et al., 2013;
QT4	Our employees find the quality training can help their work.	Ahire, 1996; Jun et al., 2006; Phan et al., 2011; Zhang et al., 2012; Zeng et al., 2013.

5.3.1.6. Product Development

Based on Table 4.3, all the participating automobile companies in the 'Phase One Study' mentioned that they develop the product by cross-functional teams. This shows the importance of cooperation among departments within the company in the field of designing the product. Moreover, the effective cooperation among different departments significantly benefits quality knowledge accumulation and working attitude correction (Ahire and Dreyfus, 2000; Zu et al., 2008). For instance, the cooperation between R&D engineers and manufacturing employees positively affects the product quality (Konecny and Thun, 2011). Because the team members come from different functions with different goals, they can identify problems and generate solutions from various aspects. Therefore, product development in this research is measured through the following aspects: the principal of product development (PD1), the structured procedures of product development (PD2, PD3, and PD4), and the focus points of product development (PD5, PD6, and PD7). Table 5.6 lists the seven measurements and corresponding references of product development.

Table 5.6: Measurements of Product Development

Product Development	Measurement Items	References
PD1	The cross-functional team is in charge of product design work.	Kaynak and Hartley, 2008; Jayaram et al., 2010; Phan et

		al., 2011; Talib et al., 2013; Zeng et al., 2013.
PD2	Our product development follows formalised procedures.	Flynn et al., 1995; Sila and Ebrahimpour, 2005; Talib et al., 2013.
PD3	New product design is thoroughly reviewed before production.	Kaynak and Hartley, 2008; Talib et al., 2013; Quang et al., 2016.
PD4	New product design is not reviewed before production.	Reverse code.
PD5	New product development emphasises cost.	Kaynak, 2003; Kaynak and Hartley, 2008; Baird et al., 2011.
PD6	New product development emphasises quality.	Kaynak, 2003; Kaynak and Hartley, 2008; Baird et al., 2011; Talib et al., 2013.
PD7	New product development emphasises producibility.	Kaynak, 2003; Kaynak and Hartley, 2008; Baird et al., 2011.

5.3.1.7. Quality Information

The quality graph and table (e.g. seven quality tools) that show the causes and the number of defects are the commonly used tools to identify and eliminate quality problems and raise employees' quality awareness (Kaynak and Hartley, 2008). Availability, accuracy, and timeliness are the three core aspects of quality information (Sila and Ebrahimpour, 2005). During the 'Phase One Study', the researcher observed a unique practice in Chinese automobile companies of presenting quality information. As stated in Section 4.3, Chinese automobile companies set up 'Creative Kongfu Kanban' and 'Visual Kanban' to analyse quality problems and provide solutions. For example, the managers of CSBPL and JVL_1 explained the function of their 'Creative Kongfu Kanban' and the benefits in the field of enhancing operational performance during the 'Phase One Study'. This kind of activity is seldom investigated in the SCQM literature. In this research, quality information is measured through the following aspects: the operation of quality information system (QI1 and QI2), the display of quality information (QI3 and QI4), and the use of quality information (QI5). Table 5.7 presents the five measurements and corresponding references of quality information. Among these five measurements, QI4 is generated from the observation and interviews of the 'Phase One Study' mentioned above.

Table 5.7: Measurements of Quality Information

Quality Information	Measurement Items	References
QI1	The seven quality tools are used to collect and record the timely quality data.	Sila and Ebrahimpour, 2005; Zeng et al., 2013; Peng and Prybutok, 2015; Zeng et al., 2015.
QI2	Our company has established a quality information system to record, analysis, and share all the quality data throughout company.	Jayaram et al., 2010; Vanichichichai and Igel, 2011; Xu, 2011; Akgün et al., 2014; Quang et al., 2016.
QI3	The quality data are displayed to all the employees and workstations.	Kaynak, 2003; Vanichchinchai and Igel, 2011; Akgün et al., 2014; Zeng et al., 2015; Quang et al., 2016.
QI4	The frequently occurred quality problems and corresponding solutions are displayed in the workshop.	Empirical data.
QI5	The quality data is the determinant of decision making during production.	Saraph et al., 1989; Flynn et al., 1995; Ahire et al., 1996; Kaynak, 2003; Baird et al., 2011; Talib et al., 2013; Quang et al., 2016.

5.3.1.8. Defect Tracking

Clarifying the source of any defects is a critical approach to solving quality problems (Kuei et al., 2011). This can minimise the number of potential problematic parts and affected products (Zhang et al., 2011). During the 'Phase One Study', all the automobile companies stated that they established a defect tracking system to quickly find defects (please see Table 4.3). Based on the observations in the assembly workshops of these automobile companies, the researcher found that a brochure is provided for each automobile. The brochure records the component code and responsible principal. Moreover, in Section 4.3, JVL_2 also stated that it utilised QCDDS to record the component information (e.g. code and manufacturer). Moreover, strictly following the procedures of the defect tracking system can speed up the processes of identifying and tracing the source of the problems (Hu and Flynn, 2015). Therefore, defect tracking is measured through the following aspects: the availability of the defect tracking system (DT1) and the operation of the defect tracking system (DT2 and DT3). Table 5.8 lists the three measurements and corresponding references of defect tracking.

Table 5.8*: Measurements of Defect Tracking*

Defect Tracking	Measurement Items	References
DT1	Our company establishes defect tracking system, which systematically records the supplied components and finished automobiles.	Li et al., 2011; Zhang et al., 2011; Quang et al., 2016.
DT2	Our company conducts the defect tracing process under regulatory guidance.	Li et al., 2011; Hu and Flynn, 2015.
DT3	Our company can trace back the defects to source in stipulated time.	Jayaram et al., 2010; Li et al., 2011; Quang et al., 2016.

5.3.2. Supplier-side SCQM Practices

An automobile cannot satisfy customers if its components fail to reach expected standards. Suppliers contribute to product quality through providing qualified materials and being involved in the product design process. Collaboration with suppliers is thus another key SCQM practice (Robinson and Malhotra, 2005). Successful buyer-seller relationships encourage suppliers to be involved earlier in the quality improvement implementation and product design processes of the buying firm (Lin et al., 2013). Effective supplier relationship management brings benefits to organisations in obtaining strategic resources and capabilities, thus increasing their competitive advantages (Prajago et al., 2012). Therefore, this research addresses supplier selection, cooperation, and development in studying supplier-side SCQM.

5.3.2.1. Supplier Selection

Improving the quality of purchased parts brings a positive effect on eliminating variance, which utilises internal controls over other variables, such as machinery and the workforce (Kaynak, 2003). In other words, once a supplier becomes part of an SC, it will have a significant effect on the competitiveness of the entire SC (Choi and Hartley, 1996; Huo et al., 2014). Thus, suppliers should be selected based on their practices in the area of quality through a structured procedure (Lin et al., 2005; Jayaram et al., 2010). The right supplier management and selection strategy is important (Mustaffa and Potter, 2009). The supplier's quality certification decreases the risk of product recalls of the materials it provides, and ensures a stable level of product quality for the buyer (Huo et al., 2014, 2016). Moreover, maintaining a small number of suppliers improves buyers' product quality by allocating buyers' limited resources to

the important suppliers and enhancing these suppliers' commitment to product quality (Kaynak, 2003). By cooperating with a small number of suppliers, providing them with the necessary training and technology, and supervising their manufacturing, the defects in the provided components could be reduced, thus improving product quality (Sila, 2007). Therefore, supplier selection is one of the critical success factors in managing SCQ (Noshad and Awasthi, 2015). In this research, supplier selection is measured through the following items: the use of a quality-based supplier selection system (SS1, SS2, SS3, and SS4) and the quantity of dependable suppliers (SS5). Table 5.9 lists the five measurements and corresponding references of supplier selection.

Table 5.9: Measurements of Supplier Selection

Supplier Selection	Measurement Items	References
SS1	Our suppliers are certified or qualified.	Flynn et al., 1995; Sila and Ebrahimpour, 2005; Jayaram et al., 2010; Huo et al., 2014.
SS2	Our company has thorough supplier selecting system.	Kaynak, 2003; Kaynak and Hartley, 2008; Jayaram et al., 2010; Li et al., 2011; Phan et al., 2011; Prajogo et al., 2012; Quang et al., 2016.
SS3	Our suppliers are selected based on their quality rather than their prices.	Saraph et al., 1989; Lin et al., 2005; Lo et al., 2007; Kaynak and Hartley, 2008; Talib et al., 2013; Quang et al., 2016.
SS4	Our suppliers are chosen based on their quality rather than their delivery schedules.	Saraph et al., 1989; Lin et al., 2005; Lo et al., 2007; Kaynak and Hartley, 2008; Talib et al., 2013; Quang et al., 2016.
SS5	Our company relies on a small number of strategic suppliers.	Baird et al., 2011; Vanichchinchai, 2012; Quang et al., 2016.

5.3.2.2. Supplier Cooperation

Manufacturers cannot continuously produce quality products without effective cooperation with suppliers (Sun and Ni, 2012). The lack of supplier involvement in establishing quality goals is one of the commonly reported challenges of SCs (Noshad and Awasthi, 2015). Supplier cooperation practices emphasise mutual benefits than the simple arm's-length relationship. This is because the company buys both product and capability from its supplier (Lo and Yeung, 2004). However, the implementation of these practices is not easy. The mutual understanding of quality requirements and goals

and the way of sharing information are the key factors of supplier cooperation practices (Fynes et al., 2005). Frequent and timely communications about quality bring benefits to the reduction of quality disputes and quality goals coordination (Bayo-Moriones et al., 2011). The information exchange via a shared platform has significantly reduced the difficulty and complexity that occurred in the traditional communication system along the SC (Wang et al., 2011). The involvement of suppliers in buyers' product design and quality goal formation is one of the best practices in the field of supplier-side quality development (Noshad and Awasthi, 2015). Early supplier involvement is a key coordinating process in product design and process design of the manufacturer (Peterson et al., 2005; Hu and Flynn, 2015). Therefore, supplier cooperation practice is measured through the following aspects: the sharing of quality information (SC1 and SC2) and supplier involvement in quality work (SC3, SC4, and SC5). Table 5.10 lists the five measurements and corresponding references of supplier cooperation.

Table 5.10: Measurements of Supplier Cooperation

Supplier Cooperation	Measurement Items	References
SC1	Our company communicates with suppliers about quality considerations at least one time per week.	Lo et al., 2007; Li et al., 2011; Prajogo et al., 2012; Huo et al., 2014; Noshad and Awasthi, 2015; Quang et al., 2016.
SC2	Our company effectively communicates with suppliers through the meeting, email, and social software.	Empirical data.
SC3	Our company actively involves suppliers in product design process.	Lo et al., 2007; Phan et al., 2011; Prajogo et al., 2012; Zeng et al., 2013; Huo et al., 2014; Noshad and Awasthi, 2015; Quang et al., 2016.
SC4	Our company doesn't involve suppliers in product design process.	Reverse code.
SC5	Our company actively involves suppliers in quality improvement activities.	Phan et al., 2011; Yu et al., 2012; Huo et al., 2014; Noshad and Awasthi, 2015; Quang et al., 2016.

5.3.2.3.Supplier Development

Successful supplier cooperation is based on long-term supplier development practices, which strengthen communication and remove barriers between the company and its suppliers (Lo and Yeung, 2004). Supplier development practice refers to an

organisation's effort to improve its supplier's capability for long-term mutual benefit (Hu and Flynn, 2015). Moreover, the company should cooperate with appropriate suppliers who are able and willing to share information and participate in buyers' quality programmes (Rodriguez et al., 2005; Shokri et al., 2010). The buyer then should increase reliance on the key suppliers and try to develop closer relationships with them through providing appropriate training and technical supports (Vanichchinchai and Igel 2011; Uluskan et al., 2016). Moreover, during the 'Phase One Study' the researcher also identified that the Chinese automobile companies also provide financial support to suppliers to improve their capability in manufacturing. For example, in Section 4.3, JVL_2 provided evidence of selectively investing in some suppliers to help them upgrade machines. This activity aims to guarantee a stable manufacturing process of suppliers and enhance their quality performance. Therefore, supplier development is measured through the following aspects: the mutual understanding of quality expectation (SD1), and the ways of strengthening suppliers' quality capability (SD2, SD3, and SD4). Table 5.11 lists the four measurements and corresponding references of supplier development. Among these four measurements, SD3 is generated from the interviews of the 'Phase One Study' mentioned above.

Table 5.11: Measurements of Supplier Development

Supplier Development	Measurement Items	References
SD1	Our company has consensual quality goals accepted by suppliers.	Li et al., 2011; Vanichchinchai and Igel 2011; Noshad and Awasthi, 2015.
SD2	Our company consolidates relationship with suppliers through long-term contracting.	Lin et al., 2005; Sila and Ebrahimpour, 2005; Lo et al., 2007; Phan et al., 2011; Parajago et al., 2012; Quang et al., 2016.
SD3	Our company provides financial support to improve supplier's quality.	Empirical data.
SD4	Our company provides training or sends professional staffs to help suppliers to improve their quality capability.	Talib et al., 2013; Noshad and Awasthi, 2015; Quang et al., 2016.

5.3.3. Customer-side SCQM

Establishing close relationships with customers requires identifying their requirements, collecting customer feedback, and transferring this feedback to the corresponding

employees, who can then make the improvement (Kaynak and Hartley, 2008). By involving customers in quality work, companies can be aware of and meet the changing demands of customers in time. Therefore, cooperation with the customer is a prerequisite for achieving supply chain quality. A successful cooperative relationship could be achieved through conducting interactive activities with customers (e.g. customer conference). In this research, the use of feedback, customer cooperation, and customer development are investigated as the core elements of customer-side SCQM. In the Chinese automobile market, dealers undertake the responsibilities of providing spare parts, selling the automobiles, offering after sales and maintenance service, and conducting customer surveys (Lu et al., 2014). They are the direct customers to provide input to assist automobile companies in conducting SCQM practices. Therefore, in our study, we refer to the automobile dealer as the 'customer'.

5.3.3.1. Use of Feedback

Customer feedback is a critical hard quality component of quality system implementation (Zhang et al., 2012). It is a major source of information about product quality and product design. It provides an opportunity for the company to learn within the SC (Hu et al., 2015). During the qualitative research, the quality chief SLY of $CSBPM_1$ also mentioned the important role of the customer in providing significant information: "*Product design and quality improvement in our company are based on customer requirements because customers are the source of our income*." Customer feedback helps the company to identify customer requirements quickly and determine whether these requirements are being met or what improvement should be made (Flynn et al., 1994). Moreover, during the qualitative research, the quality manager MFX in JVL_2 also introduced the feedback system in his company: "*Our company has a cross-functional team to handle the customer feedback. The functions of this team include analysing feedback, delivering feedback to the related employee and department, and proposing a rectification plan to customer*". This feedback system helped JVL2 to rank in 1st place in the investigation of "After Sales Customer Satisfaction" conducted by J.D. Power in 2013. This shows that besides collecting and recognising customer feedback, transferring the customer feedback to the corresponding employees and applying the modifications are also important in use of feedback. However, the literature focuses more on customer feedback collection than on feedback utilisation. Therefore, the use of feedback in this research is measured through the following

aspects: customer requirements and complaints collection (UF1 and UF2), the function of customer feedback (UF3), and the dissemination of customer feedback (UF4). Table 5.12 lists the four measurements and corresponding references of the use of feedback.

Table 5.12: Measurements of Use of Feedback

Use of Feedback	Measurement Items	References
UF1	Our employees understand the important role of the customer in quality programmes.	Samson and Terziovsk, 1999; Vanichichichai and Igel, 2011; Prajogo et al., 2012.
UF2	Our company has a system to collect customer feedback.	Phan et al., 2011; Prajogo et al., 2012; Terzioviski and Hermel, 2011; Zeng et al., 2013; Quang et al., 2016.
UF3	Our company determines customer requirement by the feedback.	Kaynak and Hartley, 2008; Yu et al., 2012; Zeng et al., 2013.
UF4	Our company conveys the customer feedback to the related employees.	Samson and Terziovsk, 1999; Kaynak and Hartley, 2008;

5.3.3.2. Customer Involvement

Enabling customer involvement in product design and quality improvement programmes is essential to satisfy the customer (Biotto et al., 2012). It is based on the understanding that companies should comply with the customer's voice, build the customer relationship, and utilise customer information (Hu et al., 2015). By involving customers in product design and quality improvement programmes, companies can be aware of and meet the changing demands of customers in time. However, the literature generally tests whether manufacturers communicate with customers. The method of communication is not an investigated point. During the 'Phase One Study', all of the participating automobile companies mentioned they communicate with customers through different channels. For example, CSBSL utilised customised MIS to share information with customers and JVL_2 applied QIS and mobile APP to communicate with customers**.** Moreover, Sila and Ebrahimpour (2005) suggested that greater information sharing with customers could increase customer focus, which in turn motivates customer to provide more input in manufacturers' quality improvement. Therefore, cooperation with the customer is a prerequisite to achieving SCQM (Kaynak and Hartley, 2008). In this research, customer involvement is measured through the following aspects: how the company communicates with customers (CI1, CI2, and CI3),

and the extent of customers' participation in quality related works (CI4 and CI5). Table 5.13 lists the five measurements and corresponding references of customer involvement. Among these five measurements, CI3 is generated from the observation and interviews of the 'Phase One Study' mentioned above.

Table 5.13: Measurements of Customer Involvement

Customer Involvement	Measurement Items	References
CI1	Our company discusses quality issues with customers at least one time per week.	Flynn et al., 1995; Sila and Ebrahimpour, 2005; Phan et al., 2011; Huo et al., 2014.
CI2	Our company does not discuss quality issues with customers.	Reverse code.
CI3	Our company communicates with customers through the meeting, email, and social software.	Empirical Data.
CI4	Our customers are actively involved in our product design processes.	Kaynak and Hartley, 2008; Phan et al., 2011; Talib et al., 2013; Zeng et al., 2013; Huo et al., 2014.
CI5	Our customers provide input to the quality improvement processes.	Kaynak and Hartley, 2008; Jayaram et al., 2010; Phan et al., 2011; Zhang et al., 2012; Zeng et al., 2013.

5.3.3.3. Customer Relationship Development

Customer relation development is defined as the practices of managing customer complaints, building long-term relationships with customers, and improving customer satisfaction (Tan et al., 1998). A close customer relationship allows an organisation to extend the value it provides to customers and enhance customer loyalty (Li et al., 2005). The ability to respond to customers' changing demands also helps firms to improve and create new products. Moreover, customer relationship development also promotes communication between the company and customers and eventually results in joint problem solving (Chin et al., 2004). Therefore, customer relation development can bring significant impact on improving the supply chain performance. In this research, customer relationship development is measured through the following aspects: the company's emphasis on the customer (CRD1 and CRD2), and the systematic interaction with the customer (CRD3). Table 5.14 lists the three measurements and corresponding references of customer relationship development.

Table 5.14: Measurements of Customer Relationship Development

Customer Relationship Development	Measurement Items	References
CRD1	"Customer focus" philosophy has been widely accepted in our company.	Kaynak and Hartley, 2008; Jayaram et al., 2010; Vanichichichai and Igel, 2011.
CRD2	Our company strives to keep highly responsive to customer complaints.	Samson and Terziovsk, 1999; Kaynak and Hartley, 2008; Jayaram et al., 2010; Phan et al., 2011; Zeng et al., 2013.
CRD3	Our company holds annual customers conferences to listen to customers' voices.	Flynn et al., 1995; Zeng et al., 2013; Huo et al., 2014.

5.3.4. SCQM Performance

SCQM performance is a subset of the overall concept of organisational effectiveness and contains both financial and operational performance (Foster, 2008). As explained in Section 2.4.4, operational performance represents the effectiveness of the operation strategy for different stakeholders and financial performance refers to the outcome-based indicators of the firm's economic goals. Because of the contextual business environment in China and the limited knowledge of respondents in the fields other than quality and supply chain, simply adopting the operational and financial performance measurements that were used in previous research is not appropriate. Therefore, we conducted a field study in eight automobile brands in China to generate the most suitable performance measurements. Based on the qualitative study, the researcher identified that First Time Through (FTT), which described quality performance, inventory turnover, which represented responsiveness, and productivity, which explained efficiency, were the most frequently used operational performance measurements. Based on the interviewees' explanation during the fieldwork, FTT measures the quantity of automobiles produced without flaws or re-work as a percentage of total units produced. For example, in Section 4.3, the managers from $CSBPM_1$ and JVL_2 explained their quality goals by using FTT figures instead of using defect rate as usually studied in the literature. Productivity represents the output per hour. Sales, profit, and cost of quality were the most representative financial performance measurements in the Chinese automobile industry. The measurements of SCQM performance and corresponding references are summarised in Tables 5.15 and

5.16. Among these three measurements of operational performance, OP1 is generated from the observation and interviews of the 'Phase One Study' mentioned above.

Table 5.15: Measurements of Financial Performance

Financial Performance	Measurement Items	References
FP1	Our company's sales are increasing.	Lin et al., 2005; Yusuf et al., 2007; Kaynak and Hartley, 2008; Li et al., 2011
FP2	Our company's profit is increasing.	Sila and Ebrahimpour, 2005; Kaynak and Hartley, 2008.
FP3	The cost of quality in our company is decreasing.	Kaynak and Hartley, 2008; Vanichichichai and Igel, 2011; Huo et al., 2014.

Table 5.16: Measurements of Operational Performance

Operational Performance	Measurement Items	References
OP1	Our company has a high First Time Through.	Empirical Data.
OP2	Our company has high inventory turnover of automobiles.	Flynn et al., 1995; Kaynak, 2003, Flynn and Flynn, 2005; Kaynak and Hartley, 2008; Zhao et al., 2015.
OP3	The annual productivity of our company is increasing.	Kuei et al., 2001; Sila et al., 2006; Kaynak and Hartley, 2008;

5.3.5. Construct Property

As discussed in Section 3.6.2, the construct can be categorised into reflective or formative groups (Diamantopoulos and Winklhofer, 2001). The reflective construct works as the causal factor that brings the impact and indicators of the formative construct influence the latent variable (Fornell and Bookstein, 1982; MacCallum and Browne, 1993). Jarvis et al. (2003)'s guideline assist academics in defining the property of construct by considering four points: (1) direction of causality, (2) interchangeability of the indicators, (3) covariation among the indicators, and (4) nomological network of the indicators. Based on this guideline, the constructs of this research are categorised in Table 5.17. The classification procedure is presented in the following paragraph by demonstrating one construct of each of the four SCQM elements.

Table 5.17: Construct Property

Reflective Construct	• Top Management Commitment • Strategic Quality Planning • Employee Management • Process Management • Quality Training • Product Development • Quality Information	• Defect Tracking • Supplier Selection • Supplier Cooperation • Supplier Development • Use of Feedback • Customer Involvement • Customer Relationship Development
Formative Construct	• Financial Performance	• Operational Performance

For example, in the companywide QM, employee management contains six measurements (please refer to Section 5.3.1.3). Among these six measurements, EM2 and EM3 share the same theme (i.e. team-based working), EM4 and EM5 also share the same theme (i.e. the use of employee suggestion). Moreover, the change of EM4 will directly influence EM6. In other words, if the automobile company does not encourage employees to participate in a quality improvement programme, it will not establish a well-managed reward system. Hence, employee management is a reflective construct. In the supplier-side SCQM, supplier cooperation contains five measurements (please refer to Section 5.3.2.2), among which SC1 and SC2 share the same theme (i.e. quality information sharing). SC3, SC4, and SC5 share the same theme (i.e. supplier involvement in quality improvement) and produce the same consequence (e.g. higher FTT). Moreover, based on the discussion in Section 5.3.2.2, the supplier involvement in buyers' quality improvement is based on the mutual understanding of quality conditions and goals. It means the sharing of quality information is the foundation of suppliers' input in improving buyers' quality. In other words, change of SC1 and SC2 will cause change of SC3, SC4, and SC5. Therefore, supplier cooperation is a reflective construct. In customer-side SCQM, customer involvement includes five measurements, among which CI1, CI2, and CI3 share the same theme (i.e. the communication between manufacturer and customer) and produce same consequence (e.g. better mutual understanding). CI4 and CI5 share the same theme (i.e. customer's participation in manufacturer's quality improvement) and produce the same result (e.g. higher FTT). In addition, as discussed in Section, 5.3.3.2, the better understanding of customers' requirement will encourage customers to provide more input in manufacturer's quality improvement programme. In other words, the change of CI1, CI2, and CI3 will result in the change of CI5. Hence, customer involvement is a reflective construct. In the

SCQM performance, operational performance contains three measurements and each of them represents a different theme. The operational performance construct does not cause quality, inventory, and production to go in the same direction and to the same extent. Moreover, items measuring quality cannot be replaced by items measuring production. Conceptually, the measurement of quality does not have to correlate with the measurement of inventory. Furthermore, Swink et al. (2007) also indicated that different antecedents may impact various operational performance dimensions to different extents. Thus, operational performance is a formative construct.

Based on the Section 5.2, eight hypotheses have been generated. They will be tested through investigating the relationships among 67 independent variables and six dependent variables. Ownership and firm size are also included in the research as the control variables to compare the results among different types of companies. In Figure 5.2, the model of this research is summarised in a single framework. Based on the above measurement generation process, the initial questionnaire of this study was developed. Because the target respondents are managers in Chinese firms, the Chinese version of the questionnaire was then created through utilising backward translation to enhance the accuracy of measurement description (Brislin, 1980).

5.4.Pilot Study

In order to ensure the accuracy of the questionnaire statements and the fulfilment of research objectives, 20 pilot study questionnaires were sent to the managers of automobile companies (not including the companies that participated in this research) and academics on 23rd of March 2015. The pilot study questionnaires are attached in Appendices 3 and 4. 14 completed documents of written feedback from the managers and one case of oral feedback from academics were received after three weeks. All of the managers claimed that this questionnaire could help them to recognise their shortcomings in SCQM and learn other manufacturers' ways of SCQM implementation. The 14 managers and one academic member of staff believed that the statements of this questionnaire could achieve research goals, and this questionnaire is

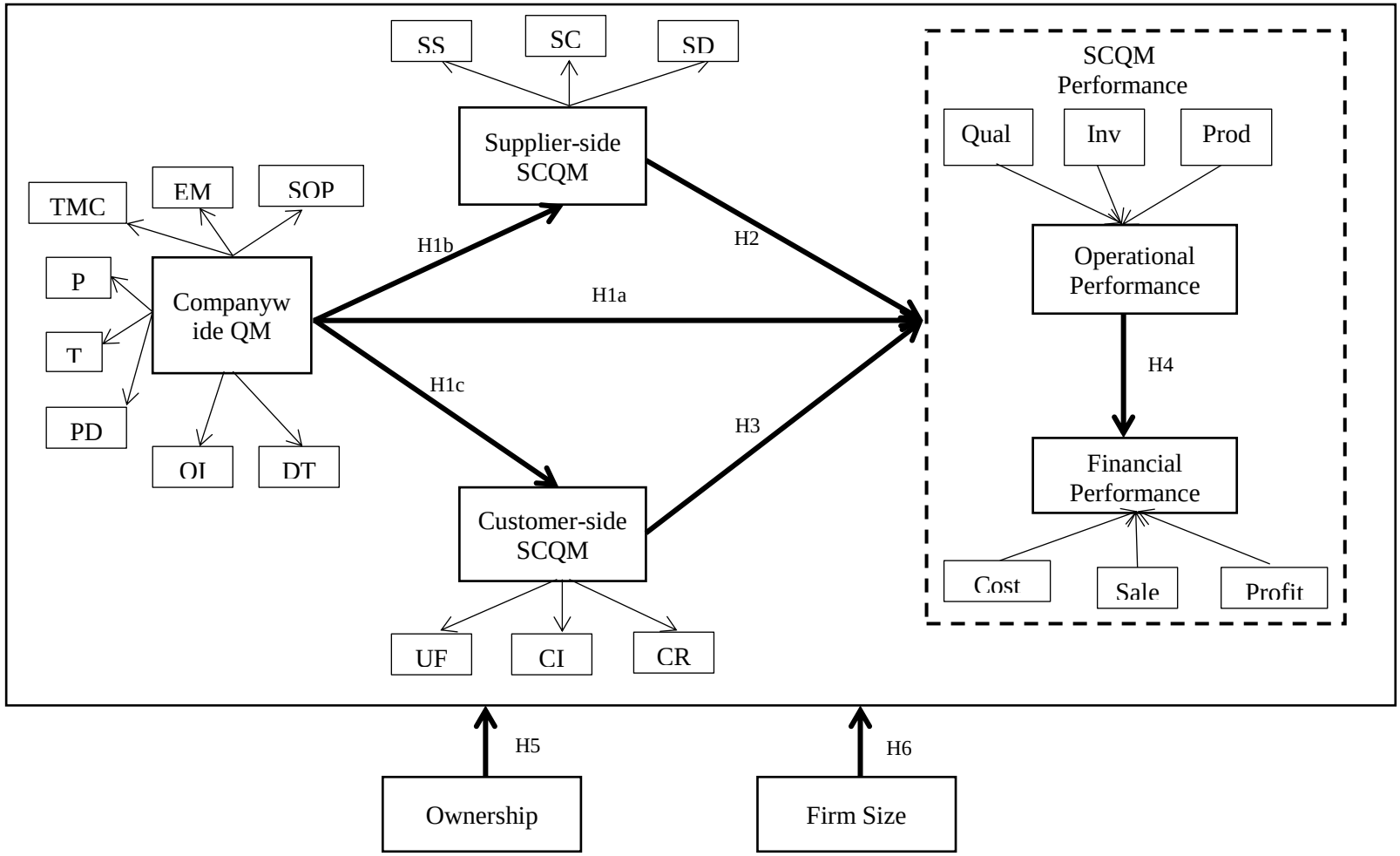


Figure 5.2: Framework of Research Model

(Thin Arrows=Causality Direction; Thick Arrows=Hypotheses; TMC=Top Management Commitment; EM=Employee Management; SQP=Strategic Quality Planning; PM= Process Management; T=Training; PD=Product Development; QI=Quality Information; DT= Defect Tracking; SS= Supplier Selection; SC= Supplier Cooperation; SD= Supplier Development; UF= Use of Feedback; CI=Customer Involvement; CRD=Customer Relationship Development; Qual=Quality; Inv=Inventory; Prod=Productivity)

valuable to the Chinese automobile market.

Based on their replies, the average adequacy score and standard deviation of each statement have been calculated. Appendix 5 shows the average adequacy score and the standard deviation of each statement. Based on the two cut-off values that were suggested by Rungtusanatham et al. (1999), the face validity of the statements can be measured. First, the average adequacy score of each statement is above 3, which means that the adequacy of the statement in measuring the corresponding dimension is high. That is, the statements are appropriate to be included in this questionnaire. However, the standard deviations of some statements are above 1, which mean that respondents have disputes in measuring these statements. These indicators are highlighted in Appendix 5. However, it is not correct to directly change these measurements (Alasuutari et al., 2008; Sarantakos, 2013). The respondents' opinions should be evaluated with the considerations of the literature focus and. questionnaire design. These indicators are: TMC1, TMC4, TMC5, TMC6, SQP1, SQP3, EM2, EM5, PM1, PD4, PD5, PD6, PD7, QI3, SC1, SC4, UF2, UF3, CI1, CI2, CI5, and CRD3. After the systematic evaluation of the respondents' feedback, it was found that some high standard deviations were due to the inaccurate descriptions of measurements. It means the respondents agreed with the meaning of the measurements but suggested to adopt better descriptions that fit the Chinese automobile industry. Therefore, some measurements were modified based on the pilot study suggestions. The other high standard deviations were due to the respondents' misunderstanding of academic research. Because the practitioners lack academic training, they do not fully understand the academic way of questionnaire design (e.g. the function of reverse code). Hence, these kinds of respondents' suggestions were not adopted in the research. The detailed analysis of these statements is presented in the following section.

5.4.1. Pilot Study Evaluation

a) TMC1: Our company has clear quality goals, which are identified by top managers

Four respondents claimed that this statement was too general to show the quality goal establishment in the company. They believed the majority of the respondents in the main survey study would give this statement a high mark. They suggested making the statement more concrete through adding the path of quality goal establishment. This

advice means the respondents recognised the necessity of including TMC1 in the questionnaire, but they did not think the expression was good enough. Therefore, in order to make TMC1 more concrete and keep its original meaning at the same time, the statement was modified:

TMC1: Top managers conduct quality goal evaluation every year to review last year's achievement and set the new quality goal.

b) TMC4: Top managers allocate adequate resources to improve quality.

Three respondents found "adequate" was difficult to understand. They believed that there was no clear boundary between adequate and inadequate. They suggested using other words to describe the company's emphasis and support of quality improvement work. This advice shows that the respondents did not want to change the original meaning of the statement but preferred a clearer expressed statement. Therefore, in order to avoid any risk in the main survey study, TMC4 was modified:

TMC4: Top managers give priority to quality improvement works when allocating resources.

c) TMC5: Considerable amount of key quality issues are reviewed in top managers' meetings.

Three respondents indicated that it was not common to use the passive tense in the Chinese questionnaire. Moreover, they claimed that only the most significant quality issues would be reported to the top managers' meeting. The better way of asking the top managers' emphases on quality work is to see whether they attend the daily quality meeting or not. TMC5 is extracted from Saraph et al. (1989), Kaynak and Hartley (2008), and Mellat-Parast (2013). Even though these papers were published in top journals, they did not consider the current situation of the Chinese automobile industry. Moreover, Qui and Tannock (2010), and Dubey and Guansekaran (2015) also clarified the importance of holding regular meetings on quality issues. Therefore, based on their opinions, TMC5 was modified:

TMC5: Top managers take part in quality meetings regularly to discuss the quality issues and provide support to quality improvement programme.

d) *TMC6: Top managers' promotion and salary closely associate with their performances in quality programmes.*

Two respondents thought "their performance in quality programmes" was too general. They suggested adding more concrete examples to strengthen the original statement. Based on their suggestions and retaining the original meaning of TMC6, the researcher modified TMC6:

TMC6: The achievements of quality goals for each job are considered as important parameter for corresponding top manager's performance evaluation.

e) *SQP1: Our company has a formal strategic planning process, which results in written strategies for implementation.*

Three respondents thought the Chinese version of this statement was awkward. They found SQP1 was difficult to read. Therefore, in order to avoid any risk in the main survey study, the word order of the Chinese translation was restructured.

f) *SQP3: Our company follows an arbitrary quality planning process. (reverse code)*

Three respondents evaluated "1" for this statement because they did not understand why the reverse code should be included in the questionnaire. They thought the reverse code would make the questionnaire long and tedious. However, because these respondents were practitioners, they overlooked the importance of reverse code in the questionnaire. The reverse code can test the consistency of the respondent's answer and check whether the respondent provides random answers without carefully reading the questions. Therefore, SQP3 was kept in the questionnaire without any modification. Moreover, in order to help the respondents to fill in the questionnaire, the explanation of the reverse code will be added in the "completing guidance". Similarly, PD4, SC4, and CI2 were all kept in the questionnaire without any modification.

g) *EM2: Our company organises employees in teams, e.g. quality control circle.*

Two respondents met problems to understand the Chinese translation of "quality control circle". Their companies may use a different translation of this terminology. Therefore, in order to avoid any misunderstanding in the main survey study, EM2 was modified:

EM2: Our company organises employees in teams to focus on quality related work.

h) *EM5: Our company evaluates and implements the employees' quality improvement suggestions every month.*

Five respondents questioned the "frequency" in the statement. They claimed that it was very difficult to provide an appropriate mark because of the different situations in their companies. They suggested using more general terms, such as "regularly" or "in time" instead of the fixed frequency. The original designing idea of this statement is to provide a standard to respondents in order to help them evaluate their companies' performance in employee management. However, this standard causes some potential risk in reality. Moreover, in the works of Ahire (1996), and Yu et al. (2012), they also implemented the general terms to ask the situation about the adoption of employees' suggestions. Therefore, based on their advice and keeping the original meaning of EM5, the statement was modified:

EM5: Our company evaluates and implements the employees' quality improvement suggestions regularly.

SC1 and CI1 also met the same problem, therefore they were also modified:

SC1: Our company evaluates suppliers' quality performance regularly and formulates improvement measures.
CI1: Our company discusses quality issues with customers in time.

i) *PM1: Our employees clearly understand their working procedures.*

Three respondents thought this statement was too general because understanding working procedures is the obligation of all the workers. They believed that all the respondents in the main survey study would mark this statement as "7". They suggested adding the "follow up" approaches to strengthen the statement. PM1 was extracted from the works of Schroeder et al. (2008) and Akgün et al. (2014). Even though the p values of PM1 were below 0.05 in these works, it is not necessary to verify the adequacy of the statement. The desirable p values may due to the high score provided by all the

respondents who may think the question was too general or easy to answer. Therefore, based on their advice and retaining the original meaning of this statement, PM1 was modified:

PM1: Our employees clearly understand their working procedures and strictly follow the rules during production.

UF2 and CRD3 also met a similar problem. They were also modified:

UF2: Our company has a system to collect customer feedback and deal with customer complaints immediately.
CRD3: Our company holds annual customers conferences to listen to customers' voices for the further quality management improvement.

j) PD5: The quality design of new product emphasises in relation to cost.

Three respondents pointed out that the Chinese translation of this statement was not accurate. There was no "质量设计" (the Chinese translation of quality plan) concept in their company. In order to avoid misunderstanding in the main survey, "质量设计" is changed to the more general term "质量策划" (the Chinese translation of quality design) in the statement. PD6 and PD7 also met the same problems. Therefore, the same modifications had been done.

k) QI3: The quality data are displayed to all the employees and work stations.

Two respondents claimed that it was not possible for the company to diffuse quality data to all the employees in the company. They thought that quality data was normally displayed in workshops. Besides the frontline workers, the employees of the quality department were the people who deal with quality data frequently. Therefore, they thought QI3 was not that accurate. However, quality improvement is the duty of all the employees in the company. Everybody should participate in quality improvement work through different paths according to his or her jobs (Dale et al., 2007). Therefore, the quality data should be diffused to all the employees to strengthen their quality awareness without any excuse. These two respondents provided this kind of opinion

may because their companies were not good at quality information diffusing. Therefore, QI3 was kept without any modification.

l) CI5: Our company actively involves customers in quality improvement activities.

Two respondents claimed that this statement was too general to show how the company involves the customer in quality improvement. They suggested adding more precise examples to specify "the way of involving" and provided this modification: "Our company conveys problems extracted from customer feedback in time and conducts the improvement approaches immediately." However, this amendment overlapped UF4. Moreover, companies implement many different methods of involving customers in quality improvement work. It is risky to select one specific method and put it in the statement. A general statement can avoid this kind of risk and give space to the respondents to answer the question. Furthermore, the standard deviation of CI5 was just above 1 (1.03) and the average adequacy score was high (6.14). Therefore, CI5 was kept without any modification.

m) UF3: Our company determines customer requirement by the feedback.

Three respondents criticised that the company cannot "determine" customer requirements. They thought the wording of this statement was not accurate. Their advice is very important because customer requirements can only be determined by customers themselves. The company can only recognise or collect customer requirements. In order to make this statement more accurate, UF3 was modified:

UF3: Our company recognises customer requirement by the feedback.

5.4.2. Other Suggestions of the Pilot Study

Besides the advice that was provided to the statements which had undesirable standard deviations, the respondents also provided some other suggestions about the questionnaire.

a) The Problem of Terminologies

Two respondents thought the "supplier" in SS3 and SS4 should be changed from "配件商 (the Chinese translation of accessory supplier) to "零部件商" (the Chinese

translation of component supplier). However, the original translation is also commonly used in China. Therefore, SS3 and SS4 were kept in the questionnaire without any modification. Moreover, two respondents thought "floor visiting" in PM5 could be changed to "5S", because they believed 5S had been widely accepted in Chinese companies. However, there are so many small automobile companies in China and it is impossible to guarantee all of them know this foreign terminology. Therefore, the researcher added "(e.g. 5S)" after "floor visiting" in PM5 to avoid any misunderstanding in the main survey study. In addition, four respondents pointed out that it was not accurate to simply use "certified or qualified" in SS1 because there are so many different kinds of certification other than quality certifications. In order to make this statement more accurate, SS1 is modified: "Our suppliers need to obtain quality system certification." Furthermore, five respondents believed that the translation of "our company" should be deleted in the Chinese version questionnaire, because they thought this kind of translation was a verbose expression in the Chinese questionnaire. Therefore, in order to make this questionnaire more formal, the "我们公司" (Chinese translation of our company) was deleted in all the statements.

b) The Problem of Answer Scales

Two respondents mentioned that the "seven scales" was too much and the "five scales" were enough to mark. However, in the literature, the majority of the top journal papers have implemented the "seven scales" in their questionnaires. Because these two respondents were not academics, they did not have a clear understanding of how to design the questionnaire. Therefore, this suggestion would not be adopted in the questionnaire.

c) The Problem of Missing the Inventory Policy

One respondent suggested that "Inventory policy is an important part of supply chain quality management. Why not to add the questions about how does the company conduct the inspection of inventory and what kind of inventory policy (first in-first out) has implemented in the company?". It is true that inventory policy has some relations with the product quality. But it is not one of the most important factors that influence the quality work in the company. In the literature, it is not common to see the academics regard inventory policy as one of the indicators that significantly impact on quality. The

inventory policy is majorly used to study the forecasting and cost control topics. Moreover, in the questionnaire, DT1, QI2, and QI3 have already involved some aspects of storage policy and inspections. Therefore, this suggestion will not be adopted in the questionnaire.

d) The Problem of Missing the Specific Technology of Automobile

One respondent suggested adding the questions to ask what kind of specific technologies or standards are implemented in production and inspection. The respondent thought this kind of question could enhance the specificity of the questionnaire. It is true that the automobile industry has different technology and standard with other industries. The researcher had also read some literature to learn how the company produces the automobile. However, this study starts from the perspective of management but not from the viewpoint of engineering. It is not necessary to add the very professional questions about the technology. Moreover, companies implement different technologies based on their own choices. Therefore, it is very difficult to design some questions about technology that can be applied to all the companies. Therefore, this suggestion would not be implemented to the questionnaire.

e) The Problem of Comparing Quality and Price

Three respondents believed that it was not easy to directly compare cost and quality due to their complex relationship in the company. They thought there was a better way to test this relationship from a different angle in TMC2. Therefore they suggested this modification:

Top managers regard "cost of poor quality" as an important criterion in the quality goal.

However, the modified statement changed the original meaning of TMC2. It directly regards cost as part of quality without any comparison. Nonetheless, the original meaning of TMC2 is to find whether quality or cost has the priority in the company. Moreover, the average adequacy score of TMC2 is high (6.5) and the standard deviation is low (0.65). Therefore, this suggestion would not be applied to the questionnaire.

Based on the pilot study, the finalised questionnaires are shown in Appendices 6 and 7.

5.5. Data Collection

The finalised questionnaires were distributed to 800 companies that were randomly selected (within the industry) and were collected during the period from 20 June 2015 to 20 December 2015. Staff members who had a comprehensive understanding of SCQM in the company (e.g. quality manager, supply chain manager) were asked to complete the questionnaire. In order to avoid the "same source bias" and "perceptual biases", the "multiple replies" collection method was implemented (Starbuck and Mezias, 1996). This method is frequently applied and suggested to eliminate the bias in QM and SCM research (Flynn et al., 1994; Wu and Zhang, 2013). The target company first received the Internet link and Word file of the questionnaire through email and face to face meeting and was then reminded by telephone to complete it. During the data collection period, the researcher received 208 completed replies in total. However, 12 replies were rejected due to missing data. Thus, 196 valid questionnaire responses were collected from 36 CSBs and 28 JVs, resulting in a response rate of 24.5%, in line with suggested response rates of survey research (van der Vaart and van Donk, 2008). For each automobile company, at least two respondents provided the replies. The number of valid responses satisfied the minimum requirement response number of 70 for each group (Hair et al., 2014; Peng and Lai, 2012). As shown in Table 5.18, 60.36% of the respondents were quality executives within their organisations. To test for the existence of a potential non-response bias, the responses of early responders (first 50 replies) were compared to late responders (last 50 replies) to identify any statistical differences (Armstrong and Overton, 1977; Lambert and Harrington, 1990). The X^2 test indicated no statistical differences at $p<0.05$; thus, the results did not show a non-response bias in the sample (Swafford et al., 2006). Table 5.18 demonstrates the information of the respondents.

Table 5.18: Respondents Information (N=196)

	Percent
Ownerships:	
CSBs	53.57%
JVs	46.43%
Position within the firm:	
Quality manager	63.27%
Supply chain manager	29.08%
Procurement manager	5.61%
General manager	2.04%
Firm Size (Employee Numbers):	

Less than 5000	47.96%
More than 5000	52.04%

5.6. Measurement Model Evaluation

The evaluation of the measurement model strictly followed the process and guidance that were mentioned in Section 3.6.7. A reflective measurement analysis was conducted first. The quality criteria discussed by Fornell and Larcker (1981) and Hair et al. (2014) were used for verification of the reflective measurement model. The first criterion to be analysed was outer loading. A loading of 0.7 indicates that about half of the item's variance can be attributed to the construct (Hair et al., 2014). Indicators with very low outer loadings (below 0.4) should be eliminated from the model (Hair et al., 2014). Indicators with outer loadings between 0.4 and 0.7 should be considered for elimination if the deletion can increase the Composite Reliability (CR) and Average Variance Extracted (AVE) (Hair et al., 2014). Thus, TMC1, SQP1, EM1, EM4, PD4, and QI4 were removed from the model. All the other outer loadings confirmed acceptable levels on this basis (shown in Appendix 8). The second criterion to be tested was internal consistency reliability through evaluating CR. CR assesses the inter-item consistency, which should have a minimum value of 0.7 (Johnston et al., 2004). All of the scales demonstrate acceptable performance on this basis. The third criterion to be assessed was convergent validity, through evaluating outer loading and average variance extracted (AVE). AVE in all cases was above the recommended value of 0.5 (Hair et al., 2014). The fourth criterion to be examined was discriminant validity, through evaluating cross-loadings (provided in the supplementary document) and the Fornell-Larcker criterion (shown in Appendix 9). As the indicators' outer loadings were greater than any other corresponding cross-loadings, and the square root of AVE was in each case larger than the correlations among other constructs, the researcher can conclude that the indicators and constructs were exhibiting sufficient levels of discriminant validity. Table 5.19 shows the reliability and validity data of reflective constructs.

Table 5.19: CR and AVE of Reflective Measurement Model

Second Order Construct	First Order construct	CR	AVE
	Top Management Commitment	0.900	0.644
	Strategic Quality Planning	0.895	0.682
	Employee Management	0.854	0.595
	Training	0.950	0.825

Companywide QM	Process Management	0.892	0.624
	Product Development	0.863	0.515
	Quality Information	0.926	0.758
	Defect Tracking	0.860	0.673
Supplier-side SCQM	Supplier Cooperation	0.963	0.839
	Supplier Development	0.889	0.669
	Supplier Selection	0.917	0.690
Customer-side SCQM	Use of Feedback	0.932	0.775
	Customer Involvement	0.916	0.685
	Customer Relationship Development	0.780	0.545

To verify the quality of the formative measurements, the criteria discussed by Peng and Lai (2012) and Hair et al. (2014) were used. The formative measurement model was resampled by bootstrapping with 5,000 subsamples. Table 5.20 shows the statistical data from the formative measurements. The first standard to be evaluated was convergent validity through evaluating R^2. Based on the recommendations of Cohen (1988) and Johnston et al. (2004), R^2 of operational performance (0.540) and financial performance (0.813) were substantial. The second criterion to be evaluated was collinearity, through analysis of the variance inflation factor (VIF). As suggested by Neter et al. (1996), a VIF value of 10 or more represents a very high level of collinearity. Thus, all the VIF scales in the model demonstrated acceptable performance on this basis. The last standard to be confirmed was the significance and relevance of outer weights. The p-values of all the indicators were less than 0.05; thus, all the outer weights were verified to be at an acceptable level.

Table 5.20: Formative Measurement Model Analysis

	R^2	**VIF**	**p-Value**
Operational Performance	0.540	-	-
Financial Performance	0.813	-	-
OP1	-	3.367	0.000***
OP2	-	2.576	0.000***
OP3	-	2.314	0.028*
FP1	-	3.386	0.000***
FP2	-	4.815	0.003***
FP3	-	3.086	0.000***

(Outer weight: *p <0.05; ***p<0.001)

5.7. Structural Model Evaluation

The evaluation of the structural model carefully followed the process and guidance that were mentioned in Section 3.6.8. Tables 5.21 and 5.22 provide the statistical data

(except for VIF) of the structural model. Because of the small VIF scores (below 10) of each indicator (shown in Appendix 8), there was no collinearity problem within the structural model. The effect size of the predicting constructs was then evaluated by testing Cohen's f^2 (Cohen, 1988). It is the increase in R^2 relative to the proportion of variance that remains unexplained in the latent variable (Peng and Lai, 2012). Based on the suggestion of Cohen (1988), 0.35, 0.15, and 0.02 are regarded as large, medium, and small, respectively. Based on Table 5.21, only H1a's f^2 is lower than 0.02, which means the predicting power of companywide QM on operational performance is undesirable. Together with H1a's large p-value, this hypothesis is rejected. The remaining Cohen's f^2 values are all above 0.02, which present the acceptable effect size of the corresponding hypotheses (Peng and Lai, 2012). The third criterion to be evaluated was Stone-Geisser's Q^2 values, using the blindfolding procedure. Q^2 values larger than 0 for an endogenous latent variable indicate the path model's predictive relevance for this particular construct (Hair et al., 2014). Based on Table 5.22, Stone-Geisser's Q^2 values of all the endogenous constructs are above 0 indicating acceptable predictive relevance. It represents that the model's predicting power is desirable (Hair et al., 2014; Peng and Lai, 2012).

Table 5.21: Path Coefficients and Effect Sizes of Structural Model

	Path Coefficient	**f^2**	**p-Value**	**Decision**
H1a: Companywide QM → Operational performance	-0.033	0.001	0.771	Rejected
H1b: Companywide QM → Supply side SCQM	0.852	2.657	0.000***	Supported
H1c: Companywide QM → Customer-side SCQM	0.771	1.469	0.000***	Supported
H2: Supply side SCQM → Operational Performance	0.270	0.039	0.015*	Supported
H3: Customer-side SCQM → Operational Performance	0.536	0.228	0.000***	Supported
H4: Operational performance → Financial performance	0.901	4.336	0.000***	Supported

(*p<0.05; ***p<0.001)

Table 5.22: Predictive Relevance of Structural Model

	Q^2
Companywide QM	Exogenous Construct
Supply side SCQM	0.413
Customer-side SCQM	0.285

Operational Performance	0.414
Financial performance	0.688

5.8. Discussion

Figure 5.3 shows the research model with path loadings, after running the PLS algorithm and bootstrapping. In general, the researcher found companywide QM had a positive and significant relationship with both supply side and customer-side SCQM. Moreover, customer-side SCQM was the key to positively influencing operational performance, while supplier-side SCQM also made a contribution to improving operational performance. The data also verified that operational performance was positively related to financial performance. However, there was no empirical evidence to confirm a positive relationship between companywide QM and operational performance. Hence, RQ1 (What are the main factors impacting on SCQM in the Chinese automobile industry?) was answered by the evaluation of H1a, H1b, H1c, H2, and H3. In addition, only the relationship between customer-side SCQM and operational performance differs between the CSBs and JVs groups. Therefore, RQ2 (What are the differences between CSBs and competitors in the field of SCQM?) was answered by the assessment of H3 and H4. The justifications of these findings are explained in the following sections.

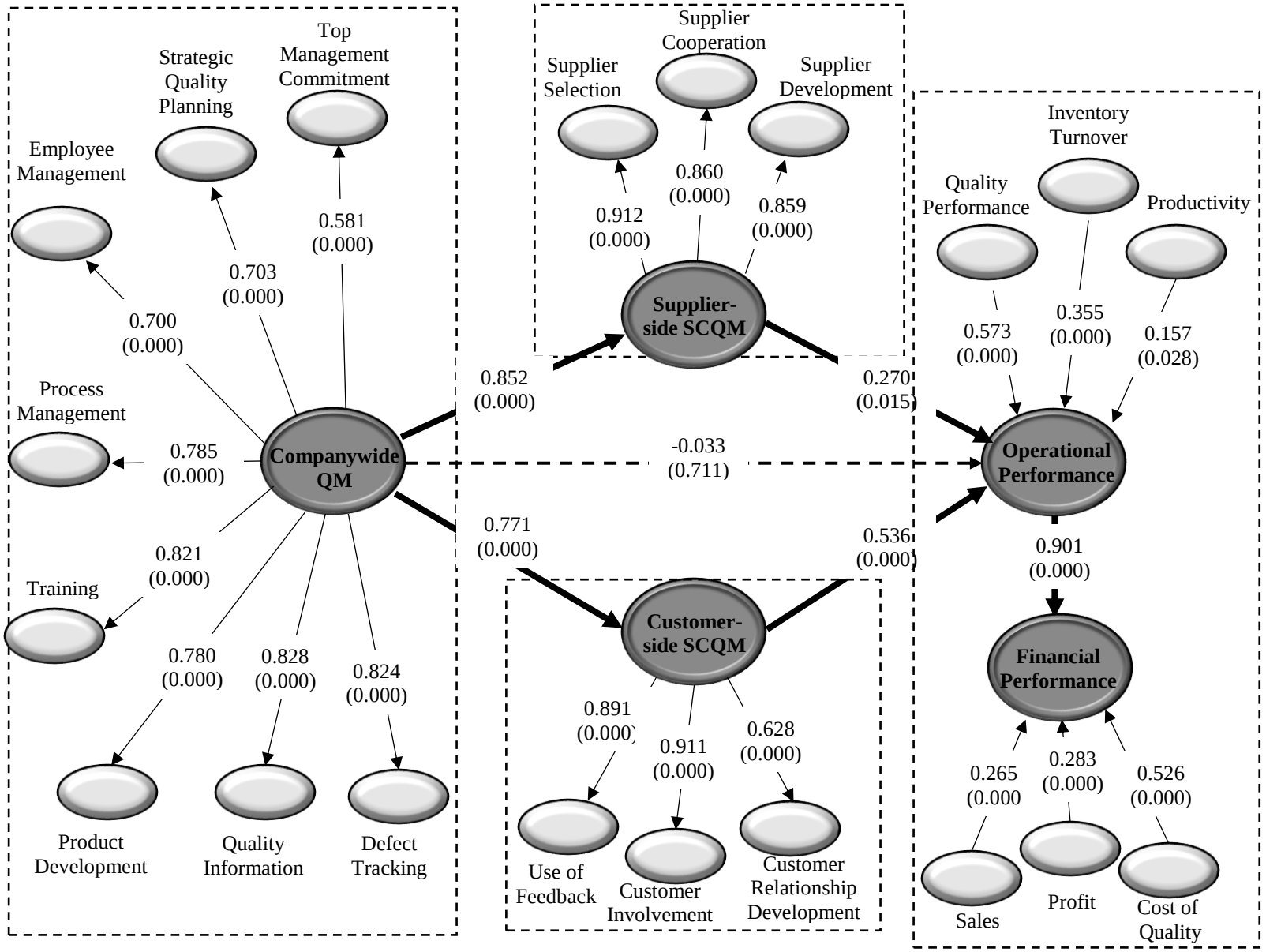


Figure 5.3: SCQM Model with Path Loadings

5.8.1. Companywide QM and Operational Performance

The researcher found no empirical support for Hypothesis 1a. The testing of the direct effects indicates a non-significant relation between companywide QM and operational performance (β = -0.033; p = 0.771). This finding verifies the work of Horn et al. (2014) but does not mean that companywide QM is not important to SCQM. Based on the bootstrapping, the indirect effect of companywide SCQM on operational performance has a value of 0.711 and the empirical t value is 6.686. Moreover, from the perspective of mediation, the mediating effects of supplier-side SCQM (M1) and customer-side SCQM (M2) between companywide QM (X) and operation performance (Y) were also calculated by following the guidance of Hair et al. (2014) that was mentioned in Section 3.6.9. The calculating process and results are listed below:

$$VAF_{supply-side\ SCQM} = \frac{In\ direct\ Effect_{X\ to\ M1} * Indirect\ Effect_{M1\ to\ Y}}{Direct\ Effect_{X\ to\ Y} + In\ direct\ Effect_{X\ to\ M1} * Indirect\ Effect_{M1\ to\ Y}} = \frac{0.852 * 0.270}{-0.033 + 0.852 * 0.270} = 116.7\%$$

$$VAF_{customer-side\ SCQM} = \frac{In\ direct\ Effect_{X\ to\ M2} * Indirect\ Effect_{M2\ to\ Y}}{Direct\ Effect_{X\ to\ Y} + In\ direct\ Effect_{X\ to\ M2} * Indirect\ Effect_{M2\ to\ Y}} = \frac{0.771 * 0.536}{-0.033 + 0.771 * 0.536} = 108.7\%$$

However, the VAF value should not exceed 100% (Hair et al., 2014). The reason for obtaining these two oversized VAF values is the opposite significant values between indirect effect paths and direct effect paths. Based on Table 5.21, the p-Values of paths ('Companywide QM to Supply-side SCQM', 'Supply-side SCQM to Operational Performance', 'Companywide QM to Customer-side SCQM', 'Customer-side SCQM to Operational Performance') show that these indirect effects are all significant. However, the p-Value of the path ('Companywide QM to Operational Performance') indicates that the direct effect is non-significant. Hence, in this situation, it is not necessary to interpret the VAF value but it directly confirms the full mediation effects in the model (Hair et al., 2014). Thus, the relationship between companywide QM and operational performance via external SCQM is significant (p < 0.01) (Hair et al., 2014).

It confirms that companywide QM closely relates to the external SCQM practices (e.g. supplier selection, supplier development, customer involvement) and influences operational performance indirectly (Horn et al., 2014). Unlike other industries, the automobile industry has an extremely long and complicated SC that includes hundreds of suppliers and customers. The automobile company cannot directly improve product quality and inventory turnover with low-quality components and weakly related dealers (i.e. only communicate market information; seldom provide quality input); it needs to involve both suppliers and customers earlier in SCQM work in order to improve performance.

5.8.2. Companywide QM and External SCQM

The researcher found empirical support for Hypotheses 1b and 1c. The test of the direct effects indicated a positive and strong relationship between companywide QM and supplier-side SCQM towards statistical significance ($\beta = 0.852$; $p = 0.000$), and also showed a positive and significant relationship between companywide QM and customer-side SCQM ($\beta = 0.771$; $p = 0.000$), which informed the test results of Hypotheses 1b and 1c.

This finding is in line with the works of Zeng et al. (2013), Hu and Flynn (2015), and Huo et al. (2014). Companywide QM is a crucial driver for SCQM because of the significant impacts that it brings for both upstream and downstream SCQM. It helps companies enable external integration with SC partners for quality improvement (Huo et al., 2014). Implementing quality improvement approaches internally will create valuable foundations when firms are considering moving towards a more extensive integration in their SCs. Companywide QM promotes the quality culture and responsibilities to each department and individual. It establishes a cooperation channel to the internal functions, which then provides the base to facilitate external cooperation with suppliers and customers. The cross-functional team (which includes the quality, purchasing and customer service departments) can assist to clarify customers' demands and transmit them to corresponding departments. It then helps everyone in the company to recognise these requirements and tailor activities to meet these demands. It means that the companywide QM can strengthen the company's capability to understand customers' expectations and to promote cooperation, which in turn enhances the customer relationship (Huo et al., 2014). Thus, companywide QM is the key to strategic

supplier management that aims to conduct continuous improvement at the SC level (Hu and Flynn, 2015) and, furthermore, it assists the integration with external customers (Huo et al., 2014). The implication is that an effective implementation of QM within an organisation is a prerequisite for moving towards SCQM, and for establishing a quality culture base for subsequent collaboration and integration with upstream and downstream organisations (Zeng et al., 2013).

5.8.3. Supplier-side SCQM and Operational Performance

The researcher found empirical support for Hypothesis 2. The examination of the direct effects indicated a positive relationship between supplier-side SCQM and operational performance towards statistical significance ($\beta = 0.270$; $p = 0.015$), which informed the Hypothesis 2 test results. This finding verifies that a company can improve quality, productivity, and inventory performance through controlling supply quality (Lo et al., 2007). Although previous literature showed mixed findings regarding the influences on operational performance brought by supplier-side SCQM (Jayaram et al., 2011; Soltani et al., 2011) the results for Hypothesis 2 add more evidence to show the situation in the Chinese automobile market. As an automobile comprises a large number of components, selecting the right supplier with the credibility of processes, supplier-side SCQM can help enhance operational performance (Huo et al., 2014). Building a solid relationship with suppliers improves a firm's manufacturing process (Devaraj et al., 2007; Ou et al., 2010; Chen et al., 2016). It is particularly important for Chinese companies when considering harsh criticisms in relation to product recalls in China.

5.8.4. Customer-side SCQM and Operational Performance

The researcher found empirical support for Hypothesis 3. The test of the direct effects indicated a positive relationship between customer-side SCQM and operational performance towards statistical significance ($\beta = 0.536$; $p = 0.000$). The customer is an important driver for the SCQM philosophy (Foster, 2008; Robinson and Malhotra, 2005). The relation between customer-side SCQM and operational performance is the strongest link between SCQM practice and operational performance, thus indicating that SCQM is customer-oriented. However, this finding is contrary to the work of Huo et al. (2014), which regarded supplier-side SCQM as the most significant factor in improving operational performance. Huo et al. (2014) collected data from different industries in ten countries, which cannot sufficiently represent the situation of the

Chinese automobile industry. According to Lu et al. (2014), China now has very strict institutions and standards (e.g. China Certification Centre for Automotive Product, China Compulsory Certification) to control the manufacturing process, quality and safety of the automobile components and assembled vehicles. The investment in advanced production lines and R&D is also increasing (DRC, 2015). Hence, the upstream and companywide SCQM are being formally supervised. However, China has the world's largest number of automobile brands and models; automobile companies need to pay much more attention to customers in order to better understand and attract them. Hence, companies need to carefully evaluate customer requirements and use that information to drive manufacturing practices. Managers need to seek more customer input in developing quality specifications and not rely solely on the development of these specifications within the company (Sila et al., 2006). The finding shows that downstream SCQM can bring direct benefits to operational performance and verifies the works of Hu and Flynn (2015) in the industry under investigation. Based on the results (shown in Figure 5.3), customer involvement ($\beta = 0.911$, $p = 0.000$) is the most significant aspect of customer-side SCQM. It means automobile companies in China emphasise frequently communicating with customers about quality issues through a variety of channels, actively involving customers in quality improvement and product design processes. It verifies the work of Jayaram et al. (2011) which shows that being in frequent close contact with customers has the most significant impact on product quality. It also identifies that besides collecting customers' feedback, designing and applying appropriate practices to jointly improve operational performance with customers is the core of customer-side SCQM (Foster, 2008; Huo et al., 2014).

5.8.5. Operational Performance and Financial Performance

The results show that the relationship between operational performance and financial performance was positive and significant ($\beta = 0.901$; $p = 0.000$), which supports Hypothesis 4. This finding verifies the work of Zhuang et al. (2015). Better quality performance can significantly decrease the number of defects, which in turn eliminates the cost of rebuilding and increases profit (Kaynak and Hartley, 2008). High inventory turnover reduces the holding cost and thus the corresponding quality cost, which in turn increases profit. Additionally, sufficient productivity guarantees sales, especially when the orders are queuing up. This finding adds further empirical evidence to show the situation of the Chinese automobile industry.

5.8.6. The Influence of Ownership

After obtaining the big picture of SCQM in the Chinese automobile market, the researcher conducted a multigroup analysis (MGA) by comparing path coefficients and standard errors between the CSBs and JVs groups to evaluate the different relationships in their models. The calculation and analysis of MGA followed the guidance that was mentioned in Section 3.6.9. Table 5.23 represents the results. Based on the calculations, only one relationship (customer-side SCQM → operational performance) differs significantly across the two groups: this relationship is statistically significant in the CSBs group (p = 0.000) but non-significant in the JVs group (p = 0.610). However, this does not mean that customer-side SCQM is not important to SCQM in JVs.

Table 5.23: MGA Results of Ownership

Paths	**CSBs VS. JVs**	
	T value	***p-value***
H1a: Companywide QM → Operational performance	1.224	0.223
H1b: Companywide QM → Supply side SCQM	0.439	0.662
H1c: Companywide QM → Customer-side SCQM	1.012	0.313
H2: Supply side SCQM → Operational Performance	1.156	0.250
H3: Customer-side SCQM → Operational Performance	3.878*	0.000***

(***p < 0.001)

According to Lu et al. (2014), JVs run a very particular business model in the Chinese market. Foreign capital provides design, technology, and management systems, while Chinese capital provides money, land, and preferential policy when establishing manufacturing operations in China (Lu et al., 2014). Thus, customer-side SCQM in the Chinese market is not the only customer side source for JVs in continuously improving supply chain quality. They also need to combine the information and guidance from foreign parent companies. Hence, compared to CSBs in which customer-side SCQM is the only downstream source for continuous improvement, based on this finding, customer-side SCQM in JVs plays a less important role in ensuring supply chain quality.

Moreover, after the Ownership-MGA test, the researcher also compared the effect size of each first order constructs of companywide QM and supplier-side SCQM to clarify

the different focus between CSBs and JVs (shown in Table 5.24). For companywide QM, quality information, employee management, and training are playing more important roles in JVs than in CSBs. It is probably because JVs have enough resources to utilise more advanced information systems, employ a more highly skilled labour force, apply a more functional quality reward system, and provide sufficient customised quality training (Chen and Tan, 2013). On the other hand, product design and strategic quality planning are acting as more significant factors in CSBs than in JVs. That is possibly because product design and strategic planning in CSBs almost entirely rely on the Chinese automobile market. However, the foreign parent company and foreign markets significantly influence JVs in these two aspects (Lu et al., 2014). It is not uncommon to find that JVs are selling models on the Chinese automobile market that are outdated on foreign markets. For example, the GL8 model of SAIC-GM in China (one of the top ten multi-purpose vehicles) is the stop production model 'Pontiac Trans Sport' of GM (production line shut down in 2005) in the North America market (Sina, 2006). For supplier-side SCQM, supplier cooperation plays the most significant role in both CSBs and JVs. Nonetheless, JVs emphasised rigorous supplier selection more than CSBs due to the stricter selection and evaluation criteria designed by the foreign parent company.

Table 5.24: Effect Size Comparison of Ownership

Second Order Construct	**First Order construct**	**Effect Size (sequence)**	
		CSBs	***JVs***
Companywide QM	Top Management Commitment	0.130 (8)	0.135 (8)
	Strategic Quality Planning	0.685 (4)	0.744 (6)
	Employee Management	0.505 (7)	0.817 (4)
	Training	0.630 (5)	0.848 (3)
	Process Management	0.764 (2)	0.855 (2)
	Product Development	0.799 (1)	0.659 (7)
	Quality Information	0.625 (6)	0.910 (1)
	Defect Tracking	0.690 (3)	0.792 (5)
Supplier-side SCQM	Supplier Cooperation	0.839 (1)	0.877 (1)
	Supplier Development	0.705 (2)	0.773 (3)
	Supplier Selection	0.687 (3)	0.816 (2)

5.8.7. The Influence of Firm Size

After the Ownership-MGA test, the researcher conducted another MGA by comparing path coefficients and standard errors between the super large automobile companies and

smaller automobile companies to evaluate the different relationships. Similarly, the calculation and analysis of MGA followed the guidance that was mentioned in Section 3.6.9 as well. Table 5.25 represents the results. The results show that there is no difference between these two groups when studying the relationships between SCQM practices and operational performance. The finding is contrary to the works of Powell (1995) and Sila (2007), which clarified that firm size brings significant impact on the relationship between quality practices and performance. However, this finding does not mean super large automobile companies and smaller automobile companies conduct SCQM in the same way. Based on the comparison of constructs' effect size, Table 5.26 clearly shows the different focuses of SCQM practices in these two groups of automobile companies.

Table 5.25: MGA Results of Firm Size

Paths	**Super Large VS. Smaller**	
	T value	***p-value***
H1a: Companywide QM → Operational performance	0.132	0.896
H1b: Companywide QM → Supply side SCQM	0.631	0.529
H1c: Companywide QM → Customer-side SCQM	0.469	0.640
H2: Supply side SCQM → Operational Performance	0.347	0.729
H3: Customer-side SCQM → Operational Performance	0.513	0.609

(*p < 0.05)

Table 5.26: Effect Size Comparison of Firm Size

Second Order Construct	**First Order construct**	**Effect Size (sequence)**	
		Super Large	***Smaller***
Companywide QM	Top Management Commitment	0.548 (8)	0.481 (8)
	Strategic Quality Planning	0.702 (6)	0.693 (4)
	Employee Management	0.843 (2)	0.503 (7)
	Training	0.807 (3)	0.656 (5)
	Process Management	0.769 (4)	0.771 (2)
	Product Development	0.564 (7)	0.836 (1)
	Quality Information	0.912 (1)	0.617 (6)
	Defect Tracking	0.759 (5)	0.722 (3)
Supplier-side SCQM	Supplier Cooperation	0.867 (2)	0.831 (1)
	Supplier Development	0.816 (3)	0.735 (2)
	Supplier Selection	0.879 (1)	0.708 (3)

Customer-side SCQM	Use of Feedback	0.907 (2)	0.822 (2)
	Customer Involvement	0.957 (1)	0.854 (1)
	Customer Development	0.649 (3)	0.489 (3)

For companywide QM, quality information, employee management, and training are playing more significant roles in super large automobile companies than in smaller automobile companies. It is probably because super large firms have more capital and workforce in implementing SCQM (Shah and Ward, 2003). Because of the large organisation size and high quantity of employees, super large automobile companies need to spend more time and invest more on collecting and analysing the quality data. They also need to build more efficient quality information systems to transmit timely quality information to all the corresponding staff. Moreover, successful SCQM implementation needs the continuous improvement of all related staff. Due to the large number of employees, super large automobile companies need to allocate more priority in enhancing employees' quality awareness, encouraging staff to provide improvement suggestions, and building more efficient reward systems than smaller automobile companies. Furthermore, in order to strengthen employees' quality knowledge and skill, super large automobile companies need to allocate more resources in training, such as providing more scheduled training courses, inviting or hiring more quality experts, and enhancing employees' enthusiasm in participating in training sessions. On the other hand, product development, process management, and defect tracking are acting as more significant factors in smaller automobile companies than in super large automobile companies. This is possibly because small firms have more agile organisational structures and more communication methods enabling more efficient quality system implementation compared to large firms (Jayaram et al., 2010). The less bureaucratic and hierarchical structure and the relatively small size can largely decrease the capital and time spent on product design and defect tracking. It also helps automobile companies to respond quickly when they find defects in production and upgrading the machinery. For supplier-side SCQM, supplier cooperation plays a more important role in smaller automobile companies than in super large automobile companies. This is probably because of the agile structure of smaller automobile companies. They can provide more responsive and practical communication and cooperating channels without tedious bureaucratic procedures. They are more open to informal ways of working with suppliers. For the customer-side SCQM, use of

feedback, customer involvement, and customer development play similar roles in both groups.

In conclusion, the hypotheses testing results are listed in Table 5.27. The researcher found no direct relationship between companywide QM and operational performance in the Chinese automobile market. Moreover, customer-side SCQM is the most significant SCQM factor of improving operational performance. Furthermore, ownership significantly influences the relationship between customer-side SCQM and operational performance. However, firm size does not affect the relationships between SCQM practices and operational performance.

Table 5.27: Summary of Hypotheses Testing Results

Hypotheses	Results
H1a: Companywide QM is positively related to operational performance.	Rejected
H1b: Companywide QM is positively related to supplier-side SCQM.	Supported
H1c: Companywide QM is positively related to customer-side SCQM.	Supported
H2: Supplier-side SCQM is positively related to operational performances.	Supported
H3: Customer-side SCQM is positively related to operational performances.	Supported
H4: Operational performance is positively related to financial performances.	Supported
H5: The total effects of SCQM practices on operational performance can vary according to ownership.	Partially Supported
H6: The total effects of SCQM practices on operational performance can vary according to firm size.	Rejected

5.9. Chapter Summary

This chapter addresses the processes of measurement development, model construction, pilot study, measurement model analysis, structural model analysis, and the discussion of the quantitative research results. That is the first attempt at measurement development of SCQM in the Chinese automobile industry. Robust empirical tests of all proposed item measures were conducted. Finally, 66 items remained after going through the assessment process. The results suggest that the items are reliable and meet the established criteria for assessing validity and reliability. The validated measurement instruments are expected to be useful for researchers who are interested in conducting

survey research related to SCQM. The researchers and practitioners can make use of the instruments to assess the state of SCQM implementation, as well as for setting up hypotheses to test how these SCQM practices impact on the performance in other countries. Hence, the proposed model forms a foundation for empirical research in SCQM. Moreover, the structural model analysis also provided the answers to RQ1 and RQ2. The researcher found that companywide QM is positively related to external SCQM. Moreover, because of suppliers' and dealers' high degree of participation in the automobile SC, our data showed that there was no direct relationship between companywide QM and operational performance. The researcher clarified that customer-side SCQM is the most significant factor to influence operational performance. Moreover, Customer Involvement, which represents the frequency of communication with customers, the communication channels with customers, and the involvement of customers in the quality improvement process and product design process, plays the core role in this downstream SCQM. Compared to customer-side SCQM, supplier-side SCQM acts as a less weighted factor of improving operational performance. In addition, the data also verified a positive relationship between operational performance and financial performance. Based on MGA, the researcher confirmed that the relationship between customer-side SCQM and operational performance differs across CSBs and JVs. Furthermore, JVs emphasise quality information, training, employee management, and supplier selection more than CSBs, which allocate more weight to product design. On the other hand, firm size did not act as a moderator that influences relationships between SCQM practices and performance. However, super large automobile companies and other size automobile companies still showed distinctive focuses in SCQM implementation.

Chapter Six: Phase Three: Root Causes of SCQM Practices

6.1. Chapter Introduction

This chapter describes the process of clarifying the root causes of SCQM practices in the Chinese automobile industry. It covers the review of research design, within-case analysis, cross-case analysis and the discussion of the findings. After conducting the 'Phase Two Study', the researcher further interviewed six quality department staff who participated in the survey research by telephone to further explain the numerical results of PLS. As discussed in sections 3.2, 3.3, and 3.7, the aims of these interviews were: 1) to identify reasons of no direct and significant relationship between companywide QM and operational performance; 2) to explain causes of customer-side SCQM as the most significant SCQM factor in influencing operational performance; 3) to clarify the reasons why automobile companies conduct SCQM differently according to their ownership and firm size. Hence, this phase of research was based on the data that was generated from the perceptions of managers in the Chinese automobile companies.

6.2. Review of Research Design

The researcher carried out follow-up interviews to interpret the PLS results and answer RQ3 on March 2016. In order to ensure a smooth environment for the interview and keep focusing on RQ3, an interview protocol was formed as stated in Section 3.7. It includes ten open-ended questions that cover three aspects: 1) overall SCQM practice; 2) the relationship among SCQM practices and performance; 3) the priority of SCQM practices in the company. The detailed information about the interview protocol is presented in Appendix 2. The participants were purposely selected in order to provide accurate and comprehensive understanding of the SCQM information in their companies. As indicated in Section 3.7, all participants were senior level managers of automobile companies that met the three selection principles. These automobile companies are located throughout China and are major players in the Chinese automobile market, hence they can be considered as the representatives of the Chinese automobile industry. The detailed information about the participants and the interviews are listed in Table 6.1. In order to assist the analysis, all the interviews were audio

recorded and the average length of each interview was around 55 minutes. After collecting the narrative data by semi-structured interviews, RQ3 (Why do such differences occur?) was answered based on the within-case analysis and cross-case analysis.

Table 6.1: Participated Interviewees and Automobile Companies

Automobile company	Ownership	Size	Interviewee	Duration (mins)	Date
$JVSL_1$	JV	Super large	MZX (Quality Manager)	63	12/03/2016
$JVSL_2$	JV	Super large	ZHY (Quality Manager)	66	16/03/2016
$CSBSL_2$	CSB	Super large	CXD* (Former Quality Chief)	59	03/03/2016
$CSBO_1$	CSB	Smaller	SKR (Quality Chief)	48	08/03/2016
$CSBO_2$	CSB	Smaller	LBX (Quality Manager)	46	18/03/2016
$CSBO_3$	CSB	Smaller	LSZ(Quality Chief)	58	04/03/2016

**: Mr. CXD was promoted to vice-general manager at the interview time.*

6.3. Within-Case Analysis

$JVSL_1$ was founded by a Chinese automobile company and a Japanese automobile company in 1998. It is located in Guangdong province with more than 8,000 employees and produces 600,000 vehicles per year. $JVSL_1$ not only imported the advanced technology from the Japanese parent company but also absorbed the modern QM system from Japan. Combining the QM system of the Japanese parent company and the practical situation of quality in $JVSL_1$, the JV established and implemented the specific quality system to control, supervise, and guide the companywide quality programme. MZX (*$JVSL_1$, Quality Manager*) explained the specific quality system: *"We emphasise the participation of the staff in the company. We insist the policy 'Whoever manufactures the product should be responsible' during the producing process. Moreover, we train the staff never to receive, manufacture, and ignore defective products"*. This specific quality system enhances the employee's quality awareness and understanding; thus, motivating employees take part in continuous improvement. $JVSL_1$ was also one of the first automobile companies that involved suppliers into the automobile company's quality improvement programme. MZX (*$JVSL_1$, Quality*

Manager) further introduced supplier-related quality improvement: *"We established the Supplier Quality Assurance System (SQAS) at the beginning of the Millennium. It helps us to ensure the components are eligible and of high-quality when suppliers are delivering them to us".* This system contains the quality based criterion to evaluate the components that are provided by suppliers. $JVSL_1$ can easily and quickly check whether the components meet or exceed the quality requirements or not. Moreover, this system can effectively share the quality related information between $JVSL_1$ and suppliers to better understanding the quality conditions. Since the foundation of $JVSL_1$, it has put "Happiness of Purchasing" first to serve the final customer. $JVSL_1$ was the first automobile company that introduced the "Contract Dealer" in China. MZX (*$JVSL_1$, Quality Manager*) further specified: *"In order to ensure the customer can enjoy the whole process from purchasing the car to driving the car, we are the first to integrate sale, service, survey, and spare part in one contract dealer in the Chinese market. With the change of customers' requirements, the four-in-one function of the contract dealer has developed to eight-in-one or even ten-in-one by including the financial service, insurance, and car club*". This statement shows that in order to effectively meet the customer requirement, $JVSL_1$ modifies the role of dealers correspondingly. Moreover, the Customer Service Department and Marketing Department were participating in the customer communication programme more frequently. Those departments started to cooperate with the online business platform and developed a mobile app to contact final customers. These kinds of customer services helped $JVSL_1$ obtain the good reputation in the field of customer satisfaction in the Chinese market.

$JVSL_2$ was established by a Chinese automobile company and a French automobile company in 1992. It is located in Hubei province with around 9000 employees. It restructured in 2003 and produces 650,000 vehicles per year. Based on the quality systems of the two parent companies, $JVSL_2$ created the "Five Process Quality Control System" (FPQCS). ZHY (*$JVSL_2$, Quality Manager*) further described: "*FPQCS includes: 1) process of plan and innovation that defines the outline of company development and profit; 2) process of product design that delineates the product and manufacturing process; 3) process of manufacturing and delivery that serves for the assembled automobile; 4) process of launching the commerce that aims to establish sales network; 5) process of improve that describes the continuous improvement in serving the customers*". This comprehensive quality control system assisted $JVSL_2$ in

ensuring quality performance from quality planning to after sales services. Moreover, $JVSL_2$ created the "PQ365" quality improvement plan to guide the daily operations within the company. ZHY (*$JVSL_2$, Quality Manager*) introduced the "PQ365": "'*3' represents the three external quality improvement plans. '6' means the six internal quality improvement programmes. '5' symbolises the five preferential quality improvement projects. Finally, '365' implies that the staff needs to keep the quality requirements in mind every day*". This "PQ365" significantly enhanced the quality awareness of all employees by integrating both internal and external quality improvement plans. Further, $JVSL_2$ built a win-win cooperative supplier management system to continuously develop strategic suppliers. ZHY (*$JVSL_2$, Quality Manager*) introduced: "*We categorise suppliers into four levels: 1) high-risk component; 2) modular component; 3) standard component; 4) low-risk component*". Based on the supplier classification, $JVSL_2$ implemented different cooperative approaches to jointly work with suppliers. The implemented different cooperative approaches with suppliers significantly improve the collaboration between $JVSL_2$ and different suppliers. Moreover, the specific ERP system closely linked $JVSL_2$ with all the suppliers. Furthermore, $JVSL_2$ conducted the "Blue Box" plan to enhance the customer experience all over China. ZHY (*$JVSL_2$, Quality Manager*) indicated: "*The Blue Box plan aims to improve the hard and soft aspect of our 4S dealers. We help them to design modern exhibition rooms and train the staff based on international standards*". The Blue Box plan assisted $JVSL_2$ to obtain a very high ranking of customer satisfaction that was evaluated by JD. Power in 2009. Recently, $JVSL_2$ set out to create more channels to communicate with and serve final customers. For example, ZHY (*$JVSL_2$, Quality Manager*) illustrated: "*The Market Quality Improvement Division has started to directly communicate with our customers. We also invest more money in the User Club (customer association) to listen, collect, and analyse the changing requirements of our customers".* This shows that $JVSL_2$ starts to rely more on its own department to contact and deal with customers.

$CSBSL_2$ is located in Anhui province with more than 8000 employees. It was founded in 1997 and it now produces more than 650,000 vehicles per year. With the aim of building safe, energy-conserving, and eco-friendly products, $CSBSL_2$ has gradually been geared to international standards, established a set of distinctive quality assurance management systems, and passed international quality system certifications such as

TS16949. It also established the specific "Intelligent Auto" system to guide the quality improvement programme within the company. CXD (*$CSBSL_2$, Former Quality Chief*) explained the "Intelligent Auto" system: "*It fully improves the quality of human senses by leading lean car design and fully matches the driving experience by strict technique and standards at the international level for car quality of the products more in line with international standards in shaping, space, operation stability and safety*". This system aims to improve the quality level of $CSBSL_2$ from enhancing employees' quality awareness, advancing quality techniques, and stabilising the manufacturing process. Moreover, $CSBSL_2$ adopts 38 quality gates in line with the international standard process to effectively control the quality of the production process. It has also introduced an advanced audit test to all parts and technical links as well as stamping, welding, painting and assembling on the basis of the original car audit test to improve standards of the original quality test. In order to ensure the quality of automobile parts, $CSBSL_2$ aligns with international auto brands. CXD (*$CSBSL_2$, Former Quality Chief*) further introduced: "*We also integrated Supply Chain Management system, Logistics Management system, and ERP based on our mySAP system*". This electronic system provides two groups of information: 1) Electronic Kanban that aims to reduce inventory and conduct JIT; 2) Electronic Announcement that focuses on real-time communication and cooperative assessing with suppliers. Based on this system, $CSBSL_2$ can effectively collect and share data to improve the cooperation with supplier. Moreover, this system also helps $CSBSL_2$ to save time in recognising quality problems of components that are provided by suppliers. Furthermore, $CSBSL_2$ relies on dealers to collect customer-side quality information. However, it categorises dealers into 4S dealers (comprehensive dealers), 3S dealers (professional sellers), and 1S dealers (specialised after sales centres).

$CSBO_1$ is located in Hebei province with more than 2700 employees. It is a CSB and was founded in 1999. It produces 150,000 automobiles per year. The company is operating under the ISO 9000 standard. However, it does not want to apply the TS16949 because of the high investment. SKR (*$CSBO_1$, Quality Chief*) explained the automobile company's choice: "*We don't have plans to implement TS16949 due to the small company scale. It is not practicable and profitable for us to obtain that certification at present*". This statement shows the $CSBO_1$ adopts the short-term perspective on SCQM. TS16949 is specifically designed for the automobile industry to ensure the quality

performance. Although the implementation of TS16949 may cause a relatively heavy investment, the long-term benefits in the field of quality is tremendous. $CSBO_1$ focuses on motivating the workers to provide quality improvement suggestions. For each suggestion, the company will award 20 RMB to the worker and add one point to its performance salary. All of the suggestions will be recorded and shared through the Product Lifecycle Management (PLM) system. The company also creates the distinct "Quality Gate" in order to supervise the quality of new models. SKR (*$CSBO_1$, Quality Chief*) explained: "*The quality gate includes nine procedures. The first is the project establishment. It describes the model's market position, cost, target, and quality. The second is concept and appeal design. During this procedure, the qualified suppliers will be selected. The third is numerical control freeze. The suppliers' plan and the moulds are prepared. The fourth is the off-tool-sample test. The mould and suppliers' plans are tested and modified. The fifth is the production confirmation. Pilot production will be conducted to see the process capability of the production line. The sixth is the production approval. The seventh is the market test. The initial customer feedback will be collected to see their opinion on the new model. The eighth is formal production. The ninth is project closure*". Those nine procedures aim to help the automobile company to eliminate the potential quality problems to the greatest extent. However, the application of the quality gate meets several difficulties due to the low ability of the employee. Moreover, $CSBO_1$ categorises its suppliers into two groups. The first one is the designing supplier which has the ability of co-designing the new models with the automobile company. $CSBO_1$ utilises strict requirements on brand, quality, cost, delivery and certification when selecting designing suppliers. The second one is the producing suppliers. This kind of supplier does not have innovation ability. $CSBO_1$ focuses more on the process capability when selecting them. Furthermore, $CSBO_1$ assigns dealers to collect the downstream quality data. SKR (*$CSBO_1$, Quality Chief*) introduced: "*Our dealers collect customer requirements as the pre-sale quality data and gather maintenance information and customer complaints as the after sale quality data*". Based on the work of the dealers, $CSBO_1$ can estimate and set up quality goals to promote brand recognition.

$CSBO_2$ is located in Liaoning province with around 4,500 full-time employees. It was founded in 1991 and it now produces 100,000 vehicles per year. In order to enhance quality within the company, $CSBO_2$ passed ISO9000 in 2002 and obtained a series of

national quality certifications as well. However, $CSBO_2$ was not satisfied with merely meeting the quality standards. It is always aiming to continually improve quality and refining the manufacturing process. LBX (*$CSBO_2$, Quality Manager*) introduced: "*To improve the management system and enhance quality control, we spent 70 million RMB to adopt the TPS in 2009. We also hired a Vice President who has worked in BMW for 40 years to guide our quality programme*". The large investment in adopting advanced quality system and hiring skilful managers shows the determination and attitude of $CSBO_2$ in improving quality. Moreover, by learning from the foreign advanced quality systems, $CSBO_2$ designed its specific quality system. LBX (*$CSBO_2$, Quality Manager*) further indicated: "*We established the 'Safety-Quality-Service' system to guide our manufacturing. It is a three-in-one system that covers all the aspects of manufacturing*". This system assists $CSBO_2$ in building a comprehensive quality control system to plan, analyse, stabilise, and improve quality. It covers the aspect of employee safety, manufacturing quality, and service for the internal customers (i.e. the staff who is in charge of the next manufacturing process). For the supplier-side quality improvement, $CSBO_2$ emphasises the exchange of quality information. LBX (*$CSBO_2$, Quality Manager*) stated: "*We asked EWININFO to help us to establish the specific quality information system to better link us with suppliers. After applying it, we can communicate in a timely manner with suppliers in the field of the quality targets, process management, quality defects, and traceability*". The efficient supplier communication system assists $CSBO_2$ to work with suppliers in a more transparent and professional manner. For customer-side quality improvement, $CSBO_2$ depends on the dealers to communicate with customers and collect customer feedback. $CSBO_2$ set up several preferential policies to attract dealers to join in its sales network. Moreover, LBX (*$CSBO_2$, Quality Manager*) indicated: "*We clearly know the importance of communicating with final customers. Hence, we send our quality staff and marketing staff to dealers to train their salespeople and maintenance personnel. Only if they serve customers with a high standard can customers then provide more valuable feedback to us*". This statement clearly shows that $CSBO_2$ significantly relies on dealers to collect customer data and communicate with customers. This kind of training helped dealers significantly enhanced their service ability, which in turn improved $CSBO_2$'s reputation. Besides training the dealers, $CSBO_2$ also devotes itself to rational distributing dealers all over China to enhance its brand recognition.

$CSBO_3$ is located in Henan province with around 2,500 full-time employees. It was established in 1988 and can produce 150,000 automobiles per year. It passed ISO9000 in 1994 and became the first CSB that obtained this quality certification. Even though $CSBO_3$ does not obtain TS16949 certification, it still conducts the "5 Major Tools" within the company. Moreover, it applies the All-For-Quality (AFQ) system in the company to motivate all the staff to participate in quality control and improvement programmes. Besides AFQ, $CSBO_3$ also implements other systems to continually improve quality. For example, LSZ (*$CSBO_3$, Quality Chief*) introduced: "*Other than the AFQ system that aims to encourage employees to continuously improve quality, we also implemented the E-NOVA-C system to test the assembled vehicles and to evaluate our quality effort*". By supporting those quality standards and management systems, $CSBO_3$ invests on upgrading decoilers, coating machines, and welding robots by purchasing them from famous national brands. The large investment on advanced machinery show the strong quality awareness of $CSBO_3$. In order to better improve supplier-side quality, $CSBO_3$ selects appropriate suppliers all over the world and cooperatively designs and sets up quality goals. LSZ (*$CSBO_3$, Quality Chief*) further explained: "*To better collaborate with suppliers, we spent 200 million RMB to build an industrial park near our factory to allocate the major suppliers from 2004*". Based on these efforts, $CSBO_3$ has successfully absorbed 110 suppliers into its ancillary system. This significantly saves the time and cost of delivering the component and promotes the implementation of JIT. For the customer-side quality improvement, $CSBO_3$ explores and collects customer requirements by continuously enhancing dealers' service standards. It facilitates more than 260 face-to-face meetings between dealers and customers to listen and collect feedback. In addition, LSZ (*$CSBO_3$, Quality Chief*) explained: "*Besides assisting our dealers in providing better service to customers, we also hired 500 examiners from the society to randomly test dealers' work. It helps us to evaluate and set up a more appropriate plan to work with dealers*". The integration of internal and external supervision of dealers' work shows that $CSBO_3$ assigns an important role to dealers in its SCQM and aims to continuously improve dealers' ability; thus, collecting more useful customer information.

The specific SCQM practices of each case are summarised in Table 6.2. Data shows that automobile companies implement SCQM in their own distinctive way. They utilise different SCQM practices in their SCs to enhance their performance. Moreover, the

CSBs focus more on companywide QM and supplier-side SCQM. For customer-side SCQM, they rely more on dealers to deal with final customers. Furthermore, the JVs said that they apply the customer-side SCQM mainly through their own staff and departments.

Table 6.2: Specific SCQM Practices of Cases

Cases	Companywide QM	Supplier-side SCQM	Customer-side SCQM
JVSL$_1$	Implements the specific quality system; conducts the "Whoever manufacture the product should be responsible" policy	One of the first automobile companies that involves suppliers into quality improve programme; implements the "Supplier Quality Assurance System"	Introduces the "Happiness of Purchasing" policy; the first to apply the "Contract Dealer" in China; Customer Service Department and Marketing Department contact final customers by the online business platform and mobile APP
JVSL$_2$	Implements the "Five Process Quality Control System"; applies the "PQ365" quality improvement plan	Builds a win-win cooperative supplier management system to continuously develop strategic suppliers; designs and utilises the specific ERP system to closely link with suppliers	Conducts the "Blue Box" plan; Market Quality Improvement Division creates more channels to communicate with and serve final customers
CSBSL$_2$	Implements TS16949; establishes the specific system "Intelligent Auto" to guide the quality improvement programme	Aligns with international brands; integrates Supply Chain Management system, Logistics Management system, and ERP based on its mySAP system	Categorises dealers into 4S dealer, 3S dealer, and 1S dealer to collect customer quality information
CSBO$_1$	Operates under ISO9000; applies the Product Lifecycle Management system to motivate staffs to join quality improvement; implements the "Nine Quality gates"	Categorises suppliers into "designing suppliers" and "producing supplier"; implements different supplier selection and evaluation criteria	Relies on dealers to collect pre-sale and after-sale quality information

$CSBO_2$	Runs the "Safety-Quality-Service" system; huge investment on advanced quality system and professionals	Designs and implements the specific quality information system to efficiently communicate with suppliers	Sets up several preferential policies to attract dealers to join in its sales network; provides training to enhance dealers' service
$CSBO_3$	Implements ISO 9000; applies "All-For-Quality" system to motivate staffs to join quality improvement; utilise the "E-NOVA-C system" to evaluate quality performance	Cooperates with famous national brands; builds industrial park to efficiently work with suppliers;	Holds 260 face-to-face meetings between dealers and customers; hires 500 examiners from the society to randomly test dealers' work

6.4. Cross-Case Analysis

6.4.1. The Relationship between Companywide QM and Operational Performance

In Section 5.8.1, the researcher found that companywide QM does not directly influence operational performance. During the telephone interviews, firstly, LSZ (*$CSBO_3$, Quality Chief*) explained the relationship between SCQM practice and operational performance by emphasising the importance of supplier-side SCQM in the company. LSZ (*$CSBO_3$, Quality Chief*) claimed: *"More than 80% of the auto parts are purchased from more than 600 suppliers. We are closely related to our suppliers. For example, we designed nine procedures to ensure the quality of a new car. Our suppliers will participate in it from the very beginning (Procedure one: Setting up the project) to discuss the performance, quality, cost and price of the new car"*. This statement shows the importance of suppliers in the automobile industry. Without the input of suppliers, the automobile company cannot manufacture the vehicles because of the lack of components. In addition, the early involvement of suppliers in the automobile companies' product design could significantly assist in SCQM implementation. Moreover, ZHY (*$JVSL_2$, Quality Manager*) stated the SC conditions in terms of component purchasing and corresponding influence in the company: *"Although we produce engines for our models, we still buy 70% of the components from external suppliers. If these components' quality is bad, we cannot satisfy the customer by only a high-performance engine"*. This statement also proves the significance of suppliers in ensuring and improving the operational performance of the automobile companies.

Because the automobile consists of a large number of components, the capability of suppliers which provide the majority of the necessary components is one of the key elements in ensuring the quality of the automobile. All of the other interviewees also mentioned the high percentage of components (the lowest level is 65%) that were procured from a large number of external suppliers. It shows that automobile companies cannot manufacture a quality vehicle without suppliers' participation due to the complexity of an automobile. Moreover, in order to ensure and improve the quality of vehicles, suppliers are taking part in automobile companies' SCQM by not only supplying the components on time but also providing quality improvement plans at the early stage of automobile companies' SCQM implementation. The input of suppliers cannot be obtained from automobile companies. For instance, SKR (*$CSBO_{1,}$ Quality Chief*) mentioned: *"We buy engines from SDWC, which is one of the best engine producers in China. We could develop the engine and produce it by ourselves. However, SDWC apparently has more resources and experience than us. So, why should we challenge ourselves?".* This statement shows that suppliers usually have better capability in providing the specific component than the automobile companies. This is the reason why the automobile companies rely on some key suppliers to save time, reduce coast, and improve quality.

Besides the importance of suppliers in SCQM implementation, LSZ (*$CSBO_{3,}$ Quality Chief*) further emphasised the importance of dealers. He then emphasised the impact that was brought by customer-side SCQM on operational performance in the company: *"We set up an annual quality target and plan based on two aspects' of information. The first source is the information of after sales and maintenance. Our 4S dealers collect this kind of data and transmit to us. The second source is market information. It includes the pre-sale market information provided by our dealers, end customers' feedback of current models also collected by 4S dealers, and the third party's annual quality investigation. Hence, dealers take part in our quality programmes from the beginning"*. In addition, SKR (*$CSBO_{1,}$ Quality Chief*) claimed: *"The formulation of the quality performance of a new model is based on the similar models' data and our expectation……The quality performance database mainly relies on the collection conducted by our (more than) 200 dealers"*. These two statements clear identify the significance of customer side SCQM. They show that the customer information/feedback, which is collected by dealers, is the key source of strategic

quality plan in automobile companies' SCQM implementation. If the collected customer information is not accurate and not on time, the automobile companies will meet difficulties in designing the quality target. All of the other interviewees also explained their processes of establishing quality targets by emphasizing the importance of customer feedback. It shows that dealers and the customer-side SCQM are the significant elements of formulating quality targets and quality improvement plans. Although the companywide QM directly influences automobile companies' manufacturing process, the desirable operational performance will not be easily achieved without a clear target and a practical improvement plan. Therefore, all of the interviewees confirmed that the automobile industry has a highly collaborated SC and that companywide QM does not influence operational performance by itself.

6.4.2. The Relationship between Customer-side SCQM and Operational Performance

In Section 5.8.4, the researcher concluded that the relation between customer-side SCQM and operational performance is the strongest link between SCQM practice and operational performance. China has the most competitive automobile market in the world, which includes more than 90 brands and 300 models (twice and three times as many as the USA, respectively). Moreover, Chinese customers are considered to be the most fastidious buyers as they are well-honed by the experience of the melamine-contaminated milk powder scandal (Mi, 2014). Therefore, how to deal with Chinese customers becomes the core issue of automobile companies. Due to the function of CSBs, their dealers are directly communicating with customers. During the interviews, LBX (*$CSBO_2$, Quality Manager*) explained the decisive role of customer-side SCQM practices in the company: *"To attract final customers, we need to know their opinions and apply this information to our production……The dealer is the core source of customer information, who collects and transmits it to us. If this information is not accurate or delayed, our SCQM will be influenced from the beginning. If we have implemented an unpractical quality plan, how can we improve our quality to meet customers' expectation?"*. It means that recognising customers' requirements is the first job of conducting SCQM. Hence, without the correct understanding of customers' expectation, automobile companies cannot satisfy customers no matter how much effort they make to manufacturing and controlling components' quality. Furthermore, CXD (*$CSBSL_2$, Former Quality Chief*) explained the importance of customer-side SCQM

from another aspect: *"Automobiles need maintenance at the regular time. It's not us but our dealers provide maintenance service to end customers. On the one hand, our dealers can collect the breakdown related information for us. On the other hand, our dealers' ability in maintenance directly influences end customers' evaluation of our brand's quality. Hence, we need to actively cooperate with customer-side SCQM to encourage dealers to provide more input, enhance dealers' performance, and obtain more valuable end customers' feedback"*. In addition, SKR (*$CSBO_1$, Quality Chief*) claimed: *"Just like Ford, we also use Things Gone Wrong (TGW) per 1000 vehicles as one criterion to evaluate our quality performance. The TGW data is mainly derived from our dealers that take charge of maintenance service for us……TGW report exposes our deficiency and assists model design".* Those statements show the significant role of dealers in the after sales market. Dealers not only collect customer feedback but also provide the objective statistical data of the breakdowns for automobile companies. It indicates that the cooperation between automobile companies and dealers is not limited to quality planning but involves product design. In addition, the quality of services that are provided by dealers is treated as automobile companies' performance by final customers in the Chinese market. Hence, dealers' ability directly influences the data quality that is provided to automobile companies and brand identity. In order to identify the expectations and the complaints of final customers, automobile companies are closely cooperating with dealers and involving dealers in their SCQM as early as possible.

The interviewees from JVs also claimed that customer-side SCQM contributes the most to their SCQM. During the interview, ZHY (*$JVSL_2$, Quality Manager*) indicated: *"Instead of merely relying on dealers, we established our electronic business platform 'CBP' last year. It was co-developed by our Marketing and After Sales Department. To date, we have obtained more than 70,000 pieces of customer information. We could spend much more time and money collecting the same amount of data if we were only cooperating with our dealers"*. It shows that instead of only involving dealers in product design and quality improvement programmes in the past, JVs start to directly communicate with customers by utilising the electronic platforms. This kind of customer-side coordination also assists automobile companies in designing appropriate new models and establishing appropriate quality goals, which leads automobile companies to improve operational performance.

6.4.3. Ownership's Effect on the Relationship between Customer-side SCQM and Operational Performance

In Section 5.8.6, the researcher identified that customer-side SCQM significantly influences operational performance in the CSBs group but not in the JVs group. During the interviews, interviewees from CSBs have explained the significant role of dealers from different perspectives. For example, Moreover, LSZ (*$CSBO_3$, Quality Chief*) mentioned: "*We set up the annual quality target and plan based on two aspects of information. The first source is the information of after sales. Our 4S dealers collected this kind of data and transmitted the data to us. The second source is the market information. It includes the pre-sale market information provided by our dealers, end customers' feedback of current models also collected by 4S dealers, and the third party's annual quality investigation"*. LSZ (*$CSBO_3$, Quality Chief*)'s description demonstrates that CSBs regard dealers not only as the core sources of customer information but also as significant and early contributors to strategic quality planning. Without the input of dealers, CSBs cannot set up the accurate quality target because of the lack of customer information. Moreover, the earlier the dealers are involved in the automobile companies' strategic quality planning, the smoother the automobile companies' SCQM implementation.

However, MZX (*$JVSL_1$, Quality Engineer*) provided another voice from the perspective of JVs: *"The role of dealers is changing. We now rely more on our Market Quality Improvement (MQI) division to collect end customers' feedback. The "800 Hotline", online BBS, and "Technology Hotline", run by our headquarters, also progressively take over the "Survey" and "Service" functions of our dealers*". Moreover, ZHY (*$JVSL_2$, Quality Manager*) indicated: "*We also start to work with some websites, such as Taobao and Autohome, to sell our models. They can provide us with more and timely end customers' information based on their big data"*. Those statements show that the way of collecting customer feedback is changing in JVs. JVs are trying to contact customers more directly by diverse methods, such as electronic platform, online BBS, and hotlines. Moreover, this kind of communication is conducted mainly by the department of JVs but not the dealers. The original roles of JVs' dealers, such as investigating customers' user experience, are being diluted. These dealers start to concentrate on test driving, vehicle delivery, and other functions. In addition, ZHY (*$JVSL_2$, Quality Manager*) claimed: *"Our Marketing Department designs mobile*

applications to enhance customers' user experience and collects timely breakdown and performance information of our models". This statement demonstrates that the development of information technology assists JVs in changing their ways to communicate with customers. In the Chinese automobile market, JVs control and own more and better resources than CSBs (Lu et al., 2014). Hence, JVs are more capable of implementing advanced digital technology to collect customer information and provide better service. Furthermore, McKinsey (2014) clarified that the development of digital technology could help automobile manufacturers to gather more real-time customer information that can lower development costs and speed up the time to market by big data simulations and virtual modelling. Moreover, with the help of advanced online platforms, manufacturers can accurately supervise the performance of vehicles and components, suggesting directions and opportunities for eliminating anything customers do not value from design and manufacturing (McKinsey, 2014).

6.4.4. Firm Size's Effect on SCQM Implementation

In Section 5.8.7, the researcher clarified the different focuses of SCQM implementation between super large automobile companies and smaller automobile companies. For companywide QM, quality information, employee management, and training are playing more important roles in super large automobile companies than in smaller automobile companies. During the interview, MZX (*$JVSL_1$, Quality Engineer)* emphasised the employee numbers (due to the firm size) in explaining the companywide QM implementation: *"Quality information is the core source of decision making during production. As we have more than 16,000 workers in the company, how to collect, analyse, and deliver this data become very critical. Hence, we cooperated with Lanyou Ltd. and developed our quality information system (QIS) to record, analyse, transmit, and save quality data more efficiently…… As I introduced, we have so many visual Kanban and Liquid Crystal Display to show timely quality information".* This statement identifies the reason for focusing on quality information in super large automobile companies. Companywide QM requires everyone in the company to participate in continuous improvement (Kaynak and Hartley, 2008). The clear understanding of quality and production conditions is the core of companywide QM implementation. Hence, for the super large automobile companies that employ thousands of staff, the way to collect, transmit, and utilise quality information becomes more and more important in effectively implementing SCQM. Moreover, ZHY (*$JVSL_2$,*

Quality Manager) illustrated the background of the "employee management" of companywide QM: *"We require our workers to provide one improvement suggestion per month. Although the majority of these suggestions only bring slight improvement or even no improvement, we still can find some excellent suggestions due to the large size of the workforce. Hence, we have consistently conducted this practice for 14 years"*. This statement clarifies that employee management, which motivates the employees to participate in quality improvement, plays a significant role in the companies that have a large number of staff. The participation of all the staff in the company is one of the prerequisites of conducting companywide QM. When a company has a large number of employees, how to motivate and empower them to provide input to performance improvement becomes important. The employee is the core of SCQM implementation, because they are the people who execute the SCQM practices. If they are not effectively motivated to continuous improve the performance, it is difficult for the automobile companies to smoothly conduct SCQM. For supplier-side SCQM, supplier selection acts as a more significant role in super large automobile companies than in smaller automobile companies. CXD (*$CSBSL_2$, Former Quality Chief*) explained the "supplier selection" by focusing on the company capability: *"Due to our company's capability, we have more choices than smaller automobile companies when selecting suppliers. Hence, we can set up more rigorous selection criteria to find the most suitable suppliers"*. This statement identifies that super large automobile companies' bargaining power in the buyer-supplier relationship supports them to promote more strict requirements to suppliers. This is because of the strong power of super large automobile companies compared with suppliers, which directly helps them to establish a wider range of supplier databases than the other size automobile companies. Due to the large number of potential suppliers, it is easier for super large automobile companies to select suppliers by applying the strict criterion than the other size automobile companies. On the other hand, supplier cooperation is a more crucial factor in smaller automobile companies than in super large automobile companies. LBX *($CSBO_2$, Quality Manager*) illustrated the "supplier cooperation" in the company by emphasizing the organisational structure: *"Unlike the big names, we are quicker in communicating with suppliers. We can discuss through QQ, WeChat, Qianniu, Skype, and other chatting software. It is not necessary to communicate by formal email or the supplier data distribution system. We also go to suppliers' sites more frequently to discuss the quality and production requirements".* This statement shows that the smaller automobile companies are more

welcoming to the informal way to coordinating with suppliers more frequently. The agile structure of smaller automobile companies assists them to try more communication and cooperation methods to work with suppliers. Due to the specific business structure, the smaller automobile companies can quickly and effectively conduct some informal communications with suppliers without the tedious administration procedure that is commonly existed in the super large automobile companies.

6.5. Findings and Discussion

6.5.1. SCQM Practices in the Chinese Automobile Market

The researcher found that companywide QM cannot directly influence operational performance due to the complexity of China's automobile SC. Automobile brands collaborate closely with suppliers and customers in order to obtain better operational performance. Because of the limited function of automobile companies in producing cars, automobile companies need to buy the vast majority of components from suppliers. Hence, the quality of components not directly controlled by automobile companies significantly influences the quality of the assembled automobiles. As stated by the interviewees, automobile companies need to spend a large amount of time, money, and energy to select, communicate, and cooperate with suppliers to ensure a stable supply and a reliable quality of components. Moreover, based on the follow-up interviews, it is clear that SCQM is a customer-oriented management philosophy. All the interviewees claimed that customers' requirements are the most critical source of decision-making in strategic quality planning. This means that the SCQM implementation of Chinese automobile companies is fundamentally relying on car owners' demand. Customers have participated in automobile companies' SCQM implementation from an early stage and play a significant role. Based on the above discussion, the reasons for "no direct and significant relationship between companywide QM and operational performance" are: *1) the large number of components provided by external suppliers; 2) the high degree and importance of dealers' participation in automobile companies' SCQM at the early stage*.

Contrary to the work of Huo et al. (2014), this study found that customer-side SCQM practices have the most significant influence on operational performance. SCQM implementation is guided by a strategic quality goal (Robinson and Malhotra, 2005).

Based on the analysis of the follow-up interviews, customer feedback and the maintenance information are the key sources of formulating the quality goals. Hence, automobile companies need to communicate in a timely manner with customers and carefully collect customer feedback. Only if customers' requirements are clearly recognised can automobile companies then set up an accurate quality goal that correctly guides the direction of SCQM implementation. Based on the interviews, the majority of CSBs rely on dealers to collect the defect data and conduct the customer survey. Dealers represent those CSBs to sell cars, provide spare parts and after sales service, and conduct customer surveys. On the other hand, interviewees also expressed that JVs not only ask dealers to collect customer information but also have direct contact with customers through their departments in various channels. For example, they started to cooperate with the website and build their own electronic business platform to obtain customer feedback. Although CSBs and JVs act differently in communicating with customers, both still put customers first to determine quality improvement goal and steer the direction of SCQM implementation. Hence, the reasons why "customer-side SCQM is the most significant SCQM factor in influencing operational performance" are: *1) dealers and automobile companies' departments are in charge of contacting customers; 2) automobile companies which established SCQM plans mainly rely on the information that collected by customer-side SCQM practices.*

6.5.2. The Influences of Ownership and Firm Size in SCQM

The results of the 'Phase Two Study' and the 'Phase Three Study' together verify the essential role of customer-side SCQM in automobile companies. However, CSBs and JVs implement it in different ways. CSBs mainly rely on dealers to identify customer requirements and involve dealers to their model design and continuous improvement at an early stage. On the other hand, JVs rely more on their own departments to collect customer feedback by more direct and diverse channels. In order to obtain more customer feedback and utilise it in continuous improvement, JV gradually initiates the cooperation with electronic platforms. Hence, JVs is now transforming customer-side SCQM from the traditional dealer-centred model to the modern e-commerce model. Moreover, the digital technology is creating an increasing level of connection between digital devices and online services. It significantly changes customers' consumption habits. Based on the report by Accenture (2015), 75% of its survey respondents would consider conducting the entire car purchase online. McKinsey (2015) also claimed that

the share of customers willing to switch their car brand for better connectivity has increased from 20% in 2014 to 37% in 2015. This kind of phenomenon is more obvious in China. Accenture (2015) identified that 53% of Chinese consumers stated that they would definitely buy a car online; 60% of Chinese customers are willing to switch their car brand for improved connectivity (McKinsey, 2015). Hence, in order to better understand Chinese customers' requirements and expectation, JVs not only focus on the cooperation with the traditional dealers but also generate an efficient strategy to enhance customer experience and satisfy customer needs by utilizing digital channels. *Thus, for JVs, the role of dealers is becoming more limited compared to the past. Due to the different characters of dealers in CSBs and JVs, customer-side SCQM plays different roles in influencing operational performance.*

The analysis of the follow-up interviews provided fruitful information to explain why super large automobile companies and smaller automobile companies focus on different SCQM practices in continuously improving operational performance. A super large company implies the availability of both capital and human resources that facilitate adoption and implementation of SCQM practices as well as returns to scale for investments associated with SCQM practices. SCQM requires all the departments and staff within the company to participate in quality improvement. Hence, super large automobile companies that hire thousands of employees need to pay much more attention to efficiently diffuse quality information and effectively manage and train employees. The high investment in equipping a large number of visual Kanban and rewarding the helpful quality improvement suggestions were the evidence extracted from the interviews. Moreover, a small size company normally has a more centralised and agile structure. Compared to super large automobile companies, smaller automobile companies are better at quickly responding to and flexibly communicating with internal and external partners. The several informal communication channels introduced by interviewees from smaller automobile companies supported this statement. *Based on the above discussion, the different structures, workforce, and capital jointly cause the different SCQM implementation of super large automobile companies and smaller automobile companies.*

6.5.3. Summary of findings

Based on the within case analysis and cross-case analysis, this chapter identified the root causes of the four specific SCQM practices in the Chinese automobile industry. Table 6.3 summarises the corresponding root causes that were clarified in the' Phase Three Study'. The large number of suppliers and the high degree of dealers' participation in automobile companies' SCQM at the early stage together cause the indirect relationship between companywide QM and operational performance. Moreover, because of the importance of collecting customer information and the significant role of customer information in designing the SCQM plan, customer-side SCQM is the most significant factor in influencing operational performance. Further, JVs start to use their own departments to directly communicate with final customers compared to CSBs that still mainly rely on dealers to deal with final customers. Hence, CSBs and JVs implement the customer-side SCQM differently. In addition, due to the different business structure, workforce size, and capital, super large automobile companies and other size automobile companies have different SCQM focuses.

Table 6.3: Root Causes of SCQM Practices

SCQM Practices	Root Causes
No direct and significant relationship between companywide QM and operational performance	*1) The large number of external components.* *2) The high degree of dealers' participation in automobile companies' SCQM at the early stage.*
Customer-side SCQM is the most significant SCQM factor in influencing operational performance	*1) The directly communication with final customers is mainly conducted by dealers and limited automobile companies' departments* *2) The establishment of the SCQM plan is mainly rely on the information that collected by customer-side SCQM practices.*
Different Customer-side SCQM implementation between CSBs and JVs	*1) CSBs still mainly rely on dealers to conduct customer-side SCQM* *2) JVs start to depend more on their departments to conduct customer-side SCQM.*
Different focus between super large automobile companies and other automobile companies on	*1) Different business structures* *2) Different size of workforce* *3) Different capital*

6.6.Chapter Summary

This chapter aims to identify reasons of "no direct and significant relationship" between companywide QM and operational performance, to explain causes of the situation where "customer-side SCQM is the most significant SCQM factor in influencing operational performance" and to clarify the reasons why automobile companies conduct SCQM differently according to their ownership and firm size. According to these three research objectives, this chapter describes the detailed process of research design, data analysis, and finding discussion. A multiple case study in six automobile companies that participated in the "Phase Two Study" by telephone interview was conducted to collect, analyse, and compare their understanding of SCQM practices in their companies. The three aspects of SCQM (i.e. companywide QM, supplier-side SCQM, customer-side SCQM) were used for building the categories of within-case analysis. The four major findings of the "Phase Two Study" were applied as higher-order labels for further reducing data and deriving commonalities and differences among the six cases. Based on the within-case analysis and cross-case analysis, the root causes of the SCQM practices were clarified to answer RQ3. Table 6.2 summarises the corresponding answers. Moreover, the answers to RQ1 and RQ2 were also supplemented by the qualitative information and analyses of the follow-up interviews. For example, Section 6.4.2 provided more empirical evidence to show the importance of customer-side SCQM in the Chinese automobile industry from the perspectives of both JVS and CSBs. Section 6.4.3 also brought more empirical evidence to show the different roles of dealers in the field of SCQM implementation between CSBs and JVs.

Chapter Seven: Conclusion

7.1. Chapter Introduction

SCQM has been one of the most discussed and interesting topics recently addressed in both academic and industrial areas. A series of high-profile product recalls has become the wake-up call to academics, practitioners, and governments warning them that they need to develop a systematic approach to dealing with quality issues in the SC. SCQM, along with a number of other emerging areas in SCM and QM, is, however, still in its embryonic stage.

This study provided a detailed description of the Chinese automobile industry and the quality level of Chinese automobile companies (i.e. Chapter 1). It identified two literature gaps by conducting the systematic literature review: 1) no study has focused on SCQM from the perspective of CSBs in the Chinese automobile industry; 2) the studied SCQM indicators are incomplete (i.e. Chapter 2). In order to answer the three RQs to cover the literature gaps, this study designed and followed a mixed research methodology (i.e. Chapter 3). Following a multiple case study in seven major Chinese automobile companies, this study identified the big picture about SCQM practices in the Chinese automobile industry and proposed an SCQM taxonomy (i.e. Chapter 4). Based on the literature review and the case study, the SCQM framework and measurements were developed (i.e. Chapter 5). Based on the measurement model analysis by applying PLS, the indicators of an SCQM model in the Chinese automobile market were finalized. By conducting structural model analysis, this study tested the proposed hypotheses. This study found that companywide QM is positively related to external SCQM. Moreover, because of suppliers' and dealers' high degree of participation in the automobile SC, the data showed that there was no direct relationship between companywide QM and operational performance. This study also clarified that customer-side SCQM is the most significant factor to influence operational performance. Moreover, customer involvement, which represents the frequency of communication with customers, the communication channels with customers and the involvement of customers in the quality improvement process and product design process, plays the core role in this downstream SCQM. Compared to customer-side

SCQM, supplier-side SCQM acts as a less weighted factor of improving operational performance. In addition, the data also verified that there is a positive relationship between operational performance and financial performance. Based on MGA tests, this study confirmed that the relationship between customer-side SCQM and operational performance differs across CSBs and JVs. The super large automobile companies and smaller automobile companies implement SCQM in different ways. Finally, based on six follow-up interviews, this study clarified the root causes of the relationships between SCQM practices and performance as well as the influence of ownership and firm size in SCQM implementation (i.e. Chapter 6).

Although both CSB and JV treat customer side SCQM as the indispensable factor in continuous improvement, CSB and JV implement it in different ways. CSB mainly relies on dealers to identify customer requirement and involves dealers to its model design and continuous improvement as early as possible. On the other hand, JV relies more on its own department to collect customer feedback by more direct and diverse channels, such as “800 Hotline”, online BBS, and “Technology Hotline”. In order to obtain more customer feedback and utilize in continuous improvement, JV gradually initiates the cooperation with electronic platforms as well. Besides the customer side SCQM, CSBs and JVs also conduct differently in the field of companywide QM and supplier side SCQM. For instance, CSBs pay more attention in strategically plan the quality and effectively design the products that are more suitable in the Chinese market. However, JVs spend more resource in accurately collecting and transmitting the quality data, effectively managing the employees, successfully quality training, and correctly selecting the suppliers.

In conclusion, quality improvement motivation, company capability, and adoption of advanced practices and techniques (i.e. three factors generated from the case study) and the customer-side SCQM are the most significant factors impacting on SCQM in the Chinese automobile industry. This answers the RQ1 (i.e. What are the main factors impacting on SCQM in the Chinese automobile industry?) and achieves RO1 (i.e. To investigate the SCQM practices of the Chinese automobile market). Moreover, JVs focus more on quality information, employee management, and training comparing to CSBs. They also implement more rigorous supplier selection than CSBs. On the other side, CSBs emphasise more on product design and strategic quality planning. This

answers RQ2 (i.e. What are the differences between CSBs and JVs in the field of SCQM?) and achieves RO2 (i.e. To clarify the different SCQM practices and performance between CSBs and JVs). Furthermore, the different roles of dealers and automobile companies' customer related departments, the different business structures, the different size of workforce, and the different capital cause the different SCQM implementation. This answers RQ3 (i.e. Why do such differences occur?) and achieves RO3 (i.e. To identify the root causes of the differences).

7.2. Theoretical Contributions

The findings of this paper provide contributions to SCQM theory. This study provides evidence on the benefits of conceptualizing SCQM practices and performance as multidimensional constructs (Li et al., 2011; Zeng et al., 2013; Dellana and Kros, 2014; Hu and Flynn, 2015). This study also assists in gaining a deeper understanding of the key relationships between SCQM practices and performance by illustrating that customer-side SCQM has the most significant impact on operational performance. Together with the indirect relationship between companywide QM and operational performance, this research also contributes to the relation view by pointing out that the cooperation with supply chain partners plays a significant role in SCQM. This study can add value to current SCQM literature as one of the first to compare SCQM between CSBs and JVs. Moreover, the comparative study between CSBs and JVs expands SCQM theory by clarifying the different impact of customer-side SCQM on operational performance and identifying the distinct focus areas on companywide QM and supplier-side SCQM between these two groups. The comparative study between super large automobile companies and smaller automobile companies also supplements the SCQM theory by identifying the different SCQM implementation between these two groups. Furthermore, because of the global importance of the Chinese automobile industry, SCQM theory cannot claim to be complete without considering the Chinese market. This study answers calls for ownership, emerging market, and automobile sector research in SCQM launched by Zhao et al. (2006a), Jiang et al. (2007), Foster (2008), Taylor and Taylor (2008), Flynn et al. (2013), and Huo et al. (2014). Hence, it significantly supplements SCQM theory and fills the gaps. In addition, this research also contributes to the RBV literature. The findings highlight the importance of resource bundles, which are barely covered in the SCM literature. Resource advantages do not simply rely on a single type of resource, but a set of inter-correlated resources. Thus,

this study provides a more comprehensive framework of resources in SCQM. For example, the comparative study between CSBs and JVs significantly add value to the RBV theory from the perspective of SCQM. Based on the discussion of chapters 4,5, and 6, JVs have higher quality improvement motivation, stronger company capability, proper attitude of adopting advanced practices and techniques, more capable suppliers, further communication channels with customers, and shorter distance to customers. These factors are the unique resource that significantly influence the SCQM implementation in CSBs and JVs. The differences between these ownership structures (i.e. CSB and JV) can explain why companies have different resources; thus, implementing SCQM practices in various ways. Chen and Tan (2013) and Lu et al. (2014) clarified that JVs control better resources, apply more advanced technology, and employ more skilled staff than CSBs in the Chinese automobile market. Thus, JVs may have better opportunity to recognise and apply the best practice due to their access to different management practices (Agarwal et al., 2013). Further, the foreign parent companies shift the advanced technologies, progressive quality skills, and high management capability to the local market by the relocation of employees and knowledge and business transactions, which significantly assists JVs in applying SCQM (Lu et al., 2014).

7.3. Managerial Implications

In terms of managerial implications, this study enhances the understanding of quality and SC managers about the best SCQM practices in the Chinese automobile industry. Based on the structural model analysis, the paper provides empirical evidence to explain why managers should attach the greatest importance to customer-side SCQM in order to achieve high level operational performance in the contextual environment of the Chinese automobile industry. According to the analysis of customer-side SCQM, customer involvement is the most significant factor. Hence, instead of merely collecting customers' requirements and consolidating relationships with customers, managers should concentrate on tailoring the practical cooperation activities to communicate with customers more efficiently and involve customers in continuous improvement programmes earlier. Moreover, managers should not ignore supplier-side SCQM and companywide QM.

Based on the results of the Ownership-MGA test, CSBs should acquire more resources

to install more efficient information systems to diffuse real-time quality information to corresponding staff. They also need to hire more skilful employees to implement advanced manufacturing technologies, conduct management practices, and provide appropriate quality training sessions. Moreover, because of the significant role of components in ensuring the high quality of an automobile, CSBs should emphasise selecting the right supplier based on quality performance and cooperating with suppliers at a deeper level by treating them as partners. Furthermore, CSBs still treat customers only as a marketing source but overlook the importance of customers in quality improvement. Hence, CSBs should be devoted to establishing a timely quality-related feedback collection system and linking it to an effective transmission channel. In addition, the proposed SCQM strategy taxonomy helps CSBs to highlight the current SCQM approaches, clarify the deficiencies in SCQM implementation, and provide SCQM advancement practices and directions. With the development of information technology and the change of customers' consumption habits, CSBs should start to adjust their customer-side SCQM by shortening the distance to customers and applying more digitalised cooperation practices. Furthermore, in line with the discussion of JVs' business strategies and structures, JVs should allocate more resource and concerns to contextual market factors when formulating quality plans and developing new products. This can directly help JVs to introduce more attractive automobile models and execute more feasible quality improvement plans.

Based on the results of Firm-Size MGA test, super large automobile companies should simplify the bureaucratic and hierarchical structure and conduct more agile and informal communication with suppliers and customers. This could assist them to capture more opportunities and save more time and cost in implementing SCQM. Moreover, due to the large number of employees, they need to focus more on how to effectively conduct product development and process management. For example, they could allocate more resources and authority to the cross-functional team in developing the new model. On the other hand, smaller automobile companies should pay more attention to provide training and motivate employees to participate in SCQM implementation. Further, due to the relatively small company capabilities, they also need to try their best to select the most appropriate suppliers that provide quality components.

In addition, the findings also help Western managers to better understand SCQM practices in the Chinese automobile industry. Hence, this study should be of assistance to practitioners in Western automobile brands with a current or future interest in establishing operations in China.

7.4. Policy Maker Implications

The Chinese government has the most significant power in the development of the Chinese automobile industry. According to "Made in China 2025", the manufacturing industry development strategy of the Chinese government, pursuing excellent quality and building brand identity are the key issues for Chinese automobile companies in the next ten years (MIIT, 2015). This study identifies strategies of improving quality through SCQM implementation. Policymakers could address this issue by encouraging automobile companies to rigorously cooperate with suppliers and customers to enhance process and product quality.

7.5. Limitations and Future Study

It is important to consider the results and contributions of the research along with the limitations. First, based on the current access, ownership and firm size were included as the only control variables. However, more factors, such as employees' education level and the operated quality standards are possible elements that may influence SCQM implementation. Second, due to the company access, only CSBs and JVs participated in this study. As discussed in Chapter 1, CSBs, JVs, and Imported brands (IBs) are the three players in the Chinese automobile industry. Even though CSBs and JVs significantly contribute to the Chinese automobile industry, IBs represent another style of automobile companies that influence Chinese customers in choosing vehicles. Third, as explained in Chapter 3, this study implemented a mixed research methodology. However, it still predominately relies on the quantitative methodology (i.e. "Phase Two Study"). The most significant SCQM factors and the different focus of SCQM practices between CSBs and JVs were identified in the "Phase Two Study". Even though some of the practitioners were contacted again for further explanatory results, it was based on certain specific issues. Moreover, some contextual issues of SCQM implementation (e.g. company culture, difficulties in cooperating with suppliers and dealers) cannot comprehensively be captured by survey questions. Revisiting the issues in a case study predominant approach may give a clearer understanding of the implementation of

SCQM. The strength of case study is that it can explain the "how" and "why" of a phenomenon which may also unravel the unobserved complementarity effect in the SCQM. Fourth, this study focused on the Chinese automobile industry. The findings of this research may be limited to China. Hence, it is possible to further generalise the findings of the SCQM study to a greater population, and collect a larger sample size. Fifth, this study adopted an outcome approach to investigate SCQM, but the antecedent mechanism of SCQM is not yet known. Thus, it will be fruitful to study the antecedent mechanism affecting SCQM in future research.

Future study should consider the obtained quality standards and employees' education level as other control variables. This can expand the understanding of additional features of SCQM and relevant practices that are influenced by organisational quality structure and employees' ability. Moreover, IBs from America, Germany, and Korea could be investigated in future study to add more comparisons to reflect more comprehensive SCQM practices in the Chinese automobile industry. This may provide more insights about the best SCQM practices. Further, a qualitative research approach can be conducted for generating deeper insights into each SCQM practice, and investigating the implementation problems by drawing from interview evidence, which potentially supports primary data collection. Also, case studies can be adopted for examining the interaction mechanism among SCQM complementary that can enhance product quality and firm performance. In addition, the proposed SCQM framework and identified findings could be modified and applied to other automobile industries of emerging countries in future study. This could help to test the generalisation of this study. Finally, the antecedent mechanisms should be investigated in future study to understand how internal and external business units (e.g. market competition, internal capacity) coordinate using the SCQM framework to achieve desired SCQM performance. Similarly, the role of organisational control, whether social or formal, should be emphasised in the Chinese automobile industry, which can affect SCQM implementation and eventually performance. Further study in this area may lead to new understanding of how the automobile companies respond to SCQM implementation.

Moreover, in today's business world, where firms are progressively affected by external pressures arising from government and society, the pursuit of sustainable development is a necessity (Jayaraman et al., 2007). In other words, these pressures motivate

organisations to thoughtfully consider the environmental and social impact while running their businesses. The employees, company-wide management, government, and non-governmental organisations are the typical internal or external sources that create these pressures. As consumers have become more knowledgeable in observing and monitoring not only at the final products or services but also at each stage of the business, these pressures influence the entire supply chain more and more significantly. Hence, the overall supply chain performance becomes a significant competitive focus due to the critical impact that the environmental and social problems bring to the brand images and organisational sales. Because the increasing importance of sustainability in operations, purchasing, supply chain, and operations managers should integrate environmental and social issues, as well as embedding related standards (e.g. ISO 14001) into their day-to-day business process (Zhu et al., 2008). With the development of China, there are more concerns about the sustainability and big data application. As the "Made in China 2025" identified, China will focus more on the development of new energy automobiles under the big data era. Hence, the study of the sustainable supply chain in the Chinese automobile industry by comparing both CSBs and JVs could significantly enhance the academic and practitioners' understanding in continuously improving the performance.

Further, Big Data is currently the industry's hottest jargon under the big environment of the digital economy (Tan et al., 2015). The ability of gaining valuable business insights by utilising Big Data is one of the most significant elements in gaining competitive advantage in today's ever-changing business environment (Wong, 2012). The company's capability of applying Big Data determines whether the firm can achieve better performance against its competitors (Oh et al., 2012). As clarified in the Chapter 5 and Chapter 6, the customer-side SCQM is the most important SCQM factor that influence the performance. CSBs and JVs act significantly different when collecting the customer-side data and communication. With the development of information technology and the change of customer's consumption habit, automobile companies should start to adjust their customer side SCQM by shortening the distance to customers and applying more digitalized cooperation practices. Therefore, the future study of big data application in the supply chain quality management can lead new understanding of how the automobile company effectively deal with the customer-side SCQM practices.

7.6. Chapter Summary

In summary, this study has exclusively focused on conceptualization and scale development of SCQM. It has operationalised the SCQM measurement scale and explored its effects on the performance in the Chinese automobile industry by comparing CSBs and JVs. This study also investigated the relationship between SCQM practices and performance between super large automobile companies and other size automobile companies. Synthesised by the new insights and findings of this research, academics, practitioners, and policymakers can refer to this study in developing or refining the existing mechanism. Furthermore, they may also gain a relatively complete and comprehensive view of SCQM in the context of improving the quality of the Chinese automobile industry. In another word, researchers can extend this study by customizing the current construct within different operational contexts to assess how additional factors may enhance the current mechanism. In conclusion, the proposed SCQM model provides a basis for the further development of both quantitative and qualitative empirical works, relating in particular to the context of SCQM in the Chinese automobile industry.

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Appendix 1: Interview Protocol for Case Study

This interview is designed to help the researcher to understand about the SCQM in the company. These questions are preliminary questions for all firms interviewed.

1. Opening Questions:

1.1. Could you please introduce your organisation's core business?
1.2. Could you please introduce your work?
1.3. Could you please briefly describe SCQM in your organisation?

2. Companywide QM:

2.1. How do the top managers treat quality?
2.2. How does your organisation evaluate top managers input in quality control?
2.3. How does your organisation establish the quality goal?
2.4. How does your organisation evaluate that goal?
2.5. Could you please introduce the product development in the organisation?
2.6. How does your organisation encourage staff take part in the quality control and improvement?
2.7. What kinds of quality technologies or tools are implemented in manufacturing?
2.8. Does your organisation use SPC to record, analysis and supervise manufacturing process?
2.9. How does your organisation record the quality and production information?
2.10. How does your organisation transfer the real-time quality and operation information among all the departments?
2.11. Could you please introduce the tracing system in your organisation?
2.12. Could you please introduce the quality training programme in your organisation?

3. Supplier Side SCQM:

3.1. Could you please introduce the supplier selection in your organisation?
3.2. How frequently does your organisation communicate with suppliers about quality issues?
3.3. How do suppliers take part in your organisation's the quality improvement programmes?
3.4. How does your organisation help suppliers to perform better in the field of quality?
3.5. Does your organisation establish information sharing systems with suppliers?
3.6. How does you organisation cope with suppliers to find out the root cause of quality problems and solve it?
3.7. How does your organisation achieve a long and solid relationship with

suppliers?

4. Customer side SCQM:

4.1. How does your company diffuse the conception of "customer" to all staffs?
4.2. How does your organisation collect customer feedback?
4.3. How does your organisation use these feedbacks in product design and quality improvement?
4.4. How does your organisation cope with customers to find out the root cause of quality problem and solve it?
4.5. How does your company establish a long and solid relationship with customers?

5. Performances:

5.1. Could you please introduce the defects rate of your products?
5.2. What is the condition of the production in your company?
5.3. Could you please introduce the level of inventory?
5.4. What is the condition of cost that spend on quality (rework, scrap, inspection)?
5.5. Could you please introduce the sales of your organisation?
5.6. Could you please introduce the profit of your organisation?
5.7. Could you please introduce the market share of your organisation?
5.8. Could you please introduce the ROI of your organisation?
5.9. Could you please introduce the ROA of your organisation?

Appendix 2: Interview Protocol for Follow-up Interview

This interview is designed to help the researcher to interpret the SCQM practices in the Chinese automobile industry. These questions are preliminary questions for all firms interviewed.

1. Overall SCQM Practices
   1.1. Could you please introduce the companywide QM in your organisation?
   1.2. How does your organisation conduct supplier-side SCQM?
   1.3. How does your organisation conduct customer-side SCQM?
   1.4. What are the benefits for implementing SCQM?

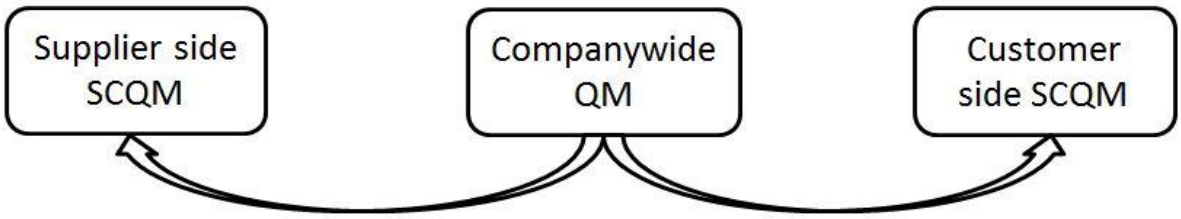
2. The relationship among SCQM dimensions
   2.1. Among companywide QM, supplier-side SCQM, and customer-side SCQM, which one do you think is the most fundamental SCQM dimension?
   2.2. What kind of relationship is existed among SCQM dimensions?
   2.3. What are the impacts of the other two SCQM dimension on the most fundamental one?

3. The influences of SCQM dimensions on operational performance
   3.1. Which SCQM dimension has the most significant impact on operational performance?
   3.2. Why do you think so?
   3.3. How does it influence the operational performance?

Appendix 3: Pilot Study Questionnaire (English version)

Examining Supply Chain Quality Management in Chinese Automobile Industry

Description: Supply chain quality management (SCQM) is the formal integration of measuring, analysing and continually improving products, services and processes in all SC members. It aims to add value for the whole SC through satisfying all the SC stakeholders. After reviewing and consolidating the literature, the SCQM is proposed to be a multi-dimensional concept, including companywide quality management, supplier side SCQM, and Customer side SCQM.



Supply Chain Quality Management

1. **Companywide quality management:** It presents the effort made by a company to facilitate quality improvement in its supply chain through the cooperation among its departments and processes. After reviewing and consolidating the literature, eight sub-dimensions have been summarised.

Please mark the following statements' adequacy to measure the corresponding dimension.

Statement		Adequacy? l=extremely weak; 4= neutral; 7=extremely strong.						
1.1.Top management commitment on quality: it includes the activities of formulating quality goal, assigning priority to quality, allocating resource to quality programmes, and managers' participation to quality programme.								
		1	**2**	**3**	**4**	**5**	**6**	**7**
TMC1	Our company has clear quality goals, which are identified by top managers.	☐	☐	☐	☐	☐	☐	☐
TMC2	Top managers view quality as being more important than cost.	☐	☐	☐	☐	☐	☐	☐
TMC3	Top managers view quality as being more important than meeting production schedules.	☐	☐	☐	☐	☐	☐	☐
TMC4	Top managers allocate adequate resources to improve quality.	☐	☐	☐	☐	☐	☐	☐

TMC5	Considerable amount of key quality issues are reviewed in top managers' meetings.	☐	☐	☐	☐	☐	☐	☐
TMC6	Top managers' promotion and salary closely associate with their performances in quality programmes.	☐	☐	☐	☐	☐	☐	☐
1.2.Strategic quality planning: it includes the formal and structured planning procedures and the consideration of stakeholder's capability and requirement in quality efforts.								
		1	**2**	**3**	**4**	**5**	**6**	**7**
SQP1	Our company has a formal strategic planning process, which results in written strategies for implementation.	☐	☐	☐	☐	☐	☐	☐
SQP2	Our company follows a comprehensive and structured planning process that sets and reviews quality goals regularly.	☐	☐	☐	☐	☐	☐	☐
SQP3	Our company follows an arbitrary quality planning process. **(reverse code)**	☐	☐	☐	☐	☐	☐	☐
SQP4	Our company closely aligns business practices and missions with quality improvement goals.	☐	☐	☐	☐	☐	☐	☐
SQP5	Our company actively incorporates customer expectation and supplier capabilities during quality plans development.	☐	☐	☐	☐	☐	☐	☐
1.3.Employee management: it involves the activities of assigning quality responsibility to employee, organising staffs in team, implementing employee's quality improvement suggestion, and operating reward system.								
		1	**2**	**3**	**4**	**5**	**6**	**7**
EM1	Our employees clearly understand their quality responsibility.	☐	☐	☐	☐	☐	☐	☐
EM2	Our company organises employees in teams, e.g. quality control circle.	☐	☐	☐	☐	☐	☐	☐
EM3	The majority of quality problems are solved by team-based quality meeting.	☐	☐	☐	☐	☐	☐	☐
EM4	Our company encourages employees to provide suggestions about quality improvement.	☐	☐	☐	☐	☐	☐	☐
EM5	Our company evaluates and implements the employees' quality improvement suggestions every month.	☐	☐	☐	☐	☐	☐	☐
EM6	Our company has an effective reward system to encourage employees to devote to quality improvement.	☐	☐	☐	☐	☐	☐	☐
1.4.Process management: it covers the aspects of the design of production process, the situation of process control, and the housekeeping.								
		1	**2**	**3**	**4**	**5**	**6**	**7**
PM1	Our employees clearly understand their working procedures.	☐	☐	☐	☐	☐	☐	☐
PM2	Production processes are designed to be mistake-proof.	☐	☐	☐	☐	☐	☐	☐

PM3	The degree of automation in our company is high.	☐	☐	☐	☐	☐	☐	☐
PM4	Statistical tools are used for conducting inspection, identifying problems, and correcting mistakes during production.	☐	☐	☐	☐	☐	☐	☐
PM5	Our company conducts floor visiting every day to ensure machineries and workplace are kept neat and tidy.	☐	☐	☐	☐	☐	☐	☐
1.5.Training: it presents the activities of delivering training sessions in the whole company and the employees' recognitions of training's effect.								
		1	**2**	**3**	**4**	**5**	**6**	**7**
T1	Our company provides sufficient resources to support quality training.	☐	☐	☐	☐	☐	☐	☐
T2	Our company provides scheduled companywide quality training session.	☐	☐	☐	☐	☐	☐	☐
T3	Various quality trainings are provided to employees based on their different roles in company.	☐	☐	☐	☐	☐	☐	☐
T4	Our employees find the quality training can help their work.	☐	☐	☐	☐	☐	☐	☐
1.6.Product development: it covers the aspects of the principal and the procedures of product development.								
		1	**2**	**3**	**4**	**5**	**6**	**7**
PD1	The cross-functional team is in charge of product design work.	☐	☐	☐	☐	☐	☐	☐
PD2	Our product development follows formalised procedures.	☐	☐	☐	☐	☐	☐	☐
PD3	New product design is thoroughly reviewed before production.	☐	☐	☐	☐	☐	☐	☐
PD4	New product design is not reviewed before production. **(reverse code)**	☐	☐	☐	☐	☐	☐	☐
PD5	The quality of new product emphasises in relation to cost.	☐	☐	☐	☐	☐	☐	☐
PD6	The quality of new product emphasises in relation to producibility.	☐	☐	☐	☐	☐	☐	☐
PD7	The quality of new product emphasises in relation to schedule.	☐	☐	☐	☐	☐	☐	☐
1.7.Quality information: it contains the aspects of quality information system, the display of quality information, and the use of quality information.								
		1	**2**	**3**	**4**	**5**	**6**	**7**
QI1	The 7 quality tools are used to collect and record the timely quality data.	☐	☐	☐	☐	☐	☐	☐
QI2	Our company has established quality information system to record, analysis, and share all the quality data throughout company.	☐	☐	☐	☐	☐	☐	☐
QI3	The quality data are displayed to all the employees and work stations.	☐	☐	☐	☐	☐	☐	☐

QI4	The frequently occurred quality problems and corresponding solutions are displayed in workshop.	☐	☐	☐	☐	☐	☐	☐
QI5	The quality data is the determinant of decision making during production.	☐	☐	☐	☐	☐	☐	☐
1.8.Defect tracking: it involves the aspects of the availability and the operation of defect tracking system.								
		1	**2**	**3**	**4**	**5**	**6**	**7**
DT1	Our company establishes defect tracking system, which systematically records the supplied components and finished automobiles.	☐	☐	☐	☐	☐	☐	☐
DT2	Our company conducts defects tracing process under regulatory guidance.	☐	☐	☐	☐	☐	☐	☐
DT3	Our company can trace back the defects to source within the promised time window.	☐	☐	☐	☐	☐	☐	☐

2. **Supplier side SCQM:** It presents the collaboration and integration with suppliers in order to improve SCQM performance. After reviewing and consolidating the literature, three sub-dimensions have been summarised.

Please mark the following statements' adequacy to measure the corresponding dimension.

Statement		**Adequacy? l=extremely weak; 4= neutral; 7=extremely strong.**						
2.1.Supplier selection: it covers the activities of operating quality-based supplier selection system and the quantity of dependable suppliers.								
		1	**2**	**3**	**4**	**5**	**6**	**7**
SS1	Our suppliers are certified or qualified.	☐	☐	☐	☐	☐	☐	☐
SS2	Our company has thorough supplier selecting system.	☐	☐	☐	☐	☐	☐	☐
SS3	Our suppliers are selected based on their quality rather than their prices.	☐	☐	☐	☐	☐	☐	☐
SS4	Our suppliers are selected based on their quality rather than their delivery schedules.	☐	☐	☐	☐	☐	☐	☐
SS5	Our company relies on a small number of strategic suppliers.	☐	☐	☐	☐	☐	☐	☐
2.2.Supplier cooperation: it contains the activities of sharing quality information with supplier and involving supplier in quality programme.								
		1	**2**	**3**	**4**	**5**	**6**	**7**
SC1	Our company communicates with suppliers about quality considerations at least one time per week.	☐	☐	☐	☐	☐	☐	☐
SC2	Our company effectively communicates with suppliers through meetings, emails, and social medias.	☐	☐	☐	☐	☐	☐	☐
SC3	Our company actively involves suppliers in product design process.	☐	☐	☐	☐	☐	☐	☐

SC4	Our company doesn't involve suppliers in product design process. **(reverse code)**	☐	☐	☐	☐	☐	☐	☐
SC5	Our company actively involves suppliers in quality improvement activities.	☐	☐	☐	☐	☐	☐	☐
2.3.Supplier development: it presents the way of strengthening suppliers' quality capability.								
		1	**2**	**3**	**4**	**5**	**6**	**7**
SD1	Our company has consensual quality goals accepted by suppliers.	☐	☐	☐	☐	☐	☐	☐
SD2	Our company consolidates relationship with suppliers through long-term contracting.	☐	☐	☐	☐	☐	☐	☐
SD3	Our company provides financial support to improve supplier's quality.	☐	☐	☐	☐	☐	☐	☐
SD4	Our company provides training or sends professional staffs to help suppliers to improve their quality capability.	☐	☐	☐	☐	☐	☐	☐

3. **Customer side SCQM:** It aims to achieve better SCQM performance through close collaboration between focal company and customer. After reviewing and consolidating the literature, three sub-dimensions have been summarised.

Please mark the following statements' adequacy to measure the corresponding dimension.

Statement		**Adequacy? l=extremely weak; 4= neutral; 7=extremely strong.**						
3.1.Use of feedback: it covers the aspects of customer requirements and complaints collection and the function and dissemination of customer feedback through the organisation.								
		1	**2**	**3**	**4**	**5**	**6**	**7**
UF1	Our employees understand the important role of customer in quality programmes.	☐	☐	☐	☐	☐	☐	☐
UF2	Our company has a system to collect customer feedback.	☐	☐	☐	☐	☐	☐	☐
UF3	Our company determines customer requirement by the feedback.	☐	☐	☐	☐	☐	☐	☐
UF4	Our company conveys the customer feedback to the related employees.	☐	☐	☐	☐	☐	☐	☐
3.2.Customer involvement: it presents the activities of communicating with customers and customers' participation in quality programmes.								
		1	**2**	**3**	**4**	**5**	**6**	**7**
CI1	Our company discusses quality issues with customers at least one time per week.	☐	☐	☐	☐	☐	☐	☐
CI2	Our company doesn't discuss quality issues with customers**. (reverse code)**	☐	☐	☐	☐	☐	☐	☐
CI3	Our company communicates with customers through meetings, emails, and social medias.	☐	☐	☐	☐	☐	☐	☐

CI4	Our customers are actively involved in our product design processes.	☐	☐	☐	☐	☐	☐	☐
CI5	Our customers provide input to the quality improvement processes.	☐	☐	☐	☐	☐	☐	☐
3.3.Customer relationship development: it contains the aspects of company's emphasis on customer and the systematic interaction with customer.								
		1	**2**	**3**	**4**	**5**	**6**	**7**
CRD1	"Customer focus" philosophy has been widely accepted in our company.	☐	☐	☐	☐	☐	☐	☐
CRD2	Our company strives to keep highly responsive to customer complaints.	☐	☐	☐	☐	☐	☐	☐
CRD3	Our company holds annual customers conferences to listen to customers' voices.	☐	☐	☐	☐	☐	☐	☐

4. **SCQM Performance:** It includes operational performances and financial performances that obtained through SCQM practices.

Please mark the following statements' adequacy to measure the corresponding dimension.

Statement		**Adequacy? l=extremely weak; 4= neutral; 7=extremely strong.**						
		1	**2**	**3**	**4**	**5**	**6**	**7**
FP1	The sale of our company is increasing.	☐	☐	☐	☐	☐	☐	☐
FP2	The profit of our company is increasing.	☐	☐	☐	☐	☐	☐	☐
FP3	The cost of quality in our company is decreasing.	☐	☐	☐	☐	☐	☐	☐
OP1	The first time through is high in our company.	☐	☐	☐	☐	☐	☐	☐
OP2	Our company has high inventory turnover of automobiles.	☐	☐	☐	☐	☐	☐	☐
OP3	The annual productivity of our company is increasing.	☐	☐	☐	☐	☐	☐	☐

Appendix 4: Pilot Study Questionnaire (Chinese version)

关于中国汽车产业供应链质量管理的问卷调查

供应链质量管理是供应链中所有成员对于测量、分析、以及不断改进产品、服务、和生产流程的整合。它通过满足供应链的利益共享者的需求来为整条供应链增加价值。通过仔细研读相关文献，供应链质量管理在本次研究中被定义为包含公司内部供应链质量管理、供应商侧供应链质量管理、以及客户侧供应链质量管理的多维概念。



1. **公司内部质量管理：**它代表了公司各部门以及所有职员为持续促进产品质量改进所做出的努力。通过回顾文献，它包含了以下八个维度。

请为以下陈述能否充足检测其对应的维度打分。

陈述		充足性 1=最弱；7=最强						
1.1. 管理层对质量工作的重视及承诺：它包括制定质量目标、分配资源、以及管理人员在质量工作中的参与和表现。								
		1	**2**	**3**	**4**	**5**	**6**	**7**
TMC1	我们公司有由管理层制定的明确的质量目标。	☐	☐	☐	☐	☐	☐	☐
TMC2	相对于成本，管理层更重视质量。	☐	☐	☐	☐	☐	☐	☐
TMC3	相对于生产计划，管理层更重视质量。	☐	☐	☐	☐	☐	☐	☐
TMC4	我们公司的管理层为质量提高工作分配了充足的资源。	☐	☐	☐	☐	☐	☐	☐
TMC5	关键的质量问题经常作为议题出现在管理层会议上。	☐	☐	☐	☐	☐	☐	☐
TMC6	管理人员的升职和加薪与其质量工作的表现密切相关。	☐	☐	☐	☐	☐	☐	☐
1.2. 战略质量规划：它包括规范的规划程序，以及对供应链其他利益相关者的质量工作的能力和要求的考量。								
		1	**2**	**3**	**4**	**5**	**6**	**7**

SQP1	我们公司有规范的规划程序并且会把制定的质量战略落实成书面文件。	☐	☐	☐	☐	☐	☐	☐
SQP2	我们公司会按照规范的程序定期制定并回顾质量目标。	☐	☐	☐	☐	☐	☐	☐
SQP3	**我们公司随意的制定质量目标。（逆向陈述）**	☐	☐	☐	☐	☐	☐	☐
SQP4	我们公司会把质量提升工作的目标和商务目标紧密结合。	☐	☐	☐	☐	☐	☐	☐
SQP5	我们公司在制定质量计划时会考虑供应商的能力及客户的期望。	☐	☐	☐	☐	☐	☐	☐
1.3.	**员工管理：它涉及员工质量责任的分配、小组活动的安排、质量改进建议的落实、以及奖励制度。**							
		1	**2**	**3**	**4**	**5**	**6**	**7**
EM1	我们公司的员工清楚地理解他们应承担的质量责任。	☐	☐	☐	☐	☐	☐	☐
EM2	我们公司把员工分为作业团队或小组 （例如：品管圈）。	☐	☐	☐	☐	☐	☐	☐
EM3	绝大部分的质量问题是由作业团队或小组解决的。	☐	☐	☐	☐	☐	☐	☐
EM4	我们公司鼓励员工提出质量改进建议。	☐	☐	☐	☐	☐	☐	☐
EM5	我们公司每个月会评判并落实员工所提出的质量改进建议。	☐	☐	☐	☐	☐	☐	☐
EM6	我们公司实施有效的奖励措施从而鼓励员工投入到质量提升工作。	☐	☐	☐	☐	☐	☐	☐
1.4.	**流程管理：它包含生产工序的设计、生产过程的控制、以及车间的内务整理。**							
		1	**2**	**3**	**4**	**5**	**6**	**7**
PM1	我们公司的员工清楚地了解其所涉及的生产工序。	☐	☐	☐	☐	☐	☐	☐
PM2	我们公司运用防错法设计生产流程。	☐	☐	☐	☐	☐	☐	☐
PM3	我们公司的生产线自动化程度很高。	☐	☐	☐	☐	☐	☐	☐
PM4	在生产时，我们公司运用统计工具来检查、发现、并解决质量问题。	☐	☐	☐	☐	☐	☐	☐
PM5	我们公司每天检查车间以确保机器及工作场所的干净和整洁。	☐	☐	☐	☐	☐	☐	☐
1.5.	**培训：它包括提供面向全公司的培训课程以及员工对培训的态度。**							
		1	**2**	**3**	**4**	**5**	**6**	**7**
T1	我们公司提供充足的资源来支持质量培训。	☐	☐	☐	☐	☐	☐	☐
T2	我们公司提供面向全公司的定期质量培训。	☐	☐	☐	☐	☐	☐	☐
T3	我们公司根据员工的工作岗位为其提供相对应的质量培训。	☐	☐	☐	☐	☐	☐	☐
T4	我们的员工认可质量培训对工作的帮助。	☐	☐	☐	☐	☐	☐	☐
1.6.	**产品开发： 它包括了产品开发的负责部门、产品开发的步骤、以及**							

产品开发的侧重点。								
		1	**2**	**3**	**4**	**5**	**6**	**7**
PD1	我们公司组建跨职能团队来负责产品开发的工作。	☐	☐	☐	☐	☐	☐	☐
PD2	我们的产品开发工作遵循正式的开发步骤。	☐	☐	☐	☐	☐	☐	☐
PD3	我们公司会在投产前会彻底的审查新产品的开发设计。	☐	☐	☐	☐	☐	☐	☐
PD4	**我们公司在投产前不会审查新产品的开发设计。（逆向陈述）**	☐	☐	☐	☐	☐	☐	☐
PD5	我们公司新产品的质量设计与成本密切相关。	☐	☐	☐	☐	☐	☐	☐
PD6	我们公司新产品的质量设计与可生产性密切相关。	☐	☐	☐	☐	☐	☐	☐
PD7	我们公司新产品的质量设计与生产计划密切相关。	☐	☐	☐	☐	☐	☐	☐
1.7.　　质量信息：它包括质量信息系统、质量信息的展示、以及质量信息的运用。								
		1	**2**	**3**	**4**	**5**	**6**	**7**
QI1	我们公司运用 7 种质量工具来收集和记录质量信息。	☐	☐	☐	☐	☐	☐	☐
QI2	我们公司搭建了质量信息平台来记录、分析、以及分享全公司的质量信息。	☐	☐	☐	☐	☐	☐	☐
QI3	我们公司向所有员工及各个工位通报质量信息。	☐	☐	☐	☐	☐	☐	☐
QI4	我们公司在车间设立目视看板来展示经常发生的质量问题及解决方案。	☐	☐	☐	☐	☐	☐	☐
QI5	我们公司把质量信息当做 生产决策的决定性因素。	☐	☐	☐	☐	☐	☐	☐
1.8.　　缺陷追踪：它包含缺陷追踪系统的存在与否以及该系统的运用。								
		1	**2**	**3**	**4**	**5**	**6**	**7**
DT1	我们公司建立了可以系统的记录供应元件及整车质量信息的缺陷追踪系统。	☐	☐	☐	☐	☐	☐	☐
DT2	我们公司按照严格的管制条例追踪缺陷产品。	☐	☐	☐	☐	☐	☐	☐
DT3	我们公司可以在规定的时间范围内追踪到缺陷产品的源头。	☐	☐	☐	☐	☐	☐	☐

2. **供应商侧供应链质量管理：**它代表了公司与供应商为了提升供应链质量管理表现的协作与整合。经过仔细的文献回顾，它包含以下三个维度。

请为以下陈述能否充足检测其对应的维度打分。

陈述	**充足性** **1=最弱；7=最强**
2.1.　　供应商选择：它包含了以质量为基础的供应商选择体系的运转以及	

核心供应商的个数。								
		1	**2**	**3**	**4**	**5**	**6**	**7**
SS1	我们的供应商都获得了质量认证。	☐	☐	☐	☐	☐	☐	☐
SS2	我们公司建立了完整的供应商选择体系。	☐	☐	☐	☐	☐	☐	☐
SS3	相对于配件价格，我们公司在选择供应商时更重视供应商的质量表现。	☐	☐	☐	☐	☐	☐	☐
SS4	相对于配件交付日程，我们公司在选择供应商时更重视供应商的质量。	☐	☐	☐	☐	☐	☐	☐
SS5	我们公司依靠少量的战略合作供应商来稳定供给。	☐	☐	☐	☐	☐	☐	☐
2.2. **供应商合作：它包含公司与供应商之间的质量信息共享以及供应商在公司质量提升工作中的参与。**								
		1	**2**	**3**	**4**	**5**	**6**	**7**
SC1	我们公司每星期最少与供应商探讨一次质量相关的问题。	☐	☐	☐	☐	☐	☐	☐
SC2	我们公司通过面对面会议、电子邮件、以及社交媒体与供应商进行切实有效的交流。	☐	☐	☐	☐	☐	☐	☐
SC3	我们公司积极地邀请供应商参与新产品的开发设计。	☐	☐	☐	☐	☐	☐	☐
SC4	**我们公司从不邀请供应商参与新产品开发设计。（逆向陈述）**	☐	☐	☐	☐	☐	☐	☐
SC5	我们公司积极地邀请供应商参与我们的质量提升工作。	☐	☐	☐	☐	☐	☐	☐
2.3. **供应商发展：它包含公司对于增强供应商质量能力所做出的努力。**								
		1	**2**	**3**	**4**	**5**	**6**	**7**
SD1	我们公司与供应商共同设立了一个双方同意的质量目标。	☐	☐	☐	☐	☐	☐	☐
SD2	我们公司通过与供应商签订长期合作协议来巩固我们与供应商的关系。	☐	☐	☐	☐	☐	☐	☐
SD3	我们公司为提高供应商的质量能力提供资金支持。	☐	☐	☐	☐	☐	☐	☐
SD4	我们公司会派遣具备充足质量知识的专业人士为增强供应商的质量能力提供帮助。	☐	☐	☐	☐	☐	☐	☐

3. **客户侧供应链质量管理：**通过与客户的密切协作提升供应链质量管理的表现。经过仔细的文献回顾，它包含以下三个维度。

请为以下陈述能否充足检测其对应的维度打分。

陈述	**充足性** **1=最弱； 7=最强**						
3.1. **客户反馈的使用：它包含收集客户需求和抱怨，以及向相关部门及人员传达客户反馈。**							
	1	**2**	**3**	**4**	**5**	**6**	**7**

UF1	我们公司的员工清楚地理解客户在质量工作中的重要性。	□	□	□	□	□	□	□
UF2	我们公司建立了全方位的客户反馈收集系统。	□	□	□	□	□	□	□
UF3	我们公司根据客户反馈来决定客户需求。	□	□	□	□	□	□	□
UF4	我们公司会在规定时间内把客户反馈传达给相应的部门及员工。	□	□	□	□	□	□	□
3.2. 客户参与：它包含公司与客户之间关于质量工作的交流以及客户在公司的质量提升工作中的参与。								
		1	**2**	**3**	**4**	**5**	**6**	**7**
CI1	我们公司每星期最少与客户探讨一次质量相关的问题。	□	□	□	□	□	□	□
CI2	我们公司从不与客户探讨质量相关的问题。（逆向陈述）	□	□	□	□	□	□	□
CI3	我们公司通过面对面会议、电子邮件、以及社交媒体与客户进行切实有效的交流。	□	□	□	□	□	□	□
CI4	我们公司积极地邀请客户参与新产品的开发设计。	□	□	□	□	□	□	□
CI5	我们公司积极地邀请客户参与我们的质量提升工作。	□	□	□	□	□	□	□
3.3. 客户关系的发展：它包含公司对于客户的重视程度以及与客户间的系统性交流。								
		1	**2**	**3**	**4**	**5**	**6**	**7**
CRD1	“客户焦点”理念在我们公司已被广泛的认可和接受。	□	□	□	□	□	□	□
CRD2	我们公司竭尽全力的对客户反馈做出快速有效的回应。	□	□	□	□	□	□	□
CRD3	我们公司定期举行客户年度大会聆听客户声音。	□	□	□	□	□	□	□

4. 供应链质量管理绩效： 包含运营绩效及财务绩效

请为以下陈述能否充足检测其对应的维度打分

陈述		**充足性 1=最弱；7=最强**						
		1	**2**	**3**	**4**	**5**	**6**	**7**
FP1	我们公司的销售额正在提升。	□	□	□	□	□	□	□
FP2	我们公司的利润正在提升。	□	□	□	□	□	□	□
FP3	我们公司的质量成本正在下降。	□	□	□	□	□	□	□
OP1	我们公司车辆的首次通过率很高。	□	□	□	□	□	□	□
OP2	我们公司的整车库存周转率很高。	□	□	□	□	□	□	□
OP3	我们公司年产量正在提升。	□	□	□	□	□	□	□

Appendix 5: The Face Validity of Questionnaire Statement

Statement	Average Adequacy Score	Standard Deviation
TMC1	6.14	**1.29**
TMC2	6.50	0.65
TMC3	6.07	0.47
TMC4	6.00	**1.24**
TMC5	5.93	**1.14**
TMC6	5.36	**1.22**
SQP1	6.43	**1.28**
SQP2	6.43	0.65
SQP3	4.50	**2.59**
SQP4	6.50	0.65
SQP5	6.21	0.58
EM1	6.71	0.61
EM2	5.07	**2.02**
EM3	5.86	0.95
EM4	6.71	0.61
EM5	5.07	**1.82**
EM6	6.14	0.86
PM1	5.93	**1.69**
PM2	5.86	0.95
PM3	6.21	0.89
PM4	6.00	0.88
PM5	6.50	0.85
T1	6.50	0.85
T2	6.21	0.89
T3	6.50	0.52
T4	6.00	0.96
PD1	6.36	0.74
PD2	6.64	0.74
PD3	6.21	0.80
PD4	4.57	**2.65**
PD5	5.50	**2.18**
PD6	5.14	**2.03**
PD7	5.00	2.00
QI1	5.79	0.97
QI2	6.29	0.91
QI3	5.64	**1.39**

QI4	6.43	0.85
QI5	6.14	0.77
DT1	6.50	0.85
DT2	6.50	0.85
DT3	6.36	0.84
SS1	6.57	0.65
SS2	6.64	0.50
SS3	6.00	0.96
SS4	5.93	0.92
SS5	6.14	0.66
SC1	5.36	**1.82**
SC2	6.71	0.61
SC3	6.29	0.73
SC4	4.50	**2.62**
SC5	6.29	0.61
SD1	6.57	0.51
SD2	6.00	0.78
SD3	5.21	0.58
SD4	6.50	0.65
UF1	6.43	0.65
UF2	6.07	**1.33**
UF3	5.64	**2.13**
UF4	6.07	0.92
CI1	5.29	**1.82**
CI2	4.50	**2.28**
CI3	6.57	0.51
CI4	5.71	0.91
CI5	6.14	**1.03**
CRD1	6.21	0.80
CRD2	6.29	0.61
CRD3	6.14	**1.23**
FP1	6.79	0.43
FP2	6.57	0.65
FP3	6.68	0.56
OP1	5.79	0.58
OP2	5.86	0.66
OP3	6.07	0.62

Appendix 6: Finalised Questionnaire (English Version)

Examining Supply Chain Quality Management in Chinese Automobile Market

Description:
The information from this survey will be useful to the researcher in studying the supply chain quality management (SCQM) in the Chinese automobile industry. It also aims to compare the different SCQM between Chinese self-owned brands and joint ventures. The information that you provide will not be used to identify individual companies. Please feel comfortable to give responses. It is important to have approximate answers rather than none to all.

Section 1: General Information

Please tick (√) in the appropriate boxes or fill in the blanks.

1.1. What is you role in the company?

☐Quality Manager ☐Supply Chain Manager ☐Others (Please specify_____)

1.2. What is the approximate employee number in your company?

☐1-300 ☐300-1000 ☐1000-5000 ☐Above 5000

1.3. What is the ownership structure of your company?

☐Chinese Private Owned ☐Chinese State Owned ☐ Joint Venture

Section 2: SCQM Practices Related Questions

Please indicate your level of agreement to the following statement by a circle: (1= strongly disagree; 7=strongly agree)								
TMC1	Top managers conduct quality goal evaluation every year to review last year's achievement and set the new quality goal.	1	2	3	4	5	6	7
TMC2	Top managers view quality as being more important than cost.	1	2	3	4	5	6	7
TMC3	Top managers view quality as being more important than meeting production schedules.	1	2	3	4	5	6	7
TMC4	Top managers give priority to quality improvement works when allocating resources.	1	2	3	4	5	6	7
TMC5	Top managers take part in quality meetings regularly in order to support quality improvement programme.	1	2	3	4	5	6	7
TMC6	The achievements of quality goals for each job are considered as important parameter for top managers' performance evaluation.	1	2	3	4	5	6	7
SQP1	Our company has a formal strategic planning process, which results in written strategies for implementation.	1	2	3	4	5	6	7
SQP2	Our company follows a comprehensive and structured planning process that sets and reviews quality goals regularly.	1	2	3	4	5	6	7
SQP3	Our company follows an arbitrary quality planning process.	1	2	3	4	5	6	7

SQP4	Our company closely aligns business practices and missions with quality improvement goals.	1	2	3	4	5	6	7
SQP5	Our company actively incorporates customer expectation and supplier capabilities during quality plans development.	1	2	3	4	5	6	7
EM1	Our employees clearly understand their quality responsibility.	1	2	3	4	5	6	7
EM2	Our company organises employees in teams to focus on quality related work.	1	2	3	4	5	6	7
EM3	The majority of quality problems are solved by team-based quality meeting.	1	2	3	4	5	6	7
EM4	Our company encourages employees to provide suggestions about quality improvement.	1	2	3	4	5	6	7
EM5	Our company evaluates and implements the employees' quality improvement suggestions regularly.	1	2	3	4	5	6	7
EM6	Our company has an effective reward system to encourage employees to devote to quality improvement.	1	2	3	4	5	6	7
PM1	Our employees clearly understand their working procedures and strictly follow the rules during production.	1	2	3	4	5	6	7
PM2	Production processes are designed to be mistake-proof.	1	2	3	4	5	6	7
PM3	The degree of automation in our company is high.	1	2	3	4	5	6	7
PM4	Statistical tools are used for conducting inspection, identifying problems, and correcting mistakes during production.	1	2	3	4	5	6	7
PM5	Our company conducts floor visiting (e.g. 5S) every day to ensure machinery and workplace are kept neat and tidy.	1	2	3	4	5	6	7
T1	Our company provides sufficient resources to support quality training.	1	2	3	4	5	6	7
T2	Our company provides scheduled companywide quality training session.	1	2	3	4	5	6	7
T3	Various quality trainings are provided to employees based on their different roles in company.	1	2	3	4	5	6	7
T4	Our employees find the quality training can help their work.	1	2	3	4	5	6	7
PD1	The cross-functional team is in charge of product design work.	1	2	3	4	5	6	7
PD2	Our product development follows formalised procedures.	1	2	3	4	5	6	7
PD3	New product design is thoroughly reviewed before production.	1	2	3	4	5	6	7
PD4	New product design is not reviewed before production.	1	2	3	4	5	6	7
PD5	The quality of new product emphasises in relation to cost.	1	2	3	4	5	6	7

PD6	The quality of new product emphasises in relation to producibility.	1	2	3	4	5	6	7
PD7	The quality of new product emphasises in relation to schedule.	1	2	3	4	5	6	7
QI1	The 7 quality tools are used to collect and record the timely quality data.	1	2	3	4	5	6	7
QI2	Our company has established quality information system to record, analysis, and share all the quality data throughout company.	1	2	3	4	5	6	7
QI3	The quality data are displayed to all the employees and work stations.	1	2	3	4	5	6	7
QI4	The frequently occurred quality problems and corresponding solutions are displayed in workshop.	1	2	3	4	5	6	7
QI5	The quality data is the determinant of decision making during production.	1	2	3	4	5	6	7
DT1	Our company establishes defect tracking system, which systematically records the supplied components and finished automobiles.	1	2	3	4	5	6	7
DT2	Our company conducts defects tracing process under regulatory guidance.	1	2	3	4	5	6	7
DT3	Our company can trace back the defects to source within the promised time window.	1	2	3	4	5	6	7
SS1	Our suppliers need to obtain quality system certification.	1	2	3	4	5	6	7
SS2	Our company has a thorough supplier selection system.	1	2	3	4	5	6	7
SS3	Our suppliers are selected based on their quality rather than their prices.	1	2	3	4	5	6	7
SS4	Our suppliers are selected based on their quality rather than their delivery schedules.	1	2	3	4	5	6	7
SS5	Our company relies on a small number of strategic suppliers to stabilise supply and quality.	1	2	3	4	5	6	7
SC1	Our company evaluates suppliers' quality performance regularly and formulates improvement measures.	1	2	3	4	5	6	7
SC2	Our company effectively communicates with suppliers through meetings, emails, and social medias.	1	2	3	4	5	6	7
SC3	Our company actively involves suppliers in product design process.	1	2	3	4	5	6	7
SC4	Our company doesn't involve suppliers in product design process.	1	2	3	4	5	6	7
SC5	Our company actively involves suppliers in quality improvement activities.	1	2	3	4	5	6	7
SD1	Our company has consensual quality goals accepted by suppliers.	1	2	3	4	5	6	7
SD2	Our company consolidates relationship with suppliers through long-term contracting.	1	2	3	4	5	6	7
SD3	Our company provides financial support to improve	1	2	3	4	5	6	7

	supplier's quality.							
SD4	Our company provides training or sends professional staffs to help suppliers to improve their quality capability.	1	2	3	4	5	6	7
UF1	Our employees understand the important role of customer in quality programmes.	1	2	3	4	5	6	7
UF2	Our company has a system to collect customer feedback and deal with customer complaints immediately.	1	2	3	4	5	6	7
UF3	Our company recognises customer requirement by the feedback.	1	2	3	4	5	6	7
UF4	Our company conveys the customer feedback to the related employees.	1	2	3	4	5	6	7
CI1	Our company discusses quality issues with customers in time.	1	2	3	4	5	6	7
CI2	Our company doesn't discuss quality issues with customers**.**	1	2	3	4	5	6	7
CI3	Our company communicates with customers through meetings, emails, and social medias.	1	2	3	4	5	6	7
CI4	Our customers are actively involved in our product design processes.	1	2	3	4	5	6	7
CI5	Our customers provide input to the quality improvement processes.	1	2	3	4	5	6	7
CRD1	"Customer focus" philosophy has been widely accepted in our company.	1	2	3	4	5	6	7
CRD2	Our company strives to keep highly responsive to customer complaints.	1	2	3	4	5	6	7
CRD3	Our company holds annual customers conferences to listen to customers' voices for the further quality management improvement.	1	2	3	4	5	6	7

Section3: SCQM Performance

Please indicate your level of agreement to the following statement by a circle: (1= strongly disagree; 7=strongly agree)								
FP1	Our company sales are increasing.	1	2	3	4	5	6	7
FP2	Our company profit is increasing.	1	2	3	4	5	6	7
FP3	The cost of quality in our company is decreasing.	1	2	3	4	5	6	7
OP1	Our company has a high First Time Through of automobiles.	1	2	3	4	5	6	7
OP2	Our company has high inventory turnover of automobiles.	1	2	3	4	5	6	7
OP3	The annual productivity of our company is increasing.	1	2	3	4	5	6	7

Appendix 7: Finalised Questionnaire (Chinese Version)

关于中国汽车产业供应链质量管理的问卷调查

此问卷调查的主要目的是了解中国汽车产业的供应链质量管的相关信并对国产汽车品牌及合资品牌进行对比研究。您所提供的资料只会用作我们的研究。如果您对某些问题不能做出完全肯定的回答，请尝试选出最接近的答案。

第一部分：基本信息

请在合适的选项内打 (√)或在空白处填写相关信息.

1.1.您在公司是什么职位？

☐质量部经理 ☐供应链部经理 ☐其他 (_请说明：_____)

1.2.贵公司大概有多少全职员工？

☐1-300 ☐300-1000 ☐1000-5000 ☐ 5000+

1.3.贵公司属于以下哪一类型?

☐民营企业 ☐国有企业 ☐ 合资企业

第二部分：供应链质量管理的相关问题

请圈出您对以下描述的同意程度 (1= 非常不认同; 7=非常认同)								
TMC1	公司管理层每年进行管理评审，并回顾去年的质量目标的完成情况，确定公司的年度质量目标。	1	2	3	4	5	6	7
TMC2	相对于成本，管理层更重视质量。	1	2	3	4	5	6	7
TMC3	相对于生产计划，管理层更重视质量。	1	2	3	4	5	6	7
TMC4	管理层优先为质量改进和质量管理工作提供资源和支持。	1	2	3	4	5	6	7
TMC5	公司的高层定时参加公司的质量会议，并给与质量部门足够的支持。	1	2	3	4	5	6	7
TMC6	各个岗位的质量目标及完成程度纳入管理人员的业绩考核 。	1	2	3	4	5	6	7
SQP1	公司有规范的质量策划程序，并依据程序制定公司的质量战略。	1	2	3	4	5	6	7
SQP2	公司会按照规范的程序定期制定并回顾质量目标。	1	2	3	4	5	6	7
SQP3	**公司随意的制定质量目标。（逆向陈述）**	1	2	3	4	5	6	7
SQP4	公司会把质量提升工作的目标和商务目标紧密结合。	1	2	3	4	5	6	7
SQP5	公司在制定质量计划时会考虑供应商的能力及客户的期望。	1	2	3	4	5	6	7
EM1	公司的员工清楚地理解他们应承担的质量责任。	1	2	3	4	5	6	7
EM2	公司把员工分为作业团队或小组来进行质量相关的工作。	1	2	3	4	5	6	7
EM3	绝大部分的质量问题是由作业团队或小组解决	1	2	3	4	5	6	7

	的。							
EM4	公司鼓励员工提出质量改进建议。	1	2	3	4	5	6	7
EM5	公司定期评估并落实员工所提出的质量改进建议。	1	2	3	4	5	6	7
EM6	公司实施有效的奖励措施从而鼓励员工投入到质量升工作。	1	2	3	4	5	6	7
PM1	公司的员工清楚地了解其所涉及的生产工序的要求并按要求操作。	1	2	3	4	5	6	7
PM2	公司运用防错法设计生产流程。	1	2	3	4	5	6	7
PM3	公司的生产线自动化程度很高。	1	2	3	4	5	6	7
PM4	在生产时，公司运用统计工具来检查、发现、并解决质量问题。	1	2	3	4	5	6	7
PM5	公司每天检查车间 （例如：5S 管理）以确保机器及工作场所的干净和整洁。	1	2	3	4	5	6	7
T1	公司提供充足的资源来支持质量培训。	1	2	3	4	5	6	7
T2	公司提供面向全公司的定期质量培训。	1	2	3	4	5	6	7
T3	公司根据员工的工作岗位为其提供相对应的质量培训。	1	2	3	4	5	6	7
T4	公司的员工认可质量培训对工作的帮助。	1	2	3	4	5	6	7
PD1	公司组建跨职能团队来负责产品开发的工作。	1	2	3	4	5	6	7
PD2	公司的产品开发工作遵循正式的开发步骤。	1	2	3	4	5	6	7
PD3	公司会在投产前会彻底的审查新产品的开发设计。	1	2	3	4	5	6	7
PD4	**公司在投产前不会审查新产品的开发设计。（逆向陈述）**	1	2	3	4	5	6	7
PD5	公司新产品的质量策划与成本密切相关。	1	2	3	4	5	6	7
PD6	公司新产品的质量策划与可生产性密切相关。	1	2	3	4	5	6	7
PD7	公司新产品的质量策划与生产计划密切相关。	1	2	3	4	5	6	7
QI1	公司运用 7 种质量工具来收集和记录质量信息。	1	2	3	4	5	6	7
QI2	公司搭建了质量信息平台来记录、分析、以及分享全公司的质量信息。	1	2	3	4	5	6	7
QI3	公司向所有员工及各个工位通报质量信息。	1	2	3	4	5	6	7
QI4	公司在车间设立目视看板来展示经常发生的质量问题及解决方案。	1	2	3	4	5	6	7
QI5	公司把质量信息当做 生产决策的决定性因素。	1	2	3	4	5	6	7
DT1	公司建立了可以系统的记录供应元件及整车质量信息的缺陷追踪系统。	1	2	3	4	5	6	7
DT2	公司按照严格的管制条例追踪缺陷产品。	1	2	3	4	5	6	7
DT3	公司可以在规定的时间范围内追踪到缺陷产品的源头。	1	2	3	4	5	6	7
SS1	公司的供应商都获得了质量体系认证。	1	2	3	4	5	6	7
SS2	公司建立了完整的供应商选择体系。	1	2	3	4	5	6	7
SS3	相对于配件价格，公司在选择供应商时更重视供	1	2	3	4	5	6	7

	应商的质量表现。							
SS4	相对于配件交付日程，公司在选择供应商时更重视供应商的质量。	1	2	3	4	5	6	7
SS5	公司依靠少量的战略合作供应商来稳定供给。	1	2	3	4	5	6	7
SC1	公司定期对供应商的质量进行评估，并制定改进措施。	1	2	3	4	5	6	7
SC2	公司通过面对面会议、电子邮件、以及社交媒体与供应商进行切实有效的交流。	1	2	3	4	5	6	7
SC3	公司积极地邀请供应商参与新产品的开发设计。	1	2	3	4	5	6	7
SC4	**公司从不邀请供应商参与新产品开发设计。（逆向陈述）**	1	2	3	4	5	6	7
SC5	公司积极地邀请供应商参与我们的质量提升工作。	1	2	3	4	5	6	7
SD1	公司与供应商共同设立了一个双方同意的质量目标。	1	2	3	4	5	6	7
SD2	公司通过与供应商签订长期合作协议来巩固我们与供应商的关系。	1	2	3	4	5	6	7
SD3	公司为提高供应商的质量能力提供资金支持。	1	2	3	4	5	6	7
SD4	公司会派遣具备充足质量知识的专业人士为增强供应商的质量能力提供帮助。	1	2	3	4	5	6	7
UF1	公司的员工清楚地理解客户在质量工作中的重要性。	1	2	3	4	5	6	7
UF2	公司建立了全方位的客户反馈收集系统并及时处理客户投诉，实施改进行动。	1	2	3	4	5	6	7
UF3	公司根据客户反馈来了解客户需求。	1	2	3	4	5	6	7
UF4	公司会在规定时间内把客户反馈传达给相应的部门及员工。	1	2	3	4	5	6	7
CI1	公司及时的与客户沟通质量管理的要求。	1	2	3	4	5	6	7
CI2	公司从不与客户探讨质量相关的问题。（逆向陈述）	1	2	3	4	5	6	7
CI3	公司通过面对面会议、电子邮件、以及社交媒体与客户进行切实有效的交流。	1	2	3	4	5	6	7
CI4	公司积极地邀请客户参与新产品的开发设计。	1	2	3	4	5	6	7
CI5	公司积极地邀请客户参与我们的质量提升工作。	1	2	3	4	5	6	7
CRD1	“客户焦点”理念在我们公司已被广泛的认可和接受。	1	2	3	4	5	6	7
CRD2	公司竭尽全力的对客户反馈做出快速有效的回应。	1	2	3	4	5	6	7
CRD3	公司每年进行客户满意度调查，聆听客户的要求，为管理评审提供证据。	1	2	3	4	5	6	7

第三部分：供应链质量管理绩效

请圈出您对以下描述的同意程度 (1= 非常不认同; 7=非常认同)								
FP1	公司的销售额正在提升。	1	2	3	4	5	6	7
FP2	公司的利润正在提升。	1	2	3	4	5	6	7
FP3	公司的质量成本正在下降。	1	2	3	4	5	6	7
OP1	公司车辆的首次通过率很高。	1	2	3	4	5	6	7
OP2	公司的整车库存周转率很高。	1	2	3	4	5	6	7
OP3	公司年产量正在提升。	1	2	3	4	5	6	7
OP4	公司车辆产品的顾客满意度很高	1	2	3	4	5	6	7

Appendix 8: Out loadings and VIF

Measurements with * were deleted after measurement model analysis.

The Constructs and Measurements for Companywide QM

Construct	Measurement Items	Out Loading	VIF
Top Management Commitment7	TMC1*: Our company has clear quality goals, which are identified by top managers.	**0.236**	**3.536**
	TMC2: Top managers view quality as being more important than cost.	0.848	2.778
	TMC3: Top managers view quality as being more important than meeting production schedules.	0.858	3.366
	TMC4: Top managers allocate adequate resources to improve quality.	0.747	2.050
	TMC5: Considerable quality issues are reviewed in top managers' meetings.	0.795	2.708
	TMC6: Top managers' promotion and salary closely associate with their performances in quality programs.	0.757	2.541
Strategic Quality Planning	SQP1*: Our company has a formal strategic planning process, which results in written strategies for implementation.	**0.312**	**4.235**
	SQP2: Our company follows a comprehensive and structured planning process that sets and reviews quality goals regularly.	0.848	4.371
	SQP3: Our company follows an arbitrary quality planning process.	0.833	3.893
	SQP4: Our company closely aligns business practices and missions with quality improvement goals.	0.837	3.384
	SQP5: Our company actively incorporates customer expectation and supplier capabilities during quality plans development.	0.784	2.225
Employee Management	EM1*: Our employees clearly understand their quality responsibility.	**0.211**	**2.568**
	EM2: Our company organises employees in teams, e.g. quality control circle.	0.728	2.906
	EM3: The majority of quality problems are solved by team-based quality meeting.	0.743	2.874
	EM4*: Our company encourages employees to provide suggestions about quality improvement.	**0.362**	**2.673**

	EM5: Our company evaluates and implements the employees' quality improvement suggestions every month.	0.815	3.078
	EM6: Our company has an effective reward system to encourage employees to devote to quality improvement.	0.796	2.926
Process Management	PM1: Our employees clearly understand their working procedures.	0.837	3.028
	PM2: Production processes are designed to be mistake-proof.	0.745	3.609
	PM3: The degree of automation in our company is high.	0.776	2.845
	PM4: Statistical Process Control tools are used for conducting inspection, identifying problems, and correcting mistakes during production.	0.829	3.384
	PM5: Our machinery and workplace are kept neat and tidy.	0.758	2.718
Training	T1: Our company provides sufficient resources to support quality training.	0.941	7.624
	T2: Our company provides scheduled companywide quality training session.	0.841	3.143
	T3: Various quality trainings are provided to employees based on their different roles in company.	0.910	4.870
	T4: Our employees find the quality training can help their work.	0.938	7.956
Product Development	PD1: The cross-functional team is in charge of product design work.	0.744	2.563
	PD2: Our product development follows formalised procedures.	0.683	3.276
	PD3: New product design is thoroughly reviewed before production.	0.605	2.847
	PD4*: New product design is not reviewed before production.	**0.253**	**3.236**
	PD5: New product development emphasises cost.	0.677	2.810
	PD6: New product development emphasises quality.	0.772	5.271
	PD7: New product development emphasises producibility.	0.808	6.866
Quality Information	QI1: The 7 quality tools are used to collect and record the timely quality data.	0.875	4.532
	QI2: Our company has established quality information system to record, analysis, and share all the quality data throughout company.	0.932	5.958
	QI3: The quality data are displayed to all the employees and work stations.	0.925	5.568
	QI4*: The frequently occurred quality problems	**0.124**	**4.325**

	and corresponding solutions are displayed in workshop.		
	QI5: The quality data is the determinant of decision making during production.	0.736	3.090
Defect Tracking	DT1: Our company establishes defect tracking system, which systematically records the supplied components and finished automobiles.	0.756	4.268
	DT2: Our company conducts defects tracing process under regulatory guidance.	0.859	3.247
	DT3: Our company can trace back the defects to source in stipulated time.	0.842	3.343

The Constructs and Measurements for Supplier Side SCQM

Construct	Measurement Items	Out Loading	VIF
Supplier Selection	SS1: Our suppliers are certified or qualified.	0.892	3.229
	SS2: Our company has thorough supplier selecting system.	0.686	1.685
	SS3: Our suppliers are selected based on their quality rather than their prices.	0.909	5.110
	SS4: Our suppliers are selected based on their quality rather than their delivery schedules.	0.840	3.668
	SS5: Our company relies on a small number of strategic suppliers.	0.807	1.928
Supplier Cooperation	SC1: Our company communicates with suppliers about quality considerations at least one time per week.	0.915	4.175
	SC2: Our company effectively communicates with suppliers through meeting, email, and social software.	0.885	3.396
	SC3: Our company actively involves suppliers in product design process.	0.934	7.822
	SC4: Our company doesn't involve suppliers in product design process.	0.912	6.573
	SC5: Our company actively involves suppliers in quality improvement activities.	0.933	5.518
Supplier Development	SD1: Our company has consensual quality goals accepted by suppliers.	0.802	1.855
	SD2: Our company consolidates relationship with suppliers through long-term contracting.	0.756	1.752
	SD3: Our company provides financial support to improve supplier's quality.	0.836	2.347
	SD4: Our company provides training or sends professional staffs to help suppliers to improve their quality capability.	0.871	2.600

The Constructs and Measurements for Customer Side SCQM

Construct	Measurement Items	Out Loading	VIF
Use of Feedback	UF1: Our employees understand the important role of customer in quality programs.	0.744	1.573
	UF2: Our company has a system to collect customer feedback.	0.916	4.984
	UF3: Our company determines customer requirement by the feedback.	0.906	3.286
	UF4: Our company conveys the customer feedback to the related employees.	0.942	6.226
Customer Involvement	CI1: Our company discusses quality issues with customers at least one time per week.	0.850	3.671
	CI2: Our company doesn't discuss quality issues with customers.	0.781	2.996
	CI3: Our company communicates with customers through meeting, email, and social software.	0.820	2.305
	CI4: Our customers are actively involved in our product design processes.	0.853	4.277
	CI5: Our customers provide input to the quality improvement processes.	0.832	4.215
Customer Relationship Development	CRD1: "Customer focus" philosophy has been widely accepted in our company.	0.840	1.364
	CRD2: Our company strives to keep highly responsive to customer complaints.	0.658	1.229
	CRD3: Our company holds annual customers conferences to listen to customers' voices.	0.705	1.141

The Constructs and Measurements for Financial Performance

Construct	Measurement Items	VIF
Sales	FP1: Our company sales are increasing.	3.386
Profit	FP2: Our company profit is increasing.	4.815
Cost	FP3: The cost of quality in our company is decreasing.	3.086

The Constructs and Measurements for Operational Performance

Construct	Measurement Items	VIF
Quality	OP1: Our company has a high First Time Through.	3.367
Responsiveness	OP2: Our company has high inventory turnover of automobiles.	2.576
Efficiency	OP3: The annual productivity of our company is increasing.	2.314

Appendix 9: Fornell-Larcker Criterion

CI: Customer Involvement; CRD: Customer Relationship Development; DT: Defect Tracking; EM: Employee Management; PM: Process Management; PD: Product Development; QI: Quality Information; SQP: Strategic Quality Planning; SC: Supplier Cooperation; SD: Supplier Development; SS: Supplier Selection; TMC: Top Management Commitment; T: Training; UF: Use of Feedback.

	CI	CRD	DT	EM	PM	PD	QI	SQP	SC	SD	SS	TMC	T	UF
CI	0.828													
CRD	0.469	0.738												
DT	0.555	0.559	0.821											
EM	0.478	0.342	0.576	0.772										
PM	0.498	0.524	0.624	0.459	0.790									
PD	0.498	0.438	0.619	0.508	0.604	0.718								
QI	0.676	0.435	0.665	0.499	0.595	0.535	0.871							
SQP	0.468	0.400	0.542	0.488	0.496	0.549	0.495	0.826						
SC	0.602	0.421	0.631	0.565	0.471	0.541	0.682	0.500	0.916					
SD	0.607	0.469	0.625	0.464	0.572	0.486	0.638	0.478	0.701	0.818				
SS	0.565	0.373	0.629	0.595	0.486	0.517	0.709	0.533	0.639	0.638	0.831			
TMC	0.373	0.228	0.409	0.425	0.283	0.343	0.398	0.316	0.511	0.396	0.456	0.802		
T	0.625	0.444	0.612	0.434	0.604	0.545	0.698	0.456	0.704	0.637	0.624	0.440	0.908	
UF	0.666	0.435	0.595	0.423	0.492	0.437	0.603	0.373	0.567	0.623	0.685	0.354	0.627	0.880